A SYSTEMS APPROACH TO SIMULATED ALTERNATIVES FOR COMMERCIAL DRIVERS LICENSING

Talleah L. Allen, Ronald W. Tarr
University of Central Florida Institute for Simulation and Training
Orlando, Florida
tallen@ist.ucf.edu, rtarr@ist.ucf.edu

John White, Scott Tanner
University of Central Florida Institute for Simulation and Training
Orlando, Florida
jwhite@ist.ucf.edu, stanner@ist.ucf.edu

ABSTRACT

Background

This paper describes the systems approach we used to develop and validate a virtual diagnostic and training solution for the ground transportation community, specifically those who hold a Commercial Drivers License (CDL). The training system integration includes a computer-based knowledge test, virtual mechanical compliance walk-around inspection, and simulator-based driving skills tests. Using a systems approach, we designed the *Virtual Check Ride System (*VCRS) to be a cost-effective, time-saving alternative to standard CDL testing and training.

ADDIE Model

Using the ADDIE (analysis, design, develop, implement, and evaluate) Instructional Design Model, we created a blended interactive multimedia intervention. Participant characteristics included commercial truck-driving students and *expert* drivers. *Expert* drivers were classified as drivers who have been driving commercial vehicles for more than three years and those with less than three years are classified as *novice*.

During the analysis phase, the Federal Department of Transportation (FDOT), Florida and Michigan State DOT, and Subject Matter Experts (SMEs) from various truck driving schools were consulted to determine federal, state and corporate CDL knowledge and driving skills requirements and challenges. Various technologies, including driving simulators, were analyzed to determine what level of simulation technology worked best with this type of blended intervention. It was during this phase that we realized the ADDIE Model would not work on a *performance and technology-based* design effort.

A Diagnostic and Training Tool

Based on the analysis, a bank of 500 knowledge test questions were developed and internally validated by Subject Matter Experts (SME). The design phase began with a Computer Based Training (CBT) module, which generates a dynamic After-Action-Review (AAR). The CBT, AAR, and simulated driving scenarios (Off-Road, Rural, Urban, Freeway and City) were assessed by SMEs to measure driving performance, driving skill levels, and critical thinking skills. Implementation, evaluation and validation are currently in progress.

The validation scores collected thus far suggest that the Virtual Check Ride is a fair assessment of the CDL and may be a cost and time benefit if incorporated into the training and re-certification procedures of organizations.

ABOUT THE AUTHORS

Talleah L. Allen, M.A. and M.S. Instructional Designer and Multimedia Development Specialist. Currently working as an Instructional Designer Research Associate for the University of Central Florida (UCF) Institute for Simulation and Training (IST), Ms. Allen participated in the analysis, design, development, implementation, programming, and evaluation of CBT, ICW, OJT, CAI, EPS, DL, and Web-based training systems. Most recent effort is her participation in the evaluation and validation of "Virtual Check Ride," a simulated Commercial Drivers License (CDL) training system using the stationary GE I Sim Mark II simulator, the mobile FAAC simulator and CBT testing elements.

Additionally, this effort includes: designing, developing and programming CDL testing scenarios for the mobile FAAC simulator. Other qualifications: Senior Instructional Designer Specialist for Marine Corps MTVR vehicle computer assisted instruction (CAI), (ICW) courseware, CBT for Instructor/Student Operating Stations, and Job Sheet work orders for simulator trainers. Modeling and Simulation Staff Officer Certified. Ms. Allen holds an M.A. degree in Instructional Technology/Media: Instructional Systems Design and an M.S. degree in Open and Distance Learning. Ms Allen may be contacted at tallen@ist.ucf.edu.

Ronald W. Tarr, M.A. Ronald W. Tarr is a senior research faculty member at the University of Central Florida and Program Manager of Advanced Performance Technologies at the Institute for Simulation and Training (IST). Mr. Tarr leads a team of inter-disciplinary researchers who function as analysts, planners, integrators and designers of the advanced applications of Simulation & Learning Technologies for the purpose of enhancing human performance. He has conducted research and workshops on distributed simulations and learning technology applications across the full spectrum of government, industry and academia. The primary focus of Ron's efforts has been on applied research of current technologies (including information, simulation and learning technologies). His most recent projects include advanced applications for the DOD Advanced Distributed Learning Initiative, high tech Web-based training for NASA engineers, non-traditional education for Forensic Scientists, research into the utility of COTS PC-based video games for support of military training, redesign of a systems model for workforce education and most recently in the world of Intelligent Transportation and enhancing driver performance through simulation and learning technology. Mr. Tarr is a retired Army officer who served for 22 years in a variety of command and staff positions, always in high tech units where human performance was critical. He may be reached via electronic mail at rtarr@ist.ucf.edu.

