Commercial Truck and Bus Safety

Synthesis 13

Effectiveness of Commercial Motor Vehicle Driver Training Curricula and Delivery Methods

Sponsored by the Federal Motor Carrier Safety Administration

A Synthesis of Safety Practice

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

COMMERCIAL TRUCK AND BUS SAFETY SYNTHESIS PROGRAM

CTBSSP SYNTHESIS 13

Effectiveness of Commercial Motor Vehicle Driver Training Curricula and Delivery Methods

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COMMERCIAL TRUCK AND BUS SAFETY SYNTHESIS PROGRAM

Safety is a principal focus of government agencies and private-sector organizations concerned with transportation. The Federal Motor Carrier Safety Administration (FMCSA) was established within the Department of Transportation on January 1, 2000, pursuant to the Motor Carrier Safety Improvement Act of 1999. Formerly a part of the Federal Highway Administration, the FMCSA's primary mission is to prevent commercial motor vehicle-related fatalities and injuries. Administration activities contribute to ensuring safety in motor carrier operations through strong enforcement of safety regulations, targeting high-risk carriers and commercial motor vehicle drivers; improving safety information systems and commercial motor vehicle technologies; strengthening commercial motor vehicle equipment and operating standards; and increasing safety awareness. To accomplish these activities, the Administration works with federal, state, and local enforcement agencies, the motor carrier industry, labor, safety interest groups, and others. In addition to safety, security-related issues are also receiving significant attention in light of the terrorist events of September 11, 2001.

Administrators, commercial truck and bus carriers, government regulators, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and underevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information available on nearly every subject of concern to commercial truck and bus safety. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the commercial truck and bus industry, the Commercial Truck and Bus Safety Synthesis Program (CTBSSP) was established by the FMCSA to undertake a series of studies to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern. Reports from this endeavor constitute the CTBSSP Synthesis series, which collects and assembles the various forms of information into single concise documents pertaining to specific commercial truck and bus safety problems or sets of closely related problems

The CTBSSP, administered by the Transportation Research Board, began in early 2002 in support of the FMCSA's safety research programs. The program initiates three to four synthesis studies annually that address concerns in the area of commercial truck and bus safety. A synthesis report is a document that summarizes existing practice in a specific technical area based typically on a literature search and a survey of relevant organizations (e.g., state DOTs, enforcement agencies, commercial truck and bus companies, or other organizations appropriate for the specific topic). The primary users of the syntheses are practitioners who work on issues or problems using diverse approaches in their individual settings. The program is modeled after the successful synthesis programs currently operated as part of the National Cooperative Highway Research Program (NCHRP) and the Transit Cooperative Research Program (TCRP).

This synthesis series reports on various practices, making recommendations where appropriate. Each document is a compendium of the best knowledge available on measures found to be successful in resolving specific problems. To develop these syntheses in a comprehensive manner and to ensure inclusion of significant knowledge, available information assembled from numerous sources, including a large number of relevant organizations, is analyzed.

For each topic, the project objectives are (1) to locate and assemble documented information (2) to learn what practice has been used for solving or alleviating problems; (3) to identify all ongoing research; (4) to learn what problems remain largely unsolved; and (5) to organize, evaluate, and document the useful information that is acquired. Each synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation.

The CTBSSP is governed by a Program Oversight Panel consisting of individuals knowledgeable in the area of commercial truck and bus safety from a number of perspectives—commercial truck and bus carriers, key industry trade associations, state regulatory agencies, safety organizations, academia, and related federal agencies. Major responsibilities of the panel are to (1) provide general oversight of the CTBSSP and its procedures, (2) annually select synthesis topics, (3) refine synthesis scopes, (4) select researchers to prepare each synthesis, (5) review products, and (6) make publication recommendations.

Each year, potential synthesis topics are solicited through a broad industry-wide process. Based on the topics received, the Program Oversight Panel selects new synthesis topics based on the level of funding provided by the FMCSA. In late 2002, the Program Oversight Panel selected two task-order contractor teams through a competitive process to conduct syntheses for Fiscal Years 2003 through 2005.

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FOREWORD

By Christopher W. Jenks
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This synthesis will be useful to federal and state agencies, commercial truck and bus operators, and others interested in improving commercial vehicle safety. The synthesis summarizes the state of commercial motor vehicle (CMV) operator training in the trucking and motorcoach industries. It captures in detail the experiences of those training programs that are using some combination of simulators and computer-based instruction. It also identifies current measures of training effectiveness being used in the CMV community. The synthesis is based on a comprehensive literature review complemented by a survey of selected truck and bus companies, industry associations, CMV driving schools, and vendors and users of training technologies such as simulators and computer-based training programs.

Administrators, commercial truck and bus carriers, government regulators, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and underevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

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For each topic, the project objectives are (1) to locate and assemble documented information; (2) to learn what practices have been used for solving or alleviating problems; (3) to identify relevant, ongoing research; (4) to learn what problems remain largely unsolved; and (5) to organize, evaluate, and document the useful information that is acquired. Each synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation.

CONTENTS

1 Summary
4 **Chapter 1** Introduction
4 1.1 Background
5 1.2 Objectives and Scope
5 1.3 Research Approach
6 **Chapter 2** Review of the Literature
6 2.1 Instructional Design
6 2.2 Instructional Technology—CBI
8 2.3 Instructional Technology—Simulator-Based Instruction
8 2.4 Training Effectiveness Measures
11 **Chapter 3** Commercial Vehicle Operator Training
11 3.1 Overview of Training Organizations
12 3.2 Commercial Driver Training
12 3.3 CDL Test
13 3.4 Instructional Design and Content
13 3.5 Documented Current Practices in Commercial Driver Training
16 3.6 Instructional Technology in Commercial Driver Training—CBI
18 3.7 Instructional Technology in Commercial Driver Training—Simulator-Based Training
21 3.8 Training Effectiveness
23 **Chapter 4** Survey Procedures and Results
23 4.1 Context of the Survey
23 4.2 Survey Respondents
23 4.3 Survey Results
24 4.4 Special Cases
26 **Chapter 5** Discussion and Conclusions
26 5.1 Discussion
26 5.2 Conclusions
28 **References**
30 **Appendix A** A Model Research Plan
32 **Appendix B** Commercial Vehicle Operator Training Survey

SUMMARY

Effectiveness of Commercial Motor Vehicle Driver Training Curricula and Delivery Methods

This synthesis provides information for the commercial vehicle safety community to assess current commercial vehicle training practices and the quality of their measures of effectiveness.

CTBSSP Synthesis 1, "Effective Commercial Truck and Bus Safety Management Techniques" (Knipling, Hickman, and Bergoffen 2003) combined a rigorous survey of the commercial truck and bus industries with a literature review. That report concluded that "The level of driving proficiency and knowledge required to earn a commercial drivers license (CDL) is widely regarded in industry as well below the level required to be a safe and reliable driver in a full-time operational setting." (p.14)

This synthesis summarizes the state of vehicle operator training in the trucking, motorcoach, and transit industries. It captures in detail the experiences of those training programs that are using some combination of simulators and computer-based instruction (CBI). The synthesis also identifies current measures of training effectiveness in the commercial vehicle operator school and carrier communities. It describes training effectiveness measures being used in the military and industry and describes some potential training effectiveness measurement models for commercial vehicle operator training programs.

The scope of the study included a comprehensive literature review complemented by a survey of selected truck and bus companies, industry associations, driving schools, and vendors and users of training technologies (e.g., simulators, computer-based training). The information sought in the literature review and survey permitted the research team to identify and examine: (1) similarities and differences in training strategies among existing driver training programs; (2) similarities and differences in the curricula applied in selected training programs; (3) the extent to which simulator and computer-based technologies can be used to enhance the effectiveness of commercial driver training programs; and (4) techniques to measure commercial operator training effectiveness.

The content that is in most reputable training programs is there because experts in truck and bus driving believe it should be there. It is a result of an informal consensus over the past 15 to 20 years of operators, trainers, and research professionals. Although there have been various analyses of commercial driver tasks, there has not been the kind of instructional design approach for commercial driving that one finds in common practice in other industries and in the military. During the past two decades, truck and bus professionals have reached an informal agreement on what entry-level drivers must be taught. But there still remain very big questions about how instruction should be conducted and how the results of commercial vehicle operator training should be evaluated.

The research team found driver training CBI courses being offered by insurance companies, for-profit training schools, not-for-profit associations and organizations, and the U.S. Military.

In Europe, much the same thing was found—that specific safety or performance data showing a causal relationship between CBI and traffic safety are lacking.

One of the fundamental questions the research team set out to answer is, Do commercial driver training programs work? Persons familiar with the motor carrier, motorcoach, transit, and school bus communities will not be surprised to learn that the answer is yes when opinions are sought but the answer is maybe when hard data are needed. In the team's survey, the most often used standard for measuring training effectiveness was CDL test pass rate. If significant numbers of students were receiving their CDL (more than 70%), the schools were seen as successful. For schools, another measure of success was the number of graduates hired for driving positions. Carriers had some general sense of improved safety performance resulting from training, but firm data were in short supply.

The research team sent the survey over the Internet using email address lists provided by various training and carrier organizations (see Appendix B). The goal was to get a snapshot of the day-to-day activities of commercial driver training organizations. Two specific areas of inquiry were of interest (1) how trainers measure the effectiveness of their training and (2) how trainers measure the effectiveness of their graduates.

The survey respondents identified four types of skills training: (1) range training with students either driving a vehicle around a restricted space or riding in a vehicle which is being driven by another student, (2) simulator training, (3) demonstration of skills by an instructor, and (4) behind-the-wheel (BTW) on road training. Not all schools use all four methods. Training organizations reported at least satisfaction with the various methods used to train. Only BTW was universally ranked as the best method to train. It is clear that training providers are convinced that the way for someone to learn how to drive a commercial vehicle is to drive a commercial vehicle under the supervision of a master driver.

In addition to the survey, literature and current training programs were reviewed to see if there were other data that might enhance the conclusions for this report. This synthesis briefly discusses three particular cases: a paper by McFann (2001) reviewing some studies on training effectiveness conducted in the 1990s; *TCRP Report 72* by Brock, Jacobs, and McCauley (2001); and a visit to Schneider National's Driver Training Facility in Green Bay, Wisconsin, in October 2006. All three sources identify a key component of a commercial vehicle driver training program: the role of the instructor.

This report presents the following conclusions:

- **Content.** There is general agreement across the industry about the core content of commercial driving curricula. However, the content has evolved through an informal consensus based on the 1984 FHWA Model Curriculum, which listed what was believed to be the necessary content at the time. There are no national standards on content, although when one examines various curricula, little content difference can be found. The industry could use a systematic development of a modern commercial driver training curriculum.
- **Instructional Methods.** The favorite method for training commercial drivers is a combination of classroom lectures and supervised driving. Most of the research findings on adult learning and instructional technology from the last 30 years have not been incorporated into many commercial driving training enterprises. In those cases where advanced technologies are being applied, early data indicate that well-designed CBI, including simulation, can improve student performance and also realize efficiencies in the instructional process. Distance learning shows great promise for post-licensing training.
- **Train the Trainer.** It is natural that older, experienced drivers are selected to be instructors, no matter if the training is administered by a school, carrier, bus company, or transit agency. But there is no evidence that a person who is a job expert is necessarily a good teacher. There are two sets of skills a good driver training instructor must possess beyond driving competence.

One set involves classroom skills (presentation fundamentals, using classroom equipment, listening to students). These skills are well recognized and are a part of good train-the-trainer programs. The second set involves BTW skills (observational fundamentals, explaining activities in understandable and behavioral terms, cool head, ability to anticipate risky situations). Since there are no standards for commercial vehicle driver training instructors, this most important role in the training process is extremely variable.