John M. White, **M.S**. Industrial Organizational Psychology with strong emphasis in Human Factors. Currently working as a Human Factors Research Associate for the University of Central Florida (UCF) Institute for Simulation and Training (IST), Mr. White is working on human-factors issues, including human performance efficiency, health and safety issues, and the social impact of the technology. Most current focus is his participation in the evaluation and validation of "Virtual Check Ride System," a simulated Commercial Drivers License (CDL) training system using GE's I Sim Mark II simulator, the mobile FAAC simulator and CBT testing elements. The main role is to ensure that the interaction between the participant and the machine does not result in adverse outcomes, as well as to ensure that human aspects are incorporated into the design and development of the simulation and CBT portions. Mr. White holds a B.S. degree in Psychology and an M.S. degree in Industrial Organizational Psychology. Mr. White may be contacted at jwhite@ist.ucf.edu.

Scott A. Tanner, M.A. Instructional Designer, UCF Institute for Simulation and Training. Mr. Tanner has participated in the analysis, design, development, implementation, and evaluation of paper, computer, and Web-based training systems. Most recent is his effort in designing and developing the Prime Skills System, a performance improvement system used to enhance and certify the fundamental soft skills of high school students pursuing a career in the IT industry. Additional projects include completing a NASA and Florida Space Research Institute sponsored Web-based training course on cryogenic engineering and a NAVAIR, Orlando Web-based training course on civilian supervisory training. The NAVAIR, Orlando effort consisted of designing the course to comply with the Advanced Distributed Learning (ADL) guidelines and Sharable Content Object Reference Model (SCORM). Mr. Tanner holds a masters degree in instructional systems design, and holds additional degrees in psychology with a minor in communication. He may be contacted via electronic mail at stanner@ist.ucf.edu.

Christopher C. Streb, B.S. Project Specialist, UCF Institute of Simulation and Training. Mr. Streb has been actively engaged in research and development of Low Cost Personal Computer Simulation Solutions (LCPCSS). Most recently his efforts have been directed towards evaluations of off-the-shelf Personal Computer Simulation software for use as training aides as a part of a mixed-reality training program. Mr. Streb has also assisted in development of a virtual Commercial Drivers License (CDL) examination labeled the Virtual Check Ride System (VCRS). This effort was sponsored through the Center for Advanced Transportation Systems Simulation, The Institute for Simulation and Training, and the Florida Department of Transportation (FDOT). Additional research interests include Knowledge Management System (KMS) data architecture, SCORM, and SCO repository design. Mr. Streb holds Bachelor of Science Degrees in Economics and Management of Information Systems from the University of Central Florida. He may be contacted via electronic mail at sstreb@ist.ucf.edu.

A SYSTEMS APPROACH TO SIMULATED ALTERNATIVES FOR COMMERCIAL DRIVERS LICENSING

Talleah L. Allen, Ronald W. Tarr
University of Central Florida Institute for Simulation and Training
Orlando, Florida
tallen@ist.ucf.edu. rtarr@ist.ucf.edu

John White, Scott Tanner
University of Central Florida Institute for Simulation and Training
Orlando, Florida
iwhite@ist.ucf.edu. stanner@ist.ucf.edu

INTRODUCTION

"The Florida Department of Transportation (FDOT) and the U.S. Department of Transportation (US DOT) have identified safety and operator performance as major objectives in addressing the inter-modal transportation needs of the state and nation. The Florida Department of Highway Safety and Motor Vehicles is working diligently to address the issue of safety on Florida's roads by developing and enforcing standards and certification of Commercial Driver License (CDL) training and issuance, as well as continual monitoring via enforcement. The Florida Trucking Association (FTA), representing the commercial industry side of the community, is likewise very concerned and is also taking steps to deal with these challenges. Clearly the issue of safety and the proper training of persons who will be operating a heavy truck is of great concern to all of us in the community. Driver training, safety, security, performance enhancements and accident reduction are priority issues in the truck driving industry. With this emphasis and the increase in highway safety compromised by fraudulent or unskilled CDL licensed drivers, a proposed Virtual Check Ride was created …" (Allen, Tarr, 2003.)

Currently the Commercial Drivers License (CDL) exam, in all states, consists of either a pencil and paper or Computer-Based-Training (CBT) Basic Truck Driving Knowledge test, a Walk-Around Pre-Trip tractor and trailer inspection test, and an On-Road Driving Skills test. The knowledge test and the pre-trip test often are conducted by a third party examiner either at a driving training school or by a consultant.

In response to the need for a cost-effective performance-based re-certification and possible alternative to full, live CDL tests, an interactive multimedia, consisting of blended systems intervention was created and validated. The CDL simulated system, or "*Virtual Check Ride System*," (VCRS). VCRS consists of CBT elements measuring truck driving basic knowledge and vehicle inspection skills as well as the utilization of Part Task Truck Driving Simulators used to measure driving performance and critical thinking and response skills.

This paper will describe the VCRS development**,** how it was designed using a performance-design model rather than using the standard ADDIE model as previously planned, the *four phases* of the VCRS validation, and what *we see* as its potential for the future of driver training and testing. An additional discussion of identified design changes from non-systems to systems design, centered around performance is discussed (Figure 1). We will talk briefly about gaming and how it influenced the VCRS validation and transfer of learning, instructional technology and tools used, Kirkpatrick's Four Levels of Evaluation as applied during this validation, and human factors considerations. The remainder of the paper will provide a detailed report on the validation study, which will include over 500 driver/subjects, 5 separate companies, assessing both experienced driver (*expert)* and trainees (*novice)*, on at least 2 different types of simulators.

We will also discuss the positive and negative outcomes of the validation and additional Educational Research and Development (R&D) opportunities such as how CBT modules and driving scenarios could be used to teach truck drivers how to identify potential terrorist attacks using commercial vehicles and a Train the Safety Examiner system that currently is in development stages.

Participants

Participants included the University of Central Florida's Center for Advanced Transportation System Simulation (CATSS) in conjunction with sponsors/co-partners University of Central Florida's

Institute for Simulation and Training (IST), Florida Trucking Association (FTA), Florida Highway Patrol (FHP), Roadmaster Truck Drivers School representatives, University of South Carolina Continuing Education, Orange County Sheriff's Department, Frito Lay, American Trucking Research Institute, Schenck Distributors, and CCC Trucking.

A special thanks to Chris Streb, a co-worker and gaming expert from IST, and Doug Johnson, a certified CDL examiner from Roadmaster Truck Drivers School, for all their help during the validation of the VCRS.

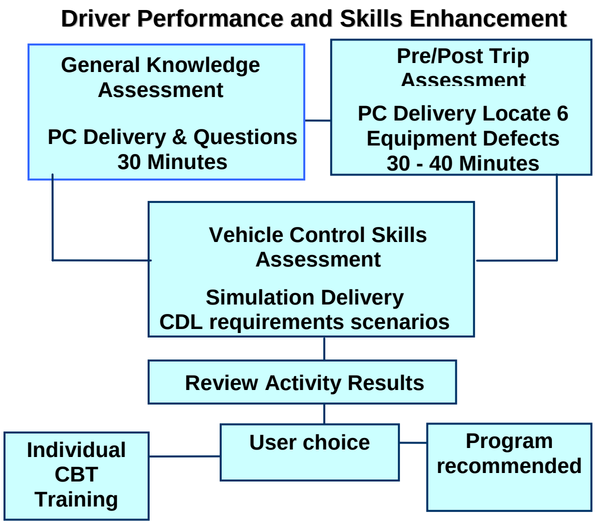

Figure 1. VCRS Functional Design

THE FOUR PHASES OF THE VCRS

The design goal for the VCRS was to produce a virtual assessment tool that mirrored the functions of the current CDL test, but did it more efficiently, more objectively and with minimal examiner involvement. This resulted in a four phase assessment, three that matched the CDL plus a fourth which provided a formal review of results.

Phase I

Knowledge Test: 55 randomly selected test items taken from a bank of 500 questions on general CDL knowledge and vehicle specific knowledge. Criteria: 80% correct.

Phase II

Pre-Trip Inspection: a virtual walk-around inspection of the seven major inspection areas includes critical vehicle inspection components. Embedded faulty components verify if subjects know how to identify faulty equipment/components. Criteria: 80% correct.

Phase III

Simulation Ride: either mobile non-motion or stationary full motion simulator ride using the same driving scenarios demonstrating basic driving skills on an Off Road and On Road Test. Criteria: 80% driving accuracy on each portion.

Phase IV

One After Action Review: upon completion of the CBT portion of the Check Ride and a second one after completion of the simulation ride.

VCRS DESIGN

The traditional instructional design or ADDIE model has been modified somewhat for our purposes, updating it to be more of a performance technology model, which looks outside of traditional instruction for alternative interventions (Figure 2). Although the ADDIE model is not focused strictly toward traditional instruction, that has been the primary application. It looks at training as the natural outcome, while we have really shifted the focus to human performance as the natural outcome.

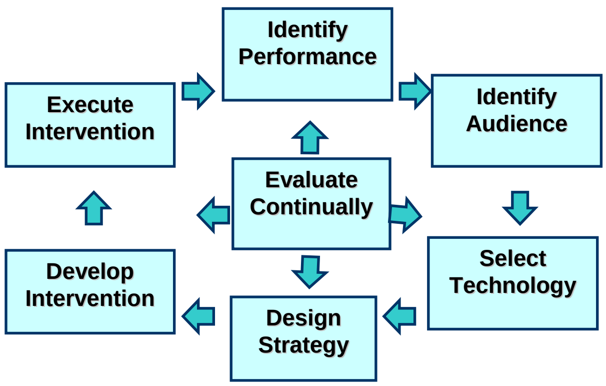

Figure 2. Advanced Performance Technology Model

The application begins with documentation of the *performance* required, either based on a gap in required performance or a new or additional requirement. It ends with the sponsoring agency specifying the measures of success for the outcome performance. This forms the basis of the specification that will be used throughout the process as the criteria for success and design.