- **Lack of Systematic Training Design.** The commercial vehicle industries have reached an informal consensus on the subject of commercial driver training. However, it has been more than 20 years since a formal curriculum design for commercial drivers was systematically developed. In those 20 years, the CDL program has become law, new technologies and regulations for truck and bus operations have had a major impact on the drivers, and the collected knowledge about what effects a commercial driver's performance (e.g., fatigue, distraction, age) has grown exponentially.
- **Lack of Standards for Measuring the Effectiveness of Driver Training Programs.** Currently, the only generally acceptable standard for measuring the effectiveness of commercial driver training is the number of graduates who can pass their CDL tests. In both the survey and in personal conversations, schools reported that they also track the number of graduates that are hired by carriers. Carriers, motorcoach operations, and transit agencies report that they are sure that training reduces accidents; however, little or no data support that view. Standards purporting to measure training effectiveness tend to measure processes (classroom hours, time spent behind the wheel) rather than specific performance outcomes.
- **Commercial Vehicle Operator Abilities.** There has been a spate of recent research on the capabilities and limitations of adolescent drivers (e.g., Winston and Senserrick 2006). However, a similar scientific approach to commercial drivers is lacking. If commercial vehicle operator trainers understood more about the learning styles, cognitive strategies, and past educational experiences, training could be tailored to the relevant needs of the individual student. A set of diagnostic tests that could funnel students into unique optimum learning opportunities would be a major jump in improving commercial driver training.

CHAPTER 1

Introduction

This synthesis provides information for the commercial vehicle safety community to assess current commercial vehicle training practices and the quality of their measures of effectiveness.

Subsequent to the work plan being approved, the Federal Motor Carrier Safety Administration (FMCSA) requested that additional work on commercial vehicle operator training be included as part of the overall project. Therefore, three additional tasks were added to the project:

- An expanded inventory of commercial driving training programs in the United States.
- A comparison of crash rates for commercial drivers who have received formal driver training and those who have received no formal training.
- A closer look at various training programs for non-commercial drivers with comparisons to commercial driver training programs.

1.1 Background

Since the late 1980s, FMCSA (formerly FHWA Office of Motor Carriers) has been conducting a program of research on commercial motor vehicle (CMV) driver training technologies. The primary emphasis has been on advanced driving simulators. FMCSA has set out to establish a set of training standards for commercial vehicle operators. Presumably, these standards would include minimum curriculum standards, acceptable training methodologies, and objective measures of training program effectiveness.

A non-government group, the Professional Truck Driver Institute (PTDI), currently provides certification to schools training professional truck drivers. Participation in the certification process is voluntary and is focused on over-the-road tractor-trailer driver training. Some states also certify commercial vehicle operator training through their education departments. These certifications tend to examine financial management and student management characteristics rather than specific curriculum issues (e.g., content, ratio of practice to instruction, time-in-cab activities).

FMCSA has sponsored research projects of driving simulators for more than 15 years. That research is directly relevant to this synthesis for two reasons: (1) simulators may provide opportunities for improved training of commercial vehicle operators and (2) they may also provide a technology for measuring the effectiveness of various operator training curricula and techniques.

Instructional technology has been the subject of major research projects in both the private sector (particularly in university psychology and education departments) and in various government departments. The Department of Defense (DOD) has funded major instructional technology research and development (R&D) projects the past 50 years. With state-of-the-art computer technology and the various models of distance learning, soldiers are learning to maintain and operate complex weapons systems, computer technicians are staying abreast of the rapid changes in their professions, and children are experiencing in real time the exploration of the Arctic, conversations with peers thousands of miles away, and the observation of a world that until recently could only be read about.

The DOD, in particular, has also developed a general approach to curriculum development that is in worldwide use across many disparate disciplines and skill sets. This approach, first developed more than 30 years ago, emphasizes training students to perform the very specific skills needed to accomplish the tasks they will have to perform on their jobs. This multi-stepped process begins with an identification of tasks to be learned and ends with the measurement of those tasks at the end of training and whenever possible, on the job as well. There is a distinct body of research into how and when training effectiveness should be measured.

Unfortunately, the majority of truck and bus operator training has not been included in these research projects and technological interventions. The model for much of commercial vehicle operator training is the stand up instructor and a conventional classroom filled with aspiring professional drivers.

However, within the truck and bus operator training world there are companies and schools that are attempting to use the technological tools available to them.

CTBSSP Synthesis 1 combined a rigorous survey of the commercial truck and bus industries with a literature review. It concluded that "The level of driving proficiency and knowledge required to earn a commercial drivers license (CDL) is widely regarded in industry as well below the level required to be a safe and reliable driver in a full-time operational setting." (p.14)

In 2004, *CTBSSP Synthesis 5,* "Training of Commercial Motor Vehicle Drivers" (Staplin, Lococo, Decina, and Bergoffen 2004) was published, which set the stage for this synthesis.

This synthesis summarizes the state of vehicle operator training in the trucking, motorcoach, and transit industries. This synthesis also captures in some detail the experiences of those training programs that are using some combination of simulators and CBI. The synthesis identifies current measures of training effectiveness in the commercial vehicle operator school and carrier communities. It also describes training effectiveness measures being used in the military and industry and proposes a training effectiveness measure model for commercial vehicle operator training programs.

Reviews and studies of driver training tend to focus on external events (e.g., lectures, simulators, BTW practice) which are presumed to cause desired internal events called learning. Learning then is measured in terms of predetermined external measures (e.g., written tests, on road performance). This emphasis on training rather than learning leads to assumptions about the homogeneity of student abilities and subjective rather than objective measures of effectiveness on the part of school administrators and instructors.

1.2 Objectives and Scope

The objectives of this research are to identify and document commercial vehicle driver training curricula and practices. The focus is on both training and training evaluation, resulting in a synthesis of best practices, instructional technologies, evaluation techniques, and trends in commercial driver training that will be useful to truck and bus carriers and driver training organizations.

The scope of the study includes a comprehensive literature review complemented by a survey of selected truck and bus companies, industry associations, driving schools, and vendors and users of training technologies (e.g., simulators, computer-based training). The information sought in the literature review and survey permitted the research team to identify and examine (1) similarities and differences in training strategies among existing driver training programs, (2) similarities and differences in the curricula applied in selected training programs, (3) the extent to which simulator- and computer-based technologies can be used to enhance the effectiveness of commercial driver training programs, and (4) techniques to measure commercial operator training effectiveness.

1.3 Research Approach

The research included three tasks: (1) identify the best sources to obtain desired technical literature and survey responses, (2) collect and analyze data on commercial truck and bus driver training research programs, regulations, effectiveness measures, current practices, and trends, and (3) synthesize results and prepare a report on the findings.

The literature review covered material on commercial truck and bus driver training research programs, regulations, effectiveness measures, current practices, and trends. Journal articles, government research publications and reports, and trade papers were identified and acquired from the following sources: electronic information and abstracting database services, state and federal department of transportation (DOT) library and information centers, and professional organizations (e.g., American Bus Association [ABA], American Association of Motor Vehicle Administrators [AAMVA], American Trucking Associations Foundation [ATAF], American Public Transportation Association [APTA], FMCSA) devoted to driver performance issues, commercial driving training, and highway safety. Key starting points for this research were the ongoing major study of commercial driving simulation sponsored by the FMCSA, *TCRP Report 72,* "Simulators and Bus Safety: Guidelines for Acquiring and Using Transit Bus Operator Driving Simulators," the recently completed AAMVA/FMCSA revision of the CDL tests, PTDI recent findings on CBT uses for commercial driver training, and a recent review on new technologies for driver training (Brock 2006).

The research team also attempted to capture information on various training programs for drivers who have obtained their CDL's and also for drivers who operate commercial vehicles that fall outside of the CDL requirement. Although there are many such training programs, they are not well documented.

The electronic index and abstract databases on transportation and highway safety topics that was searched included TRIS online, other transportation and education databases from DIALOG (e.g., Compendex, ERIC, and NTIS), and the Internet (using various search engines but especially the Google academic search capability). Search terms included the following: commercial motor vehicles, commercial driver training, driving simulators, CBT for commercial driving training, and training effectiveness.

Also in this task, a list of potential survey contacts and a survey instrument were drafted, reviewed, and augmented by the research team. Candidates were prioritized in a sample that accessed all relevant groups and entities.

CHAPTER 2

Review of the Literature

2.1 Instructional Design

Shortly after World War II, the U.S. military services realized that the training of personnel to operate and maintain increasingly sophisticated weapon systems was key to the future of those services (Dick 1987). During a 20-year period of research, development, and deployment, a set of principles and steps were derived that changed both the design and conduct of instruction. Essentially, instruction shifted from an emphasis on the teaching process to an emphasis on student performance measurement (Brock 2006).

During nearly two decades of research, development, and field studies a system that emphasized student performance based on specific task characteristics was evolved. Key studies by both behavioral theorists (e.g., Glaser 1963, Merrill and Boutwell 1973, Gagné 1965) and training practitioners (e.g., Mager 1962, 1977; Brock, McMichael, and DeLong 1975) led to a five-volume set of DOD guidelines for designing instruction (Branson, Rayner, Cox, Furman, King, and Hannum 1975). Although over time various researchers and practitioners developed variations on the basic model to meet specific training needs, the fundamentals remained constant: training will be based on the work (tasks) that the student must perform upon graduation, training objectives will be stated in terms of student performance, and it is student performance that will be measured at the end of the instructional process (Andrews and Goodson 1980). The basic Instructional Systems Design (ISD) model is shown in Figure 1.

The important point of Figure 1 is that learning objectives, content, and instructional methodologies must have their roots in real-world performance and must be evaluated against those real-world performance requirements.

Figure 2 shows the cornerstone of any model of instructional design: the learning objective. In the simplest terms, the learning objective describes what the student in a training program must do before he or she graduates from the program. The central feature of a learning objective is the *task*, which is typically taken from an analysis of the job or jobs the graduate is being trained to do (Mager 1962).

The second feature of the learning objective is a description of the conditions under which the task will be performed in the training environment. For instance, if the student were to learn to change a tire, the conditions would state the kind of vehicle, what tools would be provided, and any other conditions imposed by the trainer.

The third element of the learning objective is the standards that the student must meet to successfully complete the instruction. In the example of the tire changing, it could be expressed in terms of maximum allowable time to complete the task and amount of torque applied to each lug nut.

Glaser (1963) and Glaser and Klaus (1962) coined the term, "criterion-referenced measures," to describe a testing process that measured individual student performance against a set standard. Before the early 1960s, most tests, called norm referenced tests, were designed to spread out the performance of students across a normal distribution curve. Some students were expected to do very well and some were expected to do very poorly. Measuring students against a set of standards rather than against other students reflected the influence of having behaviorally based learning objectives for the training process.

Readers interested in a more detailed narrative of the history of instructional design can read Riesner (2001). The important point is that the systematic design of instruction begins with a description of the tasks to be trained and ends with a set of tests which measure the ability of a student to perform those tasks.

2.2 Instructional Technology—CBI

Concurrently with the development of a systematic approach to instructional design, educators, computer scientists, and instructional technologists were developing new ways to instruct. Whereas the technologies of instruction have rapidly

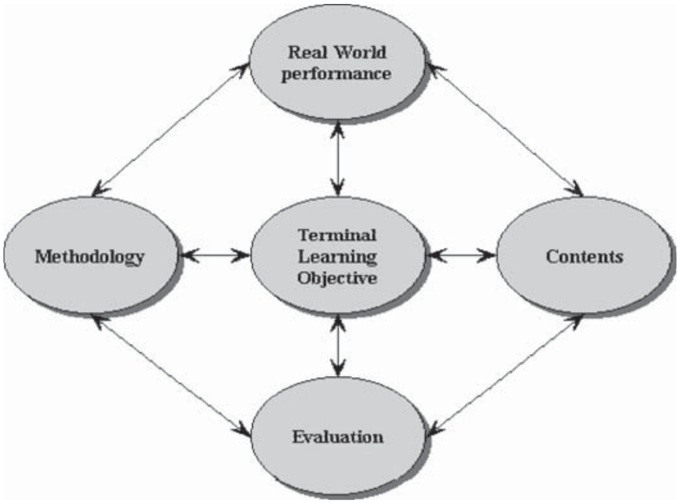

Figure 1. Basic principles of ISD.

changed (and continue to do so), the basic principles of using technology to teach have remained relatively stable (Eberts and Brock 1987, Brock 1997).

Although instructional technologies can apply to anything from slide projectors to satellite linked distance learning programs, this discussion will focus on two general technology applications that have the highest probability of directly influencing the training of commercial vehicle operators: CBI and simulation. Each will be generally discussed, and then specific current and potential motor vehicle operator training applications will be described in the next chapter.

Computers provide ways to exploit human learning capabilities (Brock 1997). Human learning capabilities themselves have not significantly changed. Swezey and Llaneras (1997) describe various instructional and learning models. CBI provides a lever that can be applied to those models to improve human performance.

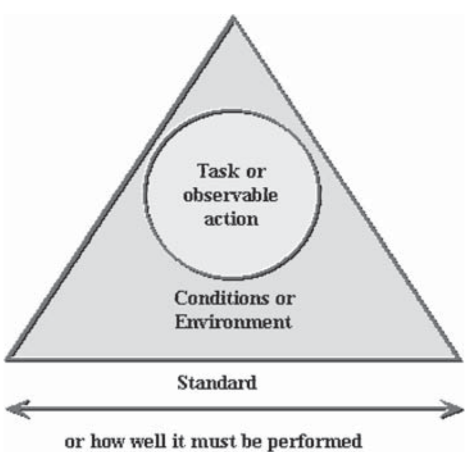

Figure 2. Components of a learning objective.

CBI is not intrinsically good. If instructional programs are not well designed, if student needs are not met, if incorrect or incomplete content is presented, and if student performance is not measured, then all that the computer does is provide an efficient means for bad instruction to be distributed (Brock 1997, 2003). CBI can be more interesting than conventional instruction; it can be more engaging, more entertaining, more individualized, and more exciting. Nevertheless, if the result of the instruction is not measurably improved human performance, it does not make any difference.

However, the power of computers to instruct is significant. It can provide graphics, video, and sound of the highest quality. Computers can adapt the pace, mode, and content of an instructional program to meet the learning needs of each student. A well-designed CBI program will test each student as he or she progresses through an instructional program and based on those test results, provide the next appropriate unit of instruction.

The most fundamental question about CBI is, Does it work? Recent research, which has applied meta-analytic techniques to answer that question, suggests that it does (Fletcher 2006, Kulik 1994, Kulik and Kulik 1991). Meta-analysis is a technique first proposed by Glass (1976). It applies statistical analysis to an accumulation of studies around the category of interest. Fletcher proposes a method by which these statistical findings can be converted to a percentile measurement to compare student performance.

Recent studies, using the approach presented by Fletcher, have indicated that the appropriate application of CBI across a wide range of a large population of students can lead to a 33% increase in the amount of material learned or a 33% decrease in the time needed to reach previously established learning criteria (Dodds and Fletcher 2004). In the following chapter, the report discusses the implications of those findings for commercial vehicle operator training.

CBI programs for the training of commercial vehicle operators are presented in the next chapter. However, there has also been some development and study of applying CBI techniques to the training of young, novice drivers (e.g., Brock 1998; Hodell, Hersch, Brock, Lonero, Clinton, and Black 2001). In the cases where studies have been conducted, CBI has been shown to be effective in very specific instances (Fisher, Laurie, Glaser, Brock, Connerney, Pollatsek and Duffy 2002).

The program studied by Brock (1998) and Fisher et al. was developed by the AAA Foundation for Traffic Safety to train a very specifically defined set of driving skills (Lonero, Clinton, Brock, Wilde, Laurie, and Black 1995). Young drivers were trained to search for, recognize, and respond to risky situations. The program is now available in both CD and DVD formats and continues to have some commercial success. However, its overall effect on young driver accidents or moving violation incidents is undocumented.

2.3 Instructional Technology—Simulator-Based Instruction

Some simulators are training devices; others are R&D tools. Some training devices are simulators, but most are not. This distinction can be made by two examples:

1. All major airlines use flight simulators for pilot training. However, NASA and other research agencies use simulators not for training, but for engineering R&D on future cockpit technology.
2. A wooden airplane on the end of a stick can be an effective training device when used by a good instructor to teach basic flight control. It is a training device but not a human-in-the-loop simulator.

To be considered a true simulation, an instructional activity must be based on the reality of a specific real-world process or situation (Clariana and Smith 1988; Heinich, Molenda and Russell 1985; Gagné 1965). Activities such as in-basket and decision-making instructional exercises and role-playing can be classified as simulations if the activity is based on a real situation or the students are required to apply a process that could be used in a real-life scenario. Note that in these examples, there are no devices. One can have *simulation* without a *simulator device.*

Simulation is an instructional method that requires students to interact with specific instructional events based on real-world scenarios. Students must see or experience the consequences of their interaction. All interactions should result in similar real-world outcomes or effects. The primary learning outcome of a simulation should be the demonstration of a real-world process, procedure, or specific behavioral change.

As Brock, Jacobs, and McCauley (2001) point out in *TCRP Report 72,* there is a long and rich body of scientific and technical literature on simulators and their use for training that goes back to at least the early 1950s. The literature can be broadly characterized as falling into four main domains. These domains are (1) descriptions of simulators (or simulator components), their characteristics, and how they are being used; (2) advice on what characteristics are required in a simulator; (3) results of research on the effects of simulator characteristics on performance; and (4) results of research on the effects of simulator characteristics on training.

The vast amount of this literature is in the context of flight simulators because that has been the predominant use of simulators for the past 60 years. Within this body of literature, the smallest segment has been the research findings on how certain simulator characteristics affect the rate of learning and proficiency.

Within the research on flight simulators, the smallest portion is on transfer of training (TOT) results, that is, how well someone performs with the actual equipment after having been trained in a simulator. However, over the accumulated history of using simulators for training, there is evidence that training simulators, particularly flight simulators are effective training devices. That is, time spent in the simulator trades off for some amount of training time using the actual equipment.

With the advantages of simulators and the changing cost of these devices in mind, it is easy to see why aviation training has been the dominant application of simulators. The cost of a full-flight simulator for a military aircraft is tens of millions of dollars. When the aircraft has a value equal to or greater than the simulator but has a much higher operating cost, the use of a simulator for training is attractive. It is even more attractive when loss of the aircraft during training is a real possibility. In addition, an expensive aircraft dedicated to training is not available for revenue-producing operations.

2.4 Training Effectiveness Measures

Perhaps the best known training effectiveness measurement methodology is Kirkpatrick's Four Level Evaluation Model (Kirkpatrick 1994) of *reaction, learning, performance,* and *impact.* Figure 3 schematically shows how the evaluation process works and Table 1 contains descriptions of the levels.

Reaction is the evaluation that measures how the learners react to the training. This level is often measured with attitude questionnaires that are passed out after most training classes. This level measures one thing: the learner's perception (reaction) of the course. In many training programs, this may be the only measure of the instruction. It provides a kind of likeability score. Skeptical instructors sometimes refer to this measurement as the "smile factor."

This level does not measure what new skills the learners have acquired or what they have learned that will transfer back to the working environment. This has caused some evaluators to downplay its value. However, the interest, attention, and motivation of the participants are critical to the success of any training program. People learn better when they react positively to the learning environment (Markus and Ruvulo 1990).

Learning is the extent to which participants change attitudes, improve knowledge, and increase skill as a result of attending the program. Measuring the learning that takes place in a training program is important to validate the learning objectives. To evaluate the learning that has taken place, the key question of any instructional program is, What knowledge and skills were acquired?

Most people are familiar with tests in conjunction with learning. The important aspect of tests to measure instructional effectiveness is that they be based on the objectives of the program. Ideally, all students would be tested on entering

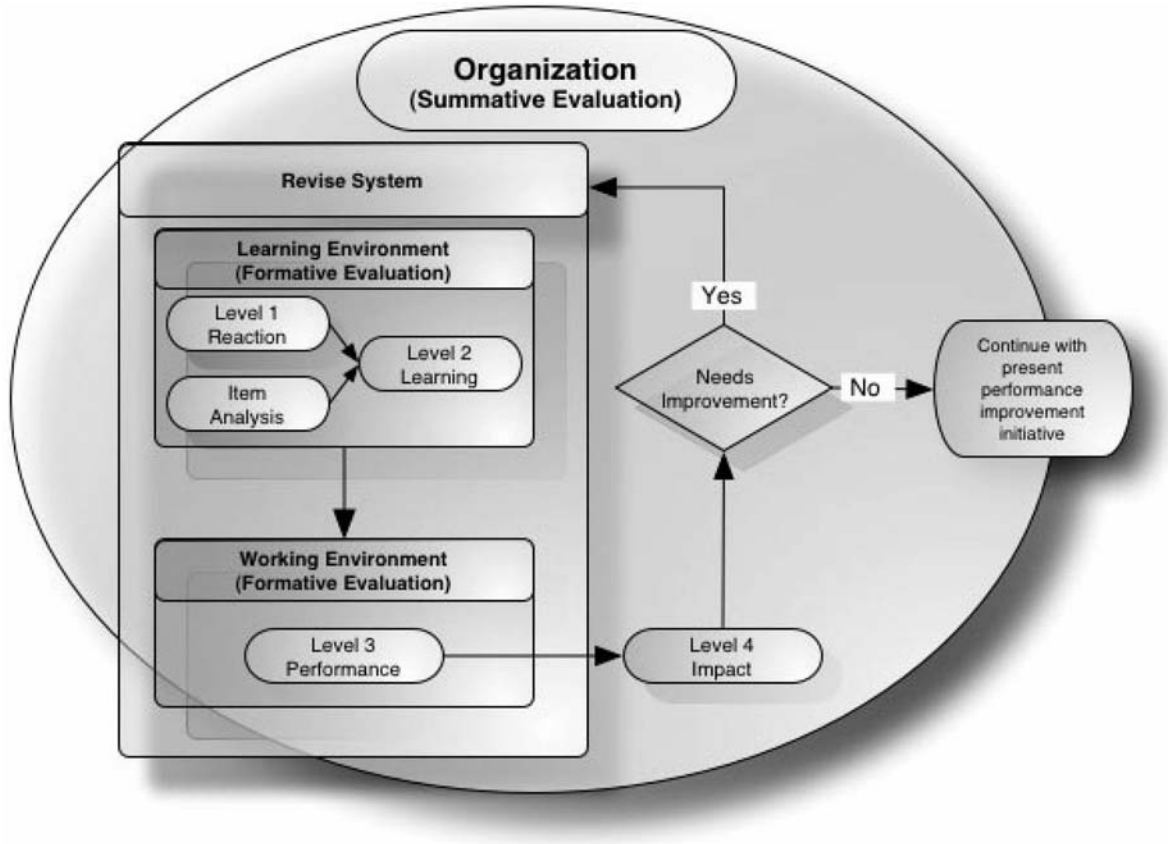

Figure 3. Kirkpatrick's four level evaluation model.

an instructional program, be tested throughout the program to ensure that they are progressing, and then be tested at the end of the program to ensure they met all the objectives of the course.

In most cases, the successful passing of an end of course test results in a certificate or diploma—some documentation of successful completion. This final step is the end of the instructional process. It is not the end of measuring the effectiveness of the instruction.

Performance refers to how students actually perform in the work place. Students may score well on post-tests in the classroom but the real question is whether or not any of the new

Table 1. Kirkpatrick's four levels of evaluation.