The next critical step is careful identification of the performers or the *audience* for the intervention. As our research has historically been for adults, this step is very critical, as adults must be treated differently from children (Knowles, 1970), and the options for intervention are much more robust for adults. Adults like to be treated as individuals and are very concerned about the relevance of any intervention.

Only after these two critical elements of information are defined, did we consider the issues of what *technology* might be useful. For our purposes, technology is used in the broadest sense of the word, including techniques and methodology as forms of technology. Job aids and technical documentation are often used as part of the intervention as well as high end Web-based learning and state-of-the-art simulations.

Once the candidate technologies are selected, the *design* begins; rarely is this design not a blend of several technologies. This is to properly match the technology with the requirements as well as to ensure a cost-effective solution. For instance, streaming video may be a good way to achieve an outcome, but high-quality still pictures with animated arrows might be as effective and much cheaper to develop. One is "eye candy" while the other is practical.

Development is pretty straight-forward, using highly qualified artists, programmers, etc., with the addition of careful management to ensure that the development is following the design and staying focused on the audience and performance requirements. This is the time when the technology can take over, as developers become caught up in the media and can lose sight of the objectives. Validation and verification techniques are used to keep things on track.

Execution of the intervention is usually done through a series of pilot or beta tests, using representatives from the audience with oversight by SMEs from the sponsoring agencies. Success is measured by the original set of specifications, to ensure the outcomes are met and the system is both effective and efficient.

The continuous monitoring of the processes within the system, measured against the documented performance specifications, is the power and the guarantee that the system will meet the needs of the sponsor while remaining cost-effective.

Design Changes

Once the design model changed to a performance model, it was determined that the initial data collection methods would need to be changed as well. Initially, data were to be collected on four groups. Group 1 was to be *novice* who would complete the VCRS prior to completion of their CDL exams. We discovered that using this process, the *novice* used the VCRS to build on their knowledge and understanding of the CDL exam items. In other words, the system became a training tool. Time to complete the process averaged three or more hours depending on individual reading and comprehension skills. We made the decision to have the *novice* Group 1 complete VCRS after they finished their formal classroom training. By making this design change, the VCRS became a diagnostic tool. Group 2 and Group 1 now received the same treatment for the validation. Time to complete the process was reduced to an average of two hours.

Another change was made with Group 3 and Group 4 *expert* participants. Using the Advanced Performance Technology (APT) Model we rapidly discovered that there was no real difference between the groups so we combined them into a new Group 2 and labeled the group as *experts*. Each received the VCRS but most were not taking a CDL re-certification exam within the realm of this validation effort. Although seemingly no real measurement was being taken, we discovered the VCRS now was functioning as a diagnostic tool for all groups. Some participants felt the system would be an excellent tool for pre-hires while others felt the system helped them realize they were weak in certain areas and used the tool for remediation. Time to complete the process averaged two to two and a half hours.

Although the initial validation design was changed, data collected through the AAR from the CBT along with the Check Ride statistics on a simulator still provided enough information to indicate the system was valid. More about this topic is discussed in the Human Factors and Validation Outcome sections of this paper.

KIRKPATRICK'S FOUR LEVELS OF EVALUATION APPLIED

One important variable that had to be considered during the initial design of the VCRS was the ability to make the system emulate the real world experience. Using a Kirkpatrick's scale from 1-5 in a pre and post questionnaire, we were able to determine satisfaction levels, learning transfer, driving behaviors and provide an accurate measured results output though the AAR.

USING GAMING IN THE VCRS VALIDATION

A systems approach often includes using various technologies and methods to achieve the final performance outcome. In our case we considered including gaming in our validation of the VCRS as the lowest simulation type, below the PC-Based simulator. Commercial titles, available for purchase for under $50 each, could be used to teach cognitive skills. We considered Commercial Hauling utilizing the game "Rebel Trucker©" by 3 Romans Software to assist inexperienced drivers with such concepts as trailer location and spatial considerations. This would add another facet to our validation but time constraints prohibited us from including gaming in the data collection process.

The primary attractiveness of the PC-based solution is the cost. If we assume that the training organization already has personal computers in place for other purposes, then the additional cost of buying the software off the shelf would be minimal. The problem -- the software could not be modified therefore it couldn't be standardize to the validation standards.

Gaming and PC-based solutions are not as powerful as dedicated simulators. The trade-off is the cost and the reduced power of the simulator. The Desk top PC simulator is not as immersive as the TransSim, FAAC, or Mark II full motion Cab, nor is it anywhere near as expensive. Although the PC simulator was not used for data collection in this validation, it played a key role in design and development. We believe the PC can be used in a stepped program moving from gaming or PC based simulations to other more robust and realistic simulators.

DETAILED VALIDATION DISCUSSION

Roadmaster Truck Drivers School, one of the participating agencies, provided data on 20 *novice* drivers. The drivers participated in the VCRS validation research study after they completed their course work and their CDL exam prior to graduation. This ensured that the system was used for validation and not training or diagnostics. Of the 20 drivers, 15 completed the CDL simulator portion which means 5 dropped out either due to claimed simulator sickness or other personal reasons. Of the 15 that completed the simulator check ride, all passed the driving simulation scenarios. The scoring system used in this validation is the same as third party examiners use. The scoring system is as follows: A score of -15 checks or more is considered failing on the basic skills test, a score of -26 or more is considered failing on the road test and a score of 79% or less is considered failing on the pre-trip inspection. All the *novice* drivers passed the basic skills test, the road test, and the pre-trip inspection.

The scores were compared to the actual scores the participants received on their basic skills, road test, and pre-trip inspection.

Table 1. Correlation Between Actual Roadmaster Off Road Scores and VCRS Scenario Scores

Correlations

		CDL 2 Off Road Total - Sim	RoadMaster Basic Skills Test
CDL 2 Off Road Total - Sim	Pearson Correlation	1.000	.961**
	Sig. (2-tailed)	.	.000
	N	16	13
RoadMaster Basic Skills Test	Pearson Correlation	.961**	1.000
	Sig. (2-tailed)	.000	.
	N	13	14

**. Correlation is significant at the 0.01 level (2-tailed).

A t-test was used to compare the scores. A comparison revealed a high correlation between the actual scores and the scores from the CDL validation effort. For the basic skills test, the scores were highly correlated. With an alpha level of .01, the strength of relatedness is high at .961. This suggests that our driving scenarios are a good representation of the actual CDL road test. Furthermore, a t-test was used to show the correlation between the actual CDL road test scores, and the VCRS road test scores. These scores were also highly correlated with an alpha level of .01, the strength of relatedness is high at .719.

Table 2. Correlation Between Actual Roadmaster On Road Scores and VCRS Scenario Scores

Correlations

		CDL On-Road Totals - Sim	Actual Score on Road Test - RM
CDL On-Road Totals - Sim	Pearson Correlation	1.000	.719**
	Sig. (2-tailed)	.	.006
	N	15	13
Actual Score on Road Test - RM	Pearson Correlation	.719**	1.000
	Sig. (2-tailed)	.006	.
	N	13	15

**. Correlation is significant at the 0.01 level (2-tailed).

The correlations demonstrate that the VCRS road test scenarios are representative of the actual CDL road test. For the pre-trip inspection, subjects had to receive a score of 80% or better to pass. With 80% being the cut off for passing the pre-trip walk around inspection, 19/20 passed the CBT Virtual Walk-Around Inspection, while all passed Roadmaster's actual CDL pre-trip inspection. This too suggests that the CBT Virtual Walk-Around Inspection is a good representation of the actual pre-trip inspection used by CDL examiners.

The *expert* subjects were recruited from Frito Lay. Drivers were determined to be expert drivers based on a minimum of three years driving experience although the average for the Frito Lay group was fourteen years driving experience. Out of a sample of 68 expert participants, there are some interesting results to report. A total of 50 subjects completed the CDL simulator portion of the validation, meaning that 18 dropped out of this phase either due to simulator sickness or other personal reasons. Of the 50 who completed the simulator phase, 47 passed the CDL simulator phase of the system based on the standardized scoring criteria used by third party examiners. All examiners in the validation were using the same scoring forms and methods. Most of the marks against the participants occurred during the scenario entitled CDL4 CITY. This scenario focuses on measuring turning abilities within a city driving route. The higher marks are primarily due to the peripheral limitation of the part-task simulator. Unlike the MARK II full motion simulation which has embedded convex mirrors on the rear view mirrors, the VS1000 part-task simulator does not have the ability to display embedded convex mirrors on the rear view mirrors. This phase of the validation is an area needing further design changes. Possible solutions to the mirror limitation are to incorporate convex mirrors, or to incorporate the four right turns and the four left turns into other scenarios. The change was made to include turns in the CDL2 Off Road scenario. Once the driver completes the Off Road tasks, he or she then drives directly into a prescribed route in the city with no traffic interference. Within this scenario, four left turns, four right turns, and intersections are also evaluated. Yet another option that could work is to evaluate two right and left turns in urban scenarios and two left and right turns in the city scenario using two and four driving lanes. This approach could be used to compare scenarios to determine how realistic they are in relationship to an actual CDL on-road exam. Furthermore, a change like this would show that either the current city driving scenario is too realistic and difficult to complete without convex mirrors, or that indeed the turning skills of the participants need improvement.