Level	Evaluation (what is measured)	Description and characteristics	Examples of evaluation tools and methods	Ease of measurement
1	Reaction	How the students feel about the instruction	• Survey • Interviews	Quick, easy, and inexpensive
2	Learning	Measures increases in skills and knowledge	• Pre- and post-tests • Observation	Stems from learning objectives; may require complex testing
3	Performance	Measures on-the-job performance	• Interviews • Observation • Supervisor ratings	Need cooperation and participation by line supervisors
4	Results	Measures organizational benefits from training	• ROI • Productivity • Organizational goals	Often based on estimates rather than on hard data

knowledge and skills transfers to the job. Level three evaluations attempt to answer whether or not students' *behaviors* actually change as a result of new learning.

Ideally, this measurement should be conducted 3 to 6 months after the training program. Observation surveys can be used. In the case of skill-based jobs, current metrics may already be in place (e.g., number of widgets produced, accident rate). Surveys can be completed by the student, the student's supervisor, individuals who report directly to the student, and even the student's customers.

Results is the fourth level in the model. The goal is to evaluate the business impact of a particular training program. Kaplan and Norton (2001) have proposed a so-called, "balanced scorecard," to look at the impact of training on a business operation from four perspectives:

- Financial: A measurement, such as return on investment (ROI), that shows a monetary return, or the impact itself, such as how the output is affected. Financial can be either soft or hard results.
- Customer: Improving an area in which the organization differentiates itself from competitors to attract, retain, and deepen relationships with its targeted customers.
- Internal: Achieve excellence by improving such processes as supply-chain management, production process, or support process.
- Innovation and Learning: Ensuring the learning package supports a climate for organizational change, innovation, and the growth of individuals.

Other measures might include improved safety performance, reduced waste, and recognized improved productivity. At least one writer (Phillips 2003) has suggested that a competent computation of the ROI of a training program should be considered a fifth evaluation level. It is certainly true that the cost of training should be offset by the benefits accrued from that training.

CHAPTER 3

Commercial Vehicle Operator Training

3.1 Overview of Training Organizations

Schools. Commercial driving schools provide the most formal driver training. The schools can range from a full semester course in a college or junior college to a 2-week program that concentrates on the minimum skills and knowledge required to obtain a CDL. Many schools are privately owned. However, there are a significant number of publicly funded truck and bus operator training programs across the United States.

Most of the larger schools concentrate on teaching tractor-trailer driving and operations. The survey reviewed in Chapter 4 provides more details about these various training programs.

Carriers and Employers. Many carriers, motorcoach companies, transit agencies, and school bus operations provide training to their prospective drivers. In some cases, these employers provide the same training in a school-like environment that the independent schools provide. In other cases, they take the graduates of commercial driver training schools and provide additional training on the specific vehicles and policies of the company, agency, or school district.

Organizations and Associations. There are several organizations that support various commercial driver training schools, carriers, transit agencies, and motorcoach companies. The organizations support various industries and have training as one of the supported services. They include the Truckload Carrier Association, the American Trucking Associations (ATA), ABA, APTA, United Motorcoach Association (UMA), National Association for Pupil Transportation (NAPT), and the National School Transportation Association (NSCA). Other organizations have broader charters but also support commercial vehicle operator training. The two best known are the International Brotherhood of Teamsters and the Owner-Operator Independent Drivers Association.

In addition, there are associations primarily concerned with the training of commercial drivers. The Association of Publicly Funded Truck Driving Schools provides regional lists of public institutions that offer driver training. The Coalition of Proprietary Schools has information on proprietary schools that offer driver training throughout the country. The Commercial Vehicle Training Association is the national trade association representing the proprietary truck driving schools in the United States and Canada.

The PTDI was established in 1986 to help carriers and students identify courses that provide quality training. PTDI's curriculum and other course certification criteria are adapted from a 1984 FHWA Model Curriculum which listed the requisite content for a commercial driving curriculum. According to its website, the PTDI is the only organization, either public or private, that has established a standard for the training of entry-level truck drivers. PTDI certifies courses at truck driving schools; it is not a school and does not offer courses. The Truckload Carriers Association assumed management of PTDI in 1997; since then, PTDI has undergone restructuring that includes the identification of skill standards, a revision in the curriculum, and modification of certification standards. The specifics of the PTDI curriculum, which has been updated as recently as 1999, are presented in Section 3.4.

In Canada, the Canadian Trucking Highway Research Council (CTHRC) provides a set of standards and guidelines for training beginning and more experienced commercial drivers. CTHRC offers a program called, Earning Your Wheels, which is an intensive 12-week program consisting of 8 weeks in-school training (a minimum of 120 hours of classroom and 85 hours BTW) followed by 4 weeks of supervised workplace experience with a carrier (a minimum of 100 hours BTW).

3.2 Commercial Driver Training

In *CTBSSP Synthesis 1,* safety managers and other industry experts ranked insufficient training as a significant safety management problem. Forty percent of the safety managers surveyed placed training and training standards as one of the top five solutions to industry safety problems.

In *CTBSSP Synthesis 5,* the authors approached the topic somewhat differently from the research team of this synthesis; however, their review of the content and training methodology of the truck and motorcoach industry is comprehensive and reflects many of the findings of the current study. This synthesis relies heavily on the information provided in *CTBSSP Synthesis 5.* Readers may refer to that synthesis for a longer discussion of these topics.

Many truckload carriers rely on entry-level drivers. Batts (1999) cites a Gallop study commissioned by the ATAF indicating that more than 80,000 new drivers per year will be needed by the trucking industry in the first decade of the 21st century. She further states that the quality of training received by entry-level drivers from the three primary sources of such driver—public schools, for-profit training programs, and carrier-based schools—remains inconsistent.

An area that has not received much investigation is the characteristics, abilities, and attitudes of the men and women entering the trucking profession and seeking commercial operator training. Nearly all of the literature and documentation focuses on the external events that are to shape the behavior of these aspiring professionals. Training and safety managers consistently report on the heterogeneous makeup of both their students and the commercial operator work force.

Most of the training programs reviewed were developed for adult learners. Comparing students in their mid-20's with students in their teens must be done with care. There is mounting data that adolescents have unique physiological and psychological characteristics that may not exist in older commercial driver students. The research team reports on some successful implementation of technology to train teen drivers (see Section 3.8).

In the *Driver Training and Development Resource Guide* (Driver Training and Development Alliance 1997), authors stated the following about the students in commercial driver training programs:

"Drivers in training want to do their jobs better, get promoted, receive raises, and generally be the best professional drivers they can be. . . . The more hands-on experiences they have, the better they will learn. This approach also keeps interest and motivation high. The best methods for practicing and testing put students to the actual job or tasks for which the training was developed." (p.58)

It is important to note that this statement came from a document prepared by truck and bus company professionals. It reflects the experiences of some of the top professionals in truck and bus operations, safety, and driver training.

3.3 CDL Test

The Commercial Vehicle Safety Act of 1986 called for the Secretary of Transportation to establish minimum federal standards for the states to use in testing and ensuring the fitness of persons who operate CMVs. The standards were to include both knowledge tests and driving tests, and required that the driving tests take place in a vehicle that was representative of the type of vehicle the driver operates or will operate. If appropriate, different minimum testing standards were to apply to different classes of CMVs. The rule subsequently issued by the FHWA (49 CFR Part 383), containing the minimum standards, stipulates specific knowledge, skills, and abilities that drivers of different types of CMVs must possess.

The initial CDL development was conducted in the late 1980s to meet the requirements of the 1986 Act and the Federal Rule by designing a CDL testing system that would "ensure the fitness of persons who will be licensed by states to drive various types of commercial vehicles." (Essex Corporation 1992, p. 1-1) CDL knowledge tests were developed that reflected both the general knowledge required of all commercial drivers and the specialized knowledge required of operators of particular classes of vehicles or vehicles hauling particular kinds of cargo. The knowledge tests to be taken by a CDL applicant directly reflected the type of vehicle that he or she operated or proposed to operate. They included the following:

- A general knowledge test of safe driving principles
- An air brakes test
- A combination vehicles test
- A tanker test
- A doubles/triples test
- A passenger transport test
- A hazardous materials test

In addition to the knowledge tests, there was also a requirement for the development of three driver skills tests that would

- Determine whether the applicant had an adequate understanding of how to ascertain the condition of key operational and safety systems of the vehicle.
- Determine whether the driver had the fundamental psychomotor and perceptual skills necessary to control and maneuver heavy vehicles.
- Determine whether the driver was capable of safely driving the vehicle in a variety of road environments and traffic conditions.

These tests were designed to be adaptable to different vehicle sizes and configurations. Each met professional standards for reliability and validity, and each measured an important, yet relatively independent, area of driver skill.

Although the CDL testing standards and requirements represent a national program, each jurisdiction must administer the various tests in compliance with jurisdictional laws and procedures. Therefore, although the overall goal of the CDL program was to have all commercial drivers meet the same standards regardless of where they receive their license, differences among the jurisdictions have increased during the decade following full program implementation.

Recently, the original tests have been revised (Brock, Golembiewski, McFann, Robinson, and Lewis 2005). The major changes to the tests saw the knowledge test item pool enlarged, the vehicle inspection test become less predictable to applicants, the basic skills test more closely reflects on-the-job performance, and the on road test become more precise.

As Staplin et al. (p.8) state: "While the CDL is a federally mandated licensing standard, there is no federally mandated standard for the training of entry-level commercial truck drivers. And while the FMCSA believes that the FHWA Model Curriculum, the PTDI Curriculum, the Model Curriculum for Training Motorcoach Drivers, and the NHTSA School Bus Driver Instructional Program represent the basis for training adequacy, such training is not mandated. At the same time, the FMCSA does not agree that training adequacy is ensured simply by having the knowledge to pass the CDL test (Federal Motor Carrier Safety Administration 2003)."

3.4 Instructional Design and Content

The content of most current motor vehicle driver training is derived from subject matter sources (regulations, textbooks, policies and procedures) rather than from an in-depth analysis of commercial vehicle operator performance requirements. This does not mean that the content is necessarily wrong, only that it is expressed in terms of instructional content rather than in performance outcome.

The content that is in most reputable training programs is there because experts in truck and bus driving believe it should be there. The content is a result of an informal consensus of operators, trainers, and research professionals over the past 15 to 20 years. Although there have been various analyses of commercial driver tasks (e.g., Essex Corporation; Brock, Durham, and Wood, 1990), there has not been the kind of instructional design approach described in Chapter 2 for commercial driving. The research team could find no evidence of the kind of performance-based learning objectives that result from the traditional ISD approach in current commercial vehicle operator training programs.

However, the PTDI curriculum comes close. Student performance is specified, but not to the level required in a formal learning objective. For instance, the PTDI curriculum has skill objectives which are stated, for example, "Practice good visual search techniques." A learning objective following the ISD model could be stated, "In a computer-generated classroom exercise, student will identify 80% of potential risks in a projected 10-mile ride in an urban setting." Note the three elements of the learning objective: Task—"identify potential risks," Condition—"computer-generated classroom exercise," and Standard—"identify 80% of potential risks in a projected 10-mile ride in an urban setting." Of course, the objective could describe different conditions (actual driving on the road) and a higher or lower performance standard.

Table 2 provides an outline of the minimum content for a PTDI-certified training program for entry-level drivers. In a report produced by the Driver Training and Development Alliance (DTDA 1997), the content in Table 2 was expanded to a list of 34 of the DTDA key topics that should be part of any entry-level driver training program (see Table 3).