In discussion of the CBT Phase II part of the validation, 65 subjects completed the phase, 45 passed the general knowledge section, 51 passed the combination vehicles section, 5 passed the hazardous materials section, 11 passed the air-brakes section, and 54 passed the walk-around inspection. The two main areas of concern discovered are the *hazardous materials* section and the *air-brakes* section. These two sections show that the subjects are not proficient in either area, and for re-certification purposes they would need to be remediated. When comparing scores that subjects received on the pre-trip verbal explanations of the operation of air-brakes, all of the them passed; however, the knowledge section clearly shows that even though they know general air-brakes' function, they do not know the braking system. It is noted that the verbal explanation is subjective and the scores may not be a true representation of each subject's actual understanding of air-brakes. The scores from the knowledge part of this phase clearly represent the questions from the actual CDL test bank are valid. This is determined by the statistics that only 5 out of 65 passed the CBT section of the validation with a score of 80 or better. In total all of those who passed this part of the validation also passed the entire validation.

To counteract the low scores on the CBT, we recommended a training course that focuses on hazardous materials and air-brakes. It is noted that knowledge of hazardous materials is now a required part of re-certification. We determined that the VCRS Training Program can easily be developed to assist drivers prior to testing.

Moreover, to further our study we would like to compare the incident reports of the above mentioned subjects to the variables of interest in the VCRS. For example, if the scores on the VCRS are showing that a majority of subjects are not good at judging distance when backing then do the incident reports reflect this deficiency? It has been noted that Frito Lay has been having some incidents due to braking issues. Our scores on air-brakes clearly represent a deficiency. This correlation still needs to be validated, but if the correlation does exist, then we recommend that drivers be re-trained on air-brake operations.

Comparing the *novice* group and *expert* group also yielded some interesting results. An independent samples t-test was performed and revealed that there were no significant difference between groups for the following driving scenarios:

- Brake Test ($p<.05$, .359)
- Off-Road Test ($p<.05$, .316)
- Urban Test ($p<.05$, .776)
- Freeway Test ($p<.05$, .728)

Statistically significant differences between groups exist on the Rural driving scenario ($p<.05$, .045) and the City driving scenario ($p<.05$, .001). However, the difference noted in the Rural is a minimal (FL: 1.7, RM: .94), while for the City scenario, Frito Lay drivers' means were 8.7 and Roadmaster drivers' means were 5.0.

All but the Combination Vehicles section of the CBT phase of the validation proved to be statistically different. This indicated that Frito Lay (*expert*) scored less on the knowledge test than the Roadmaster (*novice*) drivers.

Final Knowledge Scores:

- Frito Lay: 5/68
- Roadmaster: 8/20

Scores were low due to the scores collected in hazard materials and air brakes. It is no surprise that the experts did not perform well on the hazardous materials section because the drivers of Frito Lay do not carry hazardous materials and it has only been recently that the hazardous materials section has been added to the CDL re-certification exam.

In terms of simulator sickness, the following results are reported:
Frito Lay: 18 dropped from the study due to feelings of Sim-Sickness (roughly 26% dropped).

Roadmaster: 5 dropped from the study due to feelings of Sim-Sickness (roughly 25% dropped).

General Feelings:
Eye Strain: FL: 2.6, RM: 1.8 **
Temperature Increase: FL: 2.1, RM: 1.7
Dizziness: FL: 2.2, RM: 1.4 **
Headache: FL: 1.3, RM: 1.3
Nausea: FL: 1.8, RM: 1.3
**** Indicates statistically significantly different**

HUMAN FACTORS DISCUSSION

Visual Cues

There are visual cues both in the driving scenarios and in the CBT modules that the driver can use for reference points. The visual cues assist the driver in such tasks as reversing, parallel parking, and stopping distance . Multiple levels of photos act as visual cues in the CBT modules. There are also directional arrows that act as navigational aids to prompt the driver through a particular pre-defined course within driving scenarios. These directional arrows are also coupled with audio cuing.