FMCSA has developed minimum training requirements for operators of double and triple trucks, also known as longer combination vehicles (LCVs). LCV training will consist of driving and non-driving activities, such as route planning and checking cargo and weight. Because LCV doubles and triples have different operating characteristics, FMCSA established different training courses for each vehicle group. The rule also establishes two types of LCV driver instructors, classroom instructors and skills instructors. Table 4 shows the specific content requirements for these special classes of vehicles.

The point of this discussion and these tables is that there appear to be a set of generally agreed on topics and subject areas that entry-level drivers should learn. It is important to point out that all three examples go well beyond teaching safe driving. What are described are training programs for professional drivers. The remainder of this report will discuss the various ways such content can be taught, practiced, and tested.

3.5 Documented Current Practices in Commercial Driver Training

For an in-depth description and discussion of current commercial driver training practices in Europe and the United States, the reader is referred to Staplin et al. That report reviews the work of Horn and Tardif (1999), which found that private schools most commonly offer a 150-hour curriculum that includes classroom, range, and on-road training. They also found that nonprofit schools tended to offer a more extensive curriculum, with some countries providing 700 hours of training. In France, the curriculum can require up to 2 years to complete, depending on the entering student's experience and knowledge.

Table 2. PTDI content topics for a certified training curriculum.

UNIT 1: BASIC OPERATION	
	1.1 Orientation
	1.2 Control Systems
	1.3 Vehicle Inspections
	1.4 Basic Control
	1.5 Shifting
	1.6 Backing and Docking
	1.7 Coupling and Uncoupling
UNIT 2: SAFE OPERATING PRACTICES FOR BASIC OPERATION	
	2.1 Visual Search
	2.2 Vehicle Communication
	2.3 Speed Management
	2.4 Space Management
UNIT 3: ADVANCED OPERATING PROCEDURES	
	3.1 Night Operation
	3.2 Extreme Driving Conditions
	3.3 Hazard Perception
	3.4 Emergency Maneuvers/Skid Avoidance
	3.5 Skid Control and Recovery
	3.6 Passive (Unmarked or Uncontrolled) Railroad Crossings
UNIT 4: VEHICLE SYSTEMS AND REPORTING MALFUNCTIONS	
	4.1 Identification and Maintenance
	4.2 Diagnosing and Reporting Malfunctions
UNIT 5: NON-VEHICLE ACTIVITIES	
	5.1 Handling and Documenting Cargo
	5.2 Environmental Issues
	5.3 Hours of Service Requirements
	5.4 Accident Procedures
	5.5 Managing Life on the Road/Personal Resources
	5.6 Trip Planning
	5.7 Communication Skills

Staplin et al. also reported on a study by Dueker (1995). The Staplin et al. discussion of that study merits quoting at length:

> Dueker (1995) conducted a study to determine the effectiveness of the private sector in ensuring adequate training of entry-level CMV drivers. This study focused on training for CMV drivers of heavy trucks, motorcoaches, and school buses. Operational definitions created for each of the terms included in the study objectives are presented below.
>
> "Entry-level training" was defined as all training received during the first 3 years of the driver's experience, including pre-service training, on-the-job training, and in-service training.

Table 3. Model driver training curriculum outline.

Introduction to Trucking	Control Systems
Vehicle Inspection	Basic Control
Backing	Coupling and Uncoupling
Fifth Wheel and Sliding Tandems	Special Rigs
Night Driving	Extreme Driving Conditions
Hazard Awareness	Emergency Maneuvers
Skid Control	Vehicle Systems
Braking Systems	Driver Wellness
Pre-trip Inspection	Product Handling
Cargo Documentation	Hours of Service/Fatigue Management
Accident Procedures	Trip Planning
Public Relations	Employer/Employee Relations
CDL Requirements	Visual Search
Communications	Space Management
Speed Management	Recognizing and Reporting Malfunctions
Preventive Maintenance and Servicing	Diesel Engines
Drug and Alcohol Abuse	Continuous Career Development

(Source: DTDA 1997)

Table 4. Course topics for LCV drivers.

Section 1: Orientation	1.1 LCVs in Trucking
	1.2 Regulatory Factors
	1.3 Driver Qualifications
	1.4 Vehicle Configuration Factors
Section 2: Basic Operation	2.1 Coupling and Uncoupling
	2.2 Basic Control and Handling
	2.3 Basic Maneuvers
	2.4 Turning, Steering and Tracking
	2.5 Proficiency Development
Section 3: Safe Operating Practices	3.1 Interacting with Traffic
	3.2 Speed and Space Management
	3.3 Night Operations
	3.4 Extreme Driving Conditions
	3.5 Security Issues
	3.6 Proficiency Development
Section 4:Advanced Operations	4.1 Hazard Perception
	4.2 Hazardous Situations
	4.3 Maintenance and Troubleshooting
Section 5: Non-Driving Activities	5.1 Routes and Trip Planning
	5.2 Cargo and Weight Considerations

Included in the definition of "private sector" were driving schools (i.e., public, private, and company-operated); certification and accreditation groups; carriers and fleet operators; associations; insurance companies; and drivers. Programs were considered as "formal training" only if they provided some number of class or lab hours, to discriminate between programs that just provided on-the-job training. Further, it was determined that on-street hours must be provided in addition to classroom hours for a program to be considered "adequate."

"Adequate training" for heavy trucks and motor coaches was defined . . . using the FHWA model tractor-trailer driver curriculum (Federal Highway Administration 1985) as a starting point and the consensus of a panel of 36 experts on the minimum acceptable requirements for each of the listed curriculum characteristics. . . . Data regarding the adequacy of heavy truck and motorcoach training were provided by a total of 640 respondents from industry, schools, and individual drivers who were surveyed in the Dueker (1995) study. The study concluded that the private sector is not effective in providing adequate training for drivers of heavy trucks, motorcoaches, or school buses. Data were provided to describe percentages of motor carriers that provide adequate training as well as percentages of drivers receiving adequate training. Of the heavy truck carriers who were surveyed, only 22% indicated that they provide formal training to the entry-level drivers they hire. This compares with 63% of motorcoach carriers surveyed who provide formal training to their entry-level drivers. In terms of the adequacy of the formal training provided, approximately one-third of the heavy truck carriers and motorcoach carriers provided training that was considered "adequate," as defined by project criteria. For heavy truck carriers, 38% provided training defined as "adequate;" and, for motorcoach carriers, 30% provided training that was defined as "adequate."

Combining the prevalence of formal training and the adequacy of formal training, the findings indicated that only 8.1% of heavy truck carriers who hire entry-level drivers provide adequate training for them, and only 18.5% of the motorcoach carriers who hire entry-level drivers provide adequate training for them.

Dueker (1995) also reports data provided by 141 heavy truck drivers and 22 motorcoach drivers to describe the number of drivers who are being adequately trained and the extent to which schools (publicly funded and proprietary) add to the percentage of adequately trained truck drivers. The drivers in the sample were limited to those with 5 or fewer years of experience (i.e., "new" drivers). The findings of the driver survey . . . show that both publicly and privately funded schools contribute substantially to the number of CMV drivers who receive adequate training (pp. 9–10).

The Canadian model tends to follow either the PTDI curriculum standards or those of the CTHRC. The CTHRC curriculum is a 12-week program with 120 hours of classroom time and 185 hours BTW.

Although European Union countries tend to have longer training programs, including significantly longer in-cab practice times, the subject matter in the training is very similar to that in the United States (Horn and Tardif). It goes beyond U.S. topics in teaching the various rules, practices, and cultures of the various countries in which the drivers will eventually drive.

The basic driver training model in Europe is vocational education. The process is selective and advances overall business competence as well as driving skills. This contrasts with U.S. training that focuses solely on developing driver skills (Hartman et al. 2000).

These authors describe the basic European model: "In Europe, a public/private effort has established a standardized curriculum that often uses advanced technologies such as simulators and password-protected Internet access. . . . Promotional activities publicize truck driver and related occupations." (Hartman et al., p.4)

The Hartman et al. report describes a study financed by the Office of International Programs of the FHWA. The panel conducting the study visited two institutions that "exemplify the European focus on using new technologies and related research to educate commercial vehicle drivers: the Association for the Development of Professional Training in Transport-Institute of Training and Warehousing Techniques (AFT-IFTIM) in Menchy Saint-Eloi, France, and Stora Holm in Gothenburg, Sweden." (p.4)

The ATF-IFTIM trains 20% of France's new commercial drivers each year. The institute offers an extensive curriculum that combines simulator, personal computer, and BTW training. It also requires a prescribed number of classroom hours and closely monitors BTW performance. The institute uses an innovative onboard recording device with individualized smart cards to establish driver trainee baseline performance and skills and to assess progress at prescribed intervals. In addition to vocational training, drivers must participate in refresher programs every 5 years (Hartman et al.; Staplin et al.).

The Swedish approach concentrates on developing the overall competence of professional drivers. The approach is based on the belief that greater breadth in training will produce more effective, safer drivers. The Stora Holm in

Gothenburg, Sweden, is an example of a municipal vocational center that offers the standard vocational curriculum and training program. Drivers take a 10-week course to qualify for a commercial vehicle license. Learning involves a combination of computers, simulators, and BTW training. A noteworthy advance is the use of computer-based training delivered via an extranet. The extranet training includes narrative Q&A and illustrations that use video stream inserts. All Stora Holm graduates are hired directly into the transport industry.

Kuncyté, Laberge-Nadeau, Crainic, and Read (2003) compared the training programs for hazmat drivers in Europe and North America. The authors selected Sweden and the Netherlands to represent Europe and Canada and the United States to represent North America. The differences among the four countries reflect both various regulatory pressures and diverse cultures. They found "In Canada and the US, it is the role of the employer to ensure appropriate truck-driver training for the transportation of dangerous goods. In Sweden and the Netherlands, a competent national authority must accredit training institutions or trainers and monitor the examination of truck drivers. However, all training system approaches pursue the same goal: to ensure appropriate training and prevent the accidental release of dangerous goods during transportation. . . . The involvement of national authorities is important for truck-driver training quality and control. Hence, without some standards, training does not always meet actual driver tasks and employer expectations" (Kuncyté et al., p. 1999).

Perhaps the best example of how culture influences truck driving training can be found in India. The Ashok Leyland Driver Training Centre at Namakkal was established in 1995. ". . . . this state-of-the-art school has comprehensive training facilities including a 2.5-km driving range, and imparts wholesome training to drivers for life on and off the road: scientific driving techniques apart, the curriculum includes health care, AIDS awareness and yoga." (http://www.ashokleyland.com/home.jsp)

The research team also looked at training programs for licensed commercial vehicle operators. Many carriers and motorcoach companies have what are basically apprenticeship programs. New drivers are paired with experienced drivers for normal operations. In some cases, the senior drivers are trained as instructors; in most cases, although they may be superior drivers they are not trained instructors. There are some data that suggest that training licensed but poor commercial drivers can result in significant reductions of accident rates (McFann).

There are commercial vehicle drivers who are driving vehicles that do not require an operator to hold a CDL. These are mostly straight trucks weighing less that 26,000 lb and passenger conveyance vehicles that carry fewer than 16 persons. The training of the drivers of these vehicles is not well documented. Training tends to be company and vehicle specific.

Chapter 4 summarizes the most recent findings on the latest practices in truck and bus operator training. During the past two decades, truck and bus professionals have reached an informal consensus on what it is that entry-level drivers must be taught. But there still remain very big questions about how instruction should be conducted and how the results of commercial vehicle operator training should be evaluated. The remainder of this report will address those issues.

3.6 Instructional Technology in Commercial Driver Training—CBI

There are a wide variety of products on the market claiming to be commercial driving CBI that lack one or more of the minimum characteristics of CBI. In addition, there are no generally accepted criteria against which various products and services could be compared. The team found the same issue in the discussion of simulation-based instruction.