Feedback Systems

The simulators have the capability to replay the participant's drive. This in turn can be used as feedback for analyzing driving performance. The instructor can also use the playback as a means for identifying skills that need to be retrained or refreshed. For example, drivers may have difficulty performing alley docking skills. Simulation is an excellent means to practice this skill set. The instructor can play an overhead playback of the drivers' actions and provide feedback as to what drivers are doing wrong as well as what they are doing right. The feedback is helpful because the playback can show drivers in an unbiased manner their actions even if they are convinced that they are not performing a maneuver incorrectly. The CBT phase of the Virtual Check Ride System produces a computer-generated After Action Review (AAR) upon completion. This AAR provides automatic feedback that subjects can see immediately how they performed. The CBT phase utilizes the same 500 type of questions used in an actual CDL exam, but randomly selects 50 questions to form the CBT test verses the 100 in the actual CDL. It covers general knowledge, combination vehicles, hazardous materials, and air brakes. The AAR is detailed enough to provide the subject with the questions that they answered incorrectly and provides the correct answer as well. This feedback is important because it provides the subjects with an immediate response to how they performed and can show them areas of weakness for further improvement. Additionally, by providing the correct response the subjects can use the AAR as a learning aid. The CBT phase also has a virtual walk-around inspection that utilizes high-fidelity photos of the inspections points identified on a commercial truck. The subjects identify the inspection point, analyze it and decide if it complies or does not comply with commercial truck driving standards. Once they have completed this section, their score is generated on the AAR. A score of 80% or better is required for all areas.

Data Collection Method

Data was collected with the assistance of subject matter expert/certified examiners. The subject matter expert/examiners informed the participants of the objective of the study and briefly described the tasks at hand. Once the pre-VCRS forms have been completed, the participant begins the CBT modules of the system. The CBT phase of the system is designed to be self-explanatory and requires little or no assistance to complete. The SME/examiner provides the subjects with a brief overview of the CBT and then allows them to travel through the system at their own pace. The subject navigates through the CBT part of the system in a linear fashion using visual and audio prompting. Upon completion, an After Action Review (AAR) is generated and at that time the SME/examiner collects the data and places it in the participant's folder. The SME/examiner does not go over the result with the subject until after completion of the Check Ride phase of the system. The subjects are then briefed on the VCRS simulated scenarios and the SME/examiner provides them with a short overview of the simulator. Once they are seated and ready to begin, they are told to operate the simulator as if it was a traditional truck. They are given the opportunity to do a practice drive using a canned demo scenario. The SME/examiner rates the subject on driving skills, as done in the actual CDL exam. This maintains a high level of rater fidelity. The SME/examiner follows the same procedures as an examiner would in the actual yard and road test of the CDL exam. After completing the driving scenarios, a score is calculated in the same three key areas as the CDL: basic skills test, road test, and pre-trip inspection. The scores are then compared to the actual scores of their CDL exam when available. Both the *expert* and *novice* groups were tested in an identical manner.

Program Evaluation Standards (*Utility, Feasibility, Proprietary and Accuracy Standards)* were consulted

- *Test data* is taken from the actual completion of the VCRS, CBT, and AAR report. The software keeps score as the subject progresses through the VCRS process and captures the results in an Access Data Base. The SME/examiner manually collects performance data as the subject progress through the driving scenarios. The data is then available in various reports for use by the study team as well as the company training personnel or other key individuals as required.
- *Collect data from questionnaires*. The data is used to determine subjects requiring pre-simulator instruction. Also it is used to determine if previous simulation experience has any bearing on "Check Ride" scoring.
- *Subjects are identified* as either, *expert* or *novice*. Each group would complete the CBT phase of the VCRS prior to taking a Check Ride on the same part-task simulator.
- *After Action Review* from the CBT Virtual Check Ride and Road Skills Simulations were compared to CDL exam results.

How Data Will Be Used

The data collected during this study will be used to validate that a blended learning approach to the CDL process is indeed feasible. The results indicate that there is a high level of fidelity between the scores received from the VCRS and the actual CDL scores. The data received from the CBT phase alone can provide the participant with information on areas of concern. For example, a company was reporting a high level of braking incidents and upon running their drivers through the CBT phase of the validation, the Air Brakes section identified that the drivers were indeed deficient in the functionality of the air brake system. The company issued a mandatory refresher course on air brakes and as a result the company has been incident free for two months.

Discussion of Findings

This study process utilized several simulation validation performance concepts centered on a Quasi-Experimental Design. It is believed that the data collected in this non-pure experimental study is an accurate representation of the intended criteria, to diagnose and validate CDL knowledge and skills and to add value to CDL re-certification.

The results of the study indicate that the blended assessment techniques are a valid representation of the current CDL process. The Virtual Check Ride *System* appears to provide a new and exciting way for testing for the CDL. It is an alternative approach that is cost effective, time efficient, and a safe way to approach the traditional CDL exam.

Observations conducted while various groups of subjects completed the "Check Ride" phase of the VCRS conclude our beliefs that using simulation can add value for those drivers who are preparing for their CDL re-certification and also for the *novice* driver just learning to drive a commercial vehicle. VCRS is a cost-effective diagnostic and validation tool developed for identifying Commercial Driver License (CDL), re-certification, knowledge and skills deficiencies. We called the tool "Virtual Check Ride System".

Using blended assessment techniques, asynchronous computer-based training (CBT) and synchronous simulation-based technology, data was collected and evaluated. Responses from questionnaires were used to form logical but random groups. Data collected from this validation study was also used as a major element of the continuation of the larger CATSS research agenda which focuses on the utility of simulation and advanced learning technology to enhance performance of transportation personnel.