The senior author of this report has written extensively on CBI (e.g., Eberts and Brock; Brock 1997; Brock 2006), driver training (Brock 1998, Hodell et al., Brock 2006) and commercial vehicle operations (Llaneras, Swezey, Brock, Rogers, and Van Cott 1998; DTDA; Brock, Krueger, Golembiewski, Daecher, Bishop, and Bergoffen 2005). From these and other research and development experiences, the following list describes the minimum characteristics one should find in a CBI program for commercial vehicle operators.

Interactive Learning. Students should be able to actively effect the operation of the training program. At a minimum, the program should ask frequent questions of the student and, based on the answers of the student, direct his or her progress through the training program. The student should also be able to query the program for answers, drills, and criterion tests. A set of slides copied to a CD-ROM, DVD, or website is not CBI.

Students Enter and Exit as Needed. At the very least, the learning management system accompanying the instructional program should have the flexibility of allowing each student to stop, go back, leave the program, and return in place as needed.

Easy to Use. Most driver training students will be experienced users of technology. Many will have expectations of what computers should do through their use of video games, personal computers, automated teller machines, cell phones, and various television recording and playing devices. These students should be receptive to well-designed and challenging CBI programs. However, the challenge must come from the content and instructional strategy, not from the operation of the CBI itself. The current CDL Manual is written at a sixth grade level (Brock, Golembiewski, McFann, Robinson, and Lewis, 2005). A driving CBI must be accessible to users who may not have strong verbal skills.

Visually Rich. Major components of driving are the perception and information processing of visual information. CBI directed at teaching safe driving performance must have a rich and realistic visual component.

Can be Customized to Include Company Policies, Vehicles, and Drivers. This is an important component for any successful commercial driver training program. Training should contain elements of culture and best practices, as well as regulations and driving fundamentals. For example, an over-the-road tanker carrier will have unique instructional requirements that are different from a grocery chain with its own fleet of trucks.

High Retention by Students. Students must learn from the CBI. Seemingly obvious, the failure of some commercial CBI products to adequately define the expected learning outcome of the instruction is a major product weakness.

Information Collected on a Common Database. The documentation of student achievement and interim progress is essential to a training program provided in a regulated environment. Schools can use the documentation to track students and provide student achievement information to potential employers. Carriers can also use the documentation to provide thorough records of driver training for insurance or legal inquiries.

Students Set Their Own Pace. The key to any competent CBI is the ability for each student to set his or her own pace through the learning experience. Each student must demonstrate that he or she has met the objectives of the training by passing tests. But the rate or pathway to meeting those objectives should be under the control of the student.

Criteria Testing. Students complete the CBI when they can pass the criteria test set out in the curriculum. The amount of time spent in front of the computer is not an attribute of interest (although excessive time might indicate a student who cannot master the material). Each student must meet the minimum standards as defined in the instructional package.

Modal Consistency. It is important that the CBI provide information and practice opportunities in ways that reflect the material being taught. For instance, if a lesson is being provided on "space management of a tractor-trailer," the CBI must provide visual displays showing what space management is. Simply providing text without photographs, graphics, or videos falls short of the minimum required. By the same token, lesson on maintaining logs or hazmat documents should provide realistic examples of such documents and allow the student to actually practice his or her role in keeping those documents accurate.

Much is made of distance learning—the ability to distribute learning over the Internet to remote places. The ability to provide high quality instruction to remote locations and to be available when the student is available is a major jump forward for CBI. Distant learning's potential for carriers and over-the-road motorcoach companies is obvious. However, distance learning must meet the same criteria as other CBI. ABA members now have a new educational resource with the introduction of online driver safety training via the Internet. According to ABA, this new educational tool sets a precedent within the industry, allowing drivers and maintenance personnel to take the classes online, at their own pace, eliminating costly training classes and company turnover.

The obvious advantage to distance learning in commercial vehicle operator training is that it can go where the drivers are. Instead of forcing drivers to assemble in some centralized location, the drivers can receive the instruction at their own rates and when it is convenient for them.

CBI is popular among users, although its contribution to traffic safety has not been systematically studied. One company has provided more than 500,000 hours of training using both CD-ROM-based and web-based training since 2001 (Voorhees 2006). The survey data, presented in the next chapter shows that a few carriers and schools are relying on CBI more and more, but most of the commercial driver training programs remain conventional, in-the-classroom programs.

Some commercially available driver training CBI, whether for commercial drivers or the general public, target specific aspects of vehicle operation (e.g., risk recognition and compensation, defensive driving). Others provide either complete instructional packages (e.g., CDL in a box), or computer-based products that integrate into a complete training course.

According to Staplin et al., UPS states that its CD-ROM- and web-based training programs are much more efficient and yield better results than paper manuals. Smithway Motor Xpress uses a computer-based training program to teach load securement procedures and reports training costs decrease from $1,000 per driver to $150 per driver. Most of the cost savings result from a reduction in the time it takes drivers to learn the material.

Ryder Truck (2000) describes a computer program that delivers 32 1-hour lessons on trucking fundamentals based on the PTDI curriculum. Lessons are delivered via a high-speed internet connection to the students, rather than having the students travel to a single location. Thompson (1996) describes a CD-ROM training program implemented by Frito-Lay to train drivers about U.S. DOT regulations, focusing on alcohol and drug requirements. CD-ROMs and PCs have been placed in 40 company locations throughout the United States.

This review found driver training CBI courses being offered by insurance companies, for-profit training schools, not-for-profit associations and organizations, and the U.S. military. In Europe, much the same thing was found, with somewhat more government involvement. What was not found was specific safety or performance data showing a causal relationship between CBI and traffic safety.

However, a few carriers are measuring the effectiveness of advanced technology training that includes both CBI and simulator-based training, which is discussed in the next section. Schneider National in Green Bay, Wisconsin, has recently implemented an innovative and technology-based training program for entry-level commercial drivers. The training course included traditional classroom instruction, CBI, simulation, BTW training, and reading assignments as homework. Since the new program was put into effect, Schneider is reporting that the graduation rate has increased from 75% to 81%, average time to going on the job decreased by 38%, and 0-to-90 day accident rate decreased from 31% to 10%. Schneider also estimates that for each 1-day reduction in training time, it saved $7,000,000 annually.

3.7 Instructional Technology in Commercial Driver Training—Simulator-Based Training

Data regarding the effectiveness of simulator training for truck drivers is better documented than that for CBI. In their review of practices in the European Union and North America, Horn and Tardif state that truck driver training has generally remained low tech, with the majority of training done using traditional methods of teaching. Although training simulators are appearing in some schools, they will remain the exception for years to come because the trucking industry and the private training schools do not have the money to pay for these tools. However, where there are simulators, there is good record keeping establishing the value of such costly devices.

Pierowicz et al. (2002) evaluated the adequacy of six simulators for use in a three-part study to determine whether simulator-based training can enhance training effectiveness and improve the performance of tractor-trailer drivers, compared with conventional training methods. The bulk of the Pierowicz et al. report describes the functionality of the six simulators and their adequacy for use in three upcoming validation studies. The simulators were evaluated on 183 factors to determine their adequacy in supporting the research design of the three study phases.

Regarding the use of driving simulators for training drivers, Brock et al. (2001) conducted a literature review, surveys, and site visits for *TCRP Report 72*. They concluded that transit bus operator training can be improved with selective use of transit bus simulators. They also noted that a critical feature in the success of simulator training programs is the competence and enthusiasm of the instructional staff.

The Brock et al. (2001) report discussed three current applications of simulator technology: (1) an open-loop video simulator, (2) a low-end simulator, and (3) a so-called mid-range simulator. All three simulators are used to train new drivers; they are also often used to retrain more experienced drivers. However, each device trains a subset of the skills required by drivers of transit buses, but none trains them all. Table 5 describes these three levels of simulation; Table 6 shows how the levels of simulation can train the various components of the driving task.

Brock et al. (2001) note that the use of simulation decreased trainee drop-out rates by 35% for an agency using the mid-level simulator, decreased student failure rates by 50% in an agency that uses the open-loop and the low-end simulators, and decreased the collision rate by 10% in an agency using a combination of open-loop and low-end simulators. In addition, the use of simulation reduced training time in one agency from 19 days to 17 days by replacing classroom bus training with simulator training. In another agency, using just the open-loop system, training time was reduced by 5 days when simulation was employed.

The only agency surveyed that used the mid-range simulator reported that, 90 days after training, 32% of their conventionally trained drivers had experienced a crash, compared with 18% of their simulator trained drivers. In this agency, simulator training in tasks related to overtaking and being overtaken by vehicles on the left and right sides of the bus resulted in fewer crashes by the students performing these maneuvers in the real world (17 crashes by the simulator-trained students compared with 154 crashes for the non-simulator-trained students).

The transit agencies surveyed by Brock et al. (2001) reported that simulators are also able to replace some of the hours spent in the actual vehicle. This can have a significant impact on training costs, as simulator costs can run as low as $3 per hour per student versus $40 per hour per student for in-vehicle training. Results of a survey of bus operator trainers conducted by Brock et al. (2001) indicate a high level of satisfaction with their training simulators. Fifty-

Table 5. Levels of transit bus operator simulators.

Level 1: Open-Loop Video The most popular method of driver training delivery in use in transit agencies. It uses open-loop video to display traffic and other instructional information. It consists of several student stations, each with a steering wheel, gas and brake pedals, and a rudimentary dashboard. This device is characterized as an "open-loop" system because it is non-interactive. Although each station is equipped with a steering wheel, gas pedal, and brake pedal, the student's engagement of any of these controls will not produce any appreciable effect on the video display. The system, as designed, trains and tests very specific bus operator activities (e.g., reaction time and visual recognition). Stopping distances, road conditions, the relationship of speed to both, and the role of reaction time can be shown and then practiced. Because the instructor station for the system measures performance in each learning station, the instructors can monitor and identify students who are not correctly responding as the scenarios play out.
Level 2: Low-End Simulator The second method of driver training delivery is a model-board system. In this low-end simulation, a miniature camera is installed in a small model of a bus that physically moves about on a small terrain board in an adjoining room. This system replicates the visual, auditory, and vibratory effects of driving a bus in an urban, crowded environment to train student operators to maneuver a transit bus in relatively tight situations. The system demonstrates basic maneuvering of transit buses in typical urban areas. Such skills as approaching a bus stop, parking, tight turns, and backing can be taught to a single student without risk of damage to either an actual bus or to platforms, other vehicles, or pedestrians.
Level 3: Mid-Range Simulator The third driver training delivery method is a mid-range simulator that uses realistic audio and video; including rear projection, to deliver a fuller replication of the driving experience. A larger field-of-view (FOV), on the order of 180 degrees forward, a vertical FOV of at least 45 degrees, and 60 degrees to the rear, distinguishes this simulator from the low-end simulator. Additionally, a more sophisticated vehicle model is provided, along with more complex environmental effects (weather, day-night, and road friction), and motion cues to replicate the look and feel of the outside world as seen by a driver looking out the windows of a bus cabin. One of the very strong features of this device is the fact that the mirrors in the simulated cab are actual mirrors; they can be physically manipulated to reflect the imagery that is projected behind the simulator cab. The visual imagery for this system was developed for the specific driving environment of the transit buses for which the operators are being trained. Therefore, the device provides high fidelity simulation of actual driving situations that trainees are likely to encounter on completion of the training program.

(Source: Brock, Jacobs, and Buchter 2001)

eight percent of the respondents indicated that simulator training is more effective than traditional training for teaching certain types of knowledge, skills, or attitudes. In particular, simulator training validates defensive driving techniques taught in the classroom, provides an opportunity to experience hazardous situations without putting the students or the bus at risk, reinforces proper driving habits and defensive driving principles, and allows instructors to check reaction time, eye-hand coordination, and driving skills. Instructors indicated that trainees with little or no experience were better prepared for their initial driving assignment. Seventy-five percent of the drivers surveyed reported that their bus simulation training enhanced their learning experience, although 6 of the 51 respondents reported motion sickness, dizziness, and disorientation after bus simulation training.

Staplin et al. report on a high-end simulator application for CMV driver training. It is a $1 million system purchased by the Texas Motor Transportation Association. This system is used to allow experienced truck drivers to safely experience dangerous situations such as a veering car, a tire blowout, or dense fog. The full-motion simulator is built into a 53-ft trailer and uses an authentic truck cab that moves in response to a driver's inputs when viewing driving scenarios on a large screen. The trailer also contains a small classroom with six computers that provide interactive lessons on topics such as space management and securing loads. The association will rent the unit to carriers for $1,000 per day. No data regarding the effectiveness of this training tool was found for this review.

Throughout Europe, driving simulators are becoming an important enhancement for cost-effective, safe driver training (Hartman et al.). They are cost-effective because they allow year round training and cost less than BTW training. Hartman et al. do observe that "because simulators cannot capture real-life terrain and vehicle dynamics, the optimal

Table 6. Operational capabilities matrix.

	Open-Loop	Low-End Simulation	Mid-Range Simulation
Throughput/Session	8	1	1
Simulated Vehicle Environment	✓	✓	✓
Interactivity		✓	✓
High Task Fidelity			✓
Model Terrain Board		✓	
Realistic Audio/Visual Systems			✓
Instructor Console	✓		✓
Realistic Gauges and Instruments	✓	✓	✓
Performance Measurement Tools	✓	✓	✓
Full Visual Replication of Driving Scene			✓
Fully Functional Traffic Signals			✓
Virtual Driving World Encompassing 50 Square Miles			✓
Intelligent Traffic			✓
Real Mirrors			✓
Skill-Based Training	✓	✓	✓
Rule-Based Training		✓	✓
Knowledge-Based Training			✓

(Source: Brock, Jacobs, and McCauley 2001)

blend of simulator/computer/behind-the-wheel training needs has not yet been determined." (p.5)

First-year deployment of the AFT-IFTIM's driver simulator yielded impressive results. Reports indicate both time-saving and training effectiveness. Most notable was enhanced maneuvering training. AFT-IFTIM considers 1 hour on the simulator and 4 hours BTW to be more effective than 8 hours BTW. (Hartman et al.)

Driving simulators are also being extensively used in research settings, often with interesting and relevant experimental results. For instance, Strayer and Drews (2005) found that drivers who spent 2 hours in a simulator learning to shift to maximize fuel efficiency were "assessed over a 6-month interval using measures of fuel consumption obtained by drivers in their own vehicles driving their normal route. Training increased fuel efficiency by an average of 2.8% over the six-month interval." (p.190) These findings held steady even for those drivers who drove vehicles not specifically simulated in the training sessions, suggesting that simulators can be used to teach general driving skills.

In the Schneider data, the instructional staff believes that dramatic accident reduction and course completion can be primarily attributed to the use of simulation in the training program. Table 7 shows the ratio of various training methods to each other in the Schneider program.

It seems clear from reviewing the simulation literature and the current industry use of simulators that the real payoff from simulation technology is in the larger context of a particular training program. The senior author observed the

Table 7. Basic training methods.

METHOD	TRAINING TIME	PERCENTAGE OF COURSE
Classroom	**45 Hours**	**35%**
Truck	**53 Hours**	**43%**
Behind-the-wheel	41 Hours	33%
Observing	12 Hours	10%
Simulation	**13 Hours**	**11%**
Behind-the-wheel	7 Hours	6%
Observing	6 Hours	5%
Lab at the truck (hands on)	**13 Hours**	**11%**

(Source: Schneider International)

use of simulators at New York and New Jersey transit training facilities. The two agencies actually use quite different simulators. However, both agencies also report data supporting the use of simulation technology to reduce accidents and enhance the training experience (Brock, Jacobs, and McCauley 2001).

The key similarities of the two training programs were enthusiasm of the instructors, management support of simulator costs, and careful mentoring of each student as he or she cycles through the training program. Also, each training program capitalized on the specific capabilities of the individual device.

3.8 Training Effectiveness

Do Current Training Practices Work? Certainly, this is one of the fundamental questions the research team set out to answer. Persons familiar with the motor carrier, motorcoach, transit, and school bus communities will not be surprised to learn that the answer is "yes" when opinions are sought, but only "maybe" when hard data are needed.

The findings of the survey are presented in Chapter 4, but one question the team asked was, Do you have any data that indicates that driver training works? None reported data on the general benefit of training. A few had data on specific interventions (e.g., simulation), but it was limited and far too specific to draw any general conclusions. Ironically, the most common response to the question was, No, but could you send us some?

Is the CDL Enough? The only current U.S. measurement of driver proficiency is the CDL. Applicants for that license do not have to have completed any formal training; they simply have to pass all components of the test (knowledge, vehicle inspection, basic skills, and road test). The CDL test is a necessary step in becoming a professional driver; however, it is unlikely that it is a sufficient one.

Like most tests, the CDL test uses a sampling technique to measure each applicant. Questions on the general knowledge test, the endorsement tests, and the air brake test are randomly drawn from a pool of more than 300 questions (Essex Corporation; Brock, Golembiewski, McFann, Robinson, and Lewis 2005). The vehicle inspection test also follows a sampling model; applicants are randomly assigned to one of four (for tractor trailers) or three (for straight trucks and buses) test conditions. The basic skills test tries to measure basic maneuvering skills, but is limited by both the available time and geographic restrictions of the testing facility. The road test, while attempting to provide as many real-world situations as possible, is usually 30 to 40 minutes long, is dependent on the traffic and weather conditions occurring during the test, and is restricted to the vicinity of the test site. (Brock et al. 2005)

Current Measurement Techniques. In the surveys, the most often used standard reported for the measurement of training effectiveness was CDL test pass rate. If significant numbers of students (more than 70%) were receiving their CDL, the schools were seen as successful. For schools, another measure of success was the number of graduates hired for driving positions. Carriers had some general sense of improved safety performance resulting from training, but firm data were in short supply.

Using the language of the Kirkpatrick model presented in Chapter 2, every training organization surveyed reported measuring *reaction* (student opinions of the training) and *learning* (student test performance in the course). However, *behavior* (on-the-job) measures tended to be reflected in the CDL test pass rates and percentage of graduates hired into commercial driving jobs. Other than a general belief that training has a positive effect on the cost of operations, the surveys revealed no instance of *impact* measures.

What Needs to Be Measured? The ultimate question about commercial driver training is, Does it reduce commercial vehicle crashes? Industry also would like to see more data on the effects of training on the costs of operations, maintenance, and driver turnover. Once a chain of causation can be linked between driver on-the-job performance, organizational safety improvement, cost reductions, and training, a set of standards can be derived for appropriate measures of training effectiveness at various links on that chain.

For instance, measures of student performance in the course are essential. The ISD model, if it were followed, would provide a set of training tasks that each student would have to perform before he or she could be considered a graduate of a training program. But then what happens? The AAA Foundation for Traffic Safety has recently sponsored a research program on evaluating driver education programs (Lonero and Clinton 2006). Although specifically aimed at evaluating driver training programs for young drivers, much of the report's content can apply to evaluating commercial driver training programs as well. Table 8 shows the various events and activities that can act as targets to provide evaluation of a commercial driver training program, as well as the novice driver education program specifically addressed in the report. Two other documents (Clinton and Lonero 2006a, Clinton and Lonero 2006b), providing guidelines and a how-to manual for conducting driver education, have been published. These documents provide a sound basis for developing tools, methodologies, and procedures for evaluating

Table 8. Driver education evaluation targets.

Evaluation Types	Program Areas	General Evaluation Targets
Formative Evaluation	Program context	Regulatory environment
		Contractual environment
	Business processes	Quality management and control
		Marketing
		Customer service
	Program standards	Benchmarking and certification
		Transferability of the program
	Instructional products	Curriculum materials
		Tests and measurement
	Instructional processes	Instructor preparation
		Curriculum delivery; in-car practice
		Instructional facilities
Summative Evaluation	Student outcomes	Knowledge outcomes
		Skill outcomes
		Motivation outcomes
		Mobility outcomes
		Behavioral outcomes
	Social impacts	Crash reduction impacts
		Injury reduction impacts
		Socioeconomic impacts
Meta-evaluation	Evaluation quality	Evaluation effectiveness

(Source: Lonero and Clinton 2006, p. 50)

commercial driver training programs as well as novice driver training programs.

Final Comments on the Literature Review. Although the literature review produced instances of driving improvement linked specifically to training interventions (e.g., simulators), there are no general data linking decreased accident rates to formal training programs. The two primary reasons for this are (1) training, as a concept, is not well nor operationally defined and (2) there are no generally agreed upon standards by which various training programs can be compared. A third problem is the likelihood that most training effects are realized in the first 6 months of a driver being on the road.

CHAPTER 4

Survey Procedures and Results

4.1 Context of the Survey

This synthesis sought to determine how many commercial driver training programs exist. Based on interviews with and surveys of associations and organizations, the research team estimates that there are close to 3,600 commercial driver training programs in the United States (combining truck carriers and schools, motorcoaches, and transit agencies). This number includes not only entry-level training leading to a CDL or other license, but also specific vehicle training (e.g., tankers, transit buses) as well. The number does not include school bus training programs run by school districts or other state or country agencies.

The team sent a survey (see Appendix B) over the Internet using email address lists provided by various training and carrier organizations. The goal was to get a snapshot of the day-to-day activities of commercial driver training organizations. Two specific areas of inquiry were of interest (1) how trainers measure the effectiveness of their training and (2) how trainers measure the effectiveness of their graduates.

The team received 42 responses. Although the sample size is relatively small, the consistency of the responses and the way they support the collective experience of the research team suggests that the data are useful and do represent the truck and bus driver training industry. In the last decade, the co-authors of the research team have visited commercial driver training operations at carriers, for-profit training schools, public junior colleges that offer commercial driving training, research centers, transit agencies, and motorcoach companies.

4.2 Survey Respondents

Of the training operations responding to the survey, 7 have more than 1,000 students per year, 2 have between 500 and 1,000, 3 have between 250 and 500, 6 have between 100 and 250, and 24 have fewer than 100 students per year. This range of graduating students reflects the ratio of large to medium to small training operations that one finds in the commercial driver training population.

4.3 Survey Results

The respondents identified four types of skills training: range training with students either driving a vehicle around a restricted space or riding in a vehicle which is being driven by a different student, simulator training, demonstration of skills by an instructor, and BTW on road training. Not all schools use all four methods. Table 9 shows the number of hours for each activity in terms of the ranges, the medium, and the modes for each of the four methods. In interpreting these answers, it is important to remember that while most of the respondents offer 3 to 6 weeks of total training, the very large number of hours by method reflects training performed in 2 or 4 semester technical training schools.

The survey also asked each respondent to rate the effectiveness of each training method he or she uses, using the following scale: 1 = not effective, 2 = marginally effective, 3 = effective, 4 = very effective, 5 = most effective. No one rated any materials ineffective. Overall, there seems to be general agreement that current training methods are at least effective. There was overwhelming agreement that the most effective training method was over-the-road driving. Table 10 shows the distribution of rating for current training methods.

It is clear that training providers are convinced that the way for someone to learn how to drive a commercial vehicle is to drive a commercial vehicle under the supervision of, presumably, a master driver.

In terms of what training is offered, all of the responding training organizations offer training for Class A vehicles, 12 for Class B vehicles, and 3 for Class C vehicles. Seventeen offered remedial training (training a driver who has demonstrated

Table 9. Methods of skills training in survey sample.

SKILL TRAINING METHOD	DRIVING RANGE (N = 31)	SIMULATION (N = 16)	DEMONSTRATION (N = 22)	OVER THE ROAD (BTW) (N = 36)
Range in Hours	6-220	1-20	2-100	9-1900
Medium Number of Hours	40	3	10	42
Mode for Number of Hours	20	2	2	44

Table 10. Ratings of driver training methods.