ADDITIONAL DEVELOPMENT STEMMING FROM THE VCRS

In September 2003, developers of the VCRS attended the Florida Trucking Association Leadership Conference in Sarasota, Florida. After viewing the capabilities of the System, LTC Binder, Deputy Director of the FDOT Motor Carrier Compliance Office, expressed interest in using an offshoot of the VCRS for training Safety Examiners that work for the Motor Carrier Compliance Office. Currently there is no systematic process to help these examiners maintain their proficiency or for their leaders to assess their individual personnel's level of knowledge. Regulatory proficiency is becoming a growing problem, as large numbers of experienced examiners are near retirement. Those retiring are being replaced with inexperienced personnel. Additionally, many new "Safety Examiner" personnel have come into the Motor Carrier Compliance Office with backgrounds other than motor carrier compliance.

Based on the interest from LTC Binder, a research proposal was written to fund development of a computer-based examiner training and certification program. In May 2004, the proposal was accepted and work began on the program. A systems approach was taken to develop this program, keeping in mind the issues of reusability pertaining to audience, content, and environment. Through needs analysis, it will be determined whether the content and raw media of the already created VCRS, such as truck inspection points, can be reused for training safety examiners. Reusability is an important issue in designing this offshoot of the VCRS. The instructional designers and developers working on this project have worked with reusability and SCORM issues. During design and development of the examiner training scenarios, instructional designers worked with subject matter experts, analyzed process and procedures while out in the field with motor carrier compliance officers and safety examiners. A prototype was developed and Beta tested. Beta testing and evaluation of the safety examiner training scenarios will play an important role in determining the effectiveness of the training.

Based on some of the initial analysis conducted in May 2004, it was determined that the intended outcome of this research would be a validated, computer-based training and certification system, that will run via the World Wide Web and be capable of diagnosing "Safety Examiners" proficiency and providing formal training and remediation as required. Additionally, the system will consist of a series of high quality digital images, associated legal statutes and scenarios that require the examiner to determine whether certain tractor-trailer safety situations are mechanically and regulatory compliant or non-compliant. This process will be controlled by a state-of-the-art Knowledge Management System, which will provide the logic and data storage schemas that allow this application to be malleable to the requirement of particular safety compliance concerns.

Several participating agencies have expressed their interest in development of tailored driving scenarios and CBT modules to address their unique training, diagnostic, or pre-hire needs. Discussions with Department of Law Enforcement agencies have been conducted and some tailored scenarios are completed.

Stemming from the increased occurrences of commercial vehicle accidents and also cargo theft along with the increased level of potential terrorist threats using commercial vehicles, one very important area of future development is the use of simulation and multimedia interventions that will help train commercial drivers how to react to terrorist attack and awareness of prevention techniques. CATSS and several agencies have begun research in the use of modeling and simulation and other modalities for awareness and training against terrorist usage of commercial vehicles.

CONCLUSION

An interactive multimedia, blended systems intervention was created and validated in response to the need for a cost-effective performance based re-certification and possible alternative to full, live CDL tests. The CDL simulated system, or "*Virtual Check*

Ride System," consists of CBT phases measuring truck driving basic knowledge and vehicle inspection skills and Part Task Truck Driving Simulators used to measure driving performance and critical thinking and response skills.

The CDL exam is based upon performance and knowledge. To complete the design for this research study we developed a technology model, which looks outside of traditional instruction for alternative interventions (see Figure 2). Using this model we believe we have really shifted the focus from traditional instruction to the natural outcome of human performance.

By using blended assessment techniques, asynchronous computer-based training (CBT) and synchronous simulation-based technology, we have developed a cost-effective diagnostic and validation system that *does* identify driver CDL knowledge and skills deficiencies and strengths. The validation of the system strengthens our initial beliefs that a system could be developed that would indeed replicate the existing CDL. A system that can be delivered on-demand anywhere and anytime and truly add value to existing training modules.

As a result of our findings we believe that this approach has the potential to be expanded and applied to other aspects of ground transportation where enhancing human performance through the systematic use of technology can multiply shrinking resources and increased demands. We believe the shift in focus to human performance from technical functions offers a significant capability to many fields of endeavor and promises to be as useful as it has been for the Aviation industry and the military.

REFERENCES

Allen, Talleah & Tarr, Ronald (2003). *Validation of a "Virtual Check Ride*"; IITSEC, Dec 2003

CDL Test Validity and Reliability, State of Florida – CDL Handbook, 1998

Knowles, Malcolm S. (1970). *The Modern Practice of Adult Education: Andragogy Versus Pedagogy*. New York: Association Press

Sanders, J.R. (1994). The Program Evaluation Standards, *How to Assess Evaluations of Educational Programs,* 2nd Edition. New Delhi London, England: Sage Publication