METHODS	Not Effective	Marginally Effective	Effective	Very Effective	Most Effective
Lectures (n = 43)		1	18	16	8
Films/Video (n = 42)		1	29	12	
Computer-Based Training (n = 12)		5	6	1	
Web-Based (n = 14)		3	6	4	1
Textbooks (n = 43)		3	27	12	1
Range BTW (n = 36)		1	3	7	25
Simulation (n = 25)		5	10	9	1
Demonstrations (n = 38)			8	22	8
Over the Road (n = 43)			2	1	40

some decrement in driving skills), 27 offered refresher training, and 8 provided various specialized training (e.g., maintenance, dispatch). Table 11 shows percentages of specialized training.

The team also asked the training organizations what records they maintained to measure the effectiveness of their overall training program. Table 12 lists those results.

4.4 Special Cases

In addition to the survey, literature and current training programs were reviewed to see if there were some other data that might add to the conclusions for this report. The synthesis briefly describes three particular cases: a paper by McFann reviewing some studies on training effectiveness conducted in the 1990s; *TCRP Report 72;* and a visit to Schneider National's Driver Training Facility in Green Bay, Wisconsin, in October 2006. All three sources identified a key component of a commercial vehicle driver training program: the role of the instructor.

1990s Training Effectiveness Study. In 1991, McFann determined that 17% of the drivers in one carrier's organization were having 77% of the accidents with an annual cost between $35 and $40 million. Based on his previous experiences, McFann strongly suspected that the problem was with the on-the-job training instructors. All the trainers were brought together for a week of orientation, information, and evaluation.

As part of that initial train-the-trainer class, all the instructors were given a standardized road test. Instructor performance errors were categorized by vehicle movement. The instructor's performance errors were then compared to a list of accidents by students during their first 90 days of service. The results, shown in Table 13, were "too close to be a coincidence." (McFann, p. 8) The errors the instructors were making were being taught to the students. The apparent anomaly between percent of left-turn accidents and percent errors by vehicle movement can be explained by observing that the driver has more room and better visibility when making a left turn, but that the skills involved in making a left turn are almost identical to those used in making a right turn. So performance errors during a left-hand turn tend to result in fewer accidents.

TCRP Report 72. Brock, Jacobs, and McCauley report on two successful applications of simulator training with two different transit agencies. The interesting part of this finding is that one of the agencies was using an advanced (for 2000)

Table 11. Percentage of schools offering specialized training.

TOPIC	PERCENTAGE OF SCHOOLS PROVIDING TRAINING
Hazardous Materials Endorsement	62%
Passenger Endorsement	23%
Doubles/Triples Endorsement	59%
Tank Vehicle Endorsement	59%
School Bus Endorsement	15%
Air Brakes	100%

Table 12. Training organizations' records.

Student Records		Percentage Maintaining
	Course evaluations	100
	Written test scores	100
	Performance test scores	100
	CDL pass/fail	100
	Post-licensing data	36
	Other	20
Instructor Records		
	Course evaluations	100
	Driving records	100
	Train the trainer	79
	Length of service	100
	Other	18

Table 13. Instructor performance errors and student accidents.

VEHICLE MOVEMENT	FREQUENCY OF INSTRUCTOR VEHICLE ERRORS	FREQUENCY OF STUDENT ACCIDENTS
Right-Hand Turn	19.7	18.4
Left-Hand Turn	20.5	9.1
Lane Change	7.7	10.5
Straight Ahead	47.1	49.4
Search	49	51

(Source: McFann 2001)

driving simulator while the other agency was using a much older technology that lacked many of the features deemed important in driver simulator design. Yet both agencies were reporting high satisfaction with their systems.

The common denominator was the quality of the instructional staff. Both agencies were managed and staffed by enthusiastic, knowledgeable, and dedicated men and women. Instructors were hands on. Even when students were in the respective simulators, instructors were right there with them, guiding them much as one would in an actual vehicle. At least one vendor of driving simulators has found that the success or failure of its installed systems depends as much on the acceptance and collaboration of the training program's staff as it does on the engineering of the device itself (Brock 2003).

Schneider National's Driver Training Facility. Schneider has 250 frontline instructors (road, range, simulator) for all its training locations. Frontline instructors are accident free million milers. However, before becoming instructors, each person goes through 3 weeks of training emphasizing adult learning styles, diversity and sexual harassment, and training methods and standards.

In addition, Schneider has 700 on-the-job training instructors, called training engineers. These are drivers with at least 1 year of experience, an accident free record, and high customer service ratings. Each training engineer receives 8 days of training. The point of this is to ensure that new drivers are not just along for the ride during this final phase of training, but that actual instruction is happening in the process.

CHAPTER 5

Discussion and Conclusions

5.1 Discussion

The training of men and women to become commercial vehicle drivers is a critical step in the national transportation system. Carriers, motorcoach companies, transit agencies, and various state, county, and school district governments all report a chronic shortage of trained truck and bus drivers. Because these drivers work in the midst of the general public, their degree of driving competence has a direct effect on the safety of the population at large. Trucks are an essential part of the complex goods delivery system in the country. Buses carry groups of people who otherwise would be adding to traffic congestion and pollution or who would not have the freedom to travel at all.

The truck and bus industries have evolved into their current state without much conscious design. The men and women who need commercial vehicle operator training are in demand because the United States has an increasing need to transport goods and people on its roads. Customers demand just-in-time deliveries, consistent and predictable schedules, and rapid response to variable needs. At the same time, the general public demands safe roads and well-trained operators of commercial vehicles.

The industries face a shortage of commercial drivers. Training has the potential to bring new commercial drivers up to the level of experienced drivers more quickly. This report describes some of the efforts (both research-based and operational) that show promise in developing that potential.

The survey sent out for this study asked a final open ended question to try to identify what training standards are currently used within the industry. In replying to that question, many of the respondents stated that there are still too many training programs, products, and devices that fall far short of acceptable instructional standards. One safety officer told about a school that just keeps sending its students to CDL test sites until they eventually pass the test. Others complained that having the CDL as the only objective measure of a student's driving ability left open the door for so-called CDL mills that teach the minimum required to pass the CDL test.

Appendix A describes two research approaches that could lead to higher standards for commercial vehicle operator training without major disruptions of current surface transportation operations. This report tries to capture a snapshot of the state of commercial vehicle operator training in the United States in 2006. The conclusions that follow combine the results of the literature review, the survey, individual conversations held with safety and training personnel throughout the truck and bus community, and the collective experiences and knowledge of the research team.

5.2 Conclusions

- **Content.** There is general agreement across the industry about the core content of commercial driving curricula. However, the content has evolved through an informal consensus based on the 1984 FHWA Model Curriculum, which listed what was believed to be the necessary content at the time. There are no national standards on content, although when one examines various curricula little content difference can be found. The industry could use a systematic development of a modern commercial driver training curriculum.
- **Instructional Methods.** By far, the favorite method for training commercial drivers is a combination of classroom lectures and supervised driving. Most of the research findings on adult learning and instructional technology from the last 30 years have not penetrated a significant number of commercial driving training enterprises. In those cases where advanced technologies are being applied, early data indicate that well-designed CBI, including simulation, can improve student performance and also realize efficiencies in the instructional process. Distance learning shows great promise for post-licensing training. Modern display technologies currently being installed in truck cabs

could serve double duty as displays for computer-based training administered from some central location but downloaded to any point in the country.

- **Train the Trainer.** It is natural that older, experienced drivers are selected to be instructors, no matter if the training is administered by a school, carrier, bus company, or transit agency. But there is no evidence that a person who is a job expert is necessarily a good teacher. There are two clusters of skills a good driver training instructor must possess beyond driving competence. The first cluster, classroom skills (presentation fundamentals, using classroom equipment, listening to students), is well recognized and a part of good train-the-trainer programs. The second cluster is what is required of a BTW instructor (observational fundamentals, explaining activities in understandable and behavioral terms, cool head, ability to anticipate risky situations). Since there are no standards for commercial vehicle driver training instructors, this most important role in the training process is extremely variable.
- **Lack of Systematic Training Design.** The commercial vehicle industries have reached an informal consensus on the subject matter of commercial driver training. But is has been more than 20 years since a formal curriculum design for commercial drivers was systematically developed. In that 20 years, the CDL program has become law, new technologies and regulations for truck and bus operations have had a major impact on the drivers, and the collected knowledge about what affects commercial driver's performance (e.g., fatigue, distraction, age) has grown exponentially.
- **Lack of Standards for Measuring the Effectiveness of Driver Training Programs.** Currently, the only generally acceptable standard for measuring the effectiveness of commercial driver training is the number of graduates who can pass the CDL test. In the survey and in personal conversations, schools reported that they also track the number of graduates that are hired by carriers. Carriers, motorcoach operations, and transit agencies report that they are sure that training reduces accidents; however, there is little or no data that support that view. There is a general belief that competent training reduces accidents, at least among graduates during the first 6 months of their on-the-job driving. However, the standards used to measure training effectiveness tend to measure processes (classroom hours, time spent BTW) rather than specific performance outcomes. Appendix A proposes some approaches to developing more performance-based standards to measure the effectiveness of commercial driver training.
- **Commercial Vehicle Operator Abilities.** There has been a spate of recent research on the capabilities and limitations of adolescent drivers (e.g., Winston and Senserrick). However, a similar scientific approach to commercial drivers is lacking. If driver trainers understood more about the learning styles, cognitive strategies, and past educational experiences, training could be tailored to the relevant needs of the individual student. Stereotypes of commercial drivers are not congruent with the actual people the research team knows who drive trucks and buses. Good instructors and safety directors recognize the variety of the driver student population. A set of diagnostic tests that could funnel students into unique optimum learning opportunities would be a major step in improving commercial driver training.

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APPENDIX A

A Model Research Plan

At a meeting with key researchers in late summer 2006, the senior author was asked to include a research approach to answering some of the fundamental questions about commercial driver training. The two questions addressed in this brief discussion were (1) Does commercial driver training contribute to traffic safety? and if so, (2) What are some optimum approaches to maximizing that contribution? Table A-1 provides an outline of this appendix.

Macro Approach. The data that are missing from this report would answer the question, Does training work? Although there are specific instances discussed in the body of the report, a general data based conclusion on the importance of driving training is lacking. One problem, of course, is the variability of what is called, "training." A large field study would be needed to establish if there is a general safety benefit from training, no matter its particular form.

Such a study would require the cooperation of many, if not all, the states plus active participation by appropriate industry associations. The overall approach would be to collect training background information on every CDL applicant in the participating jurisdictions for a period of 6 months. Each applicant would need to fill out a short (this is important) form identifying if he or she had graduated from a training program and, if so, what kind (e.g., length of course, any technologies, apprenticeship opportunities). Each participant would need to sign an informed consent form to allow access to his or her driving records for the period of the study.

Each participant would be followed for 6 months beyond obtaining his or her CDL. Data would also be collected on those who fail the CDL test or who have to take it multiple times. Data analysis would be massive. The best outcome that could be expected would be a set of correlations between driving records (accidents, citations) and various kinds of training including a "no formal training" category. Once the initial data collection and analysis were completed, random samples of the participants could be followed for a longer period of time.

The major weakness of this approach would be that even with the high number of participants (the team estimates between 90,000 and 125,000), the variety of training experiences from which the participants come will make it difficult to make any generalizations about training effectiveness. The strength of the approach is that if there are any significant findings, they will be important. One possible finding, that new CDL owners who get additional training after licensing have better safety records than those that go directly into the workforces, could lead to new post-CDL training standards with high safety payoffs.

Micro Approach. This approach would try to identify specific instructional interventions that produce increased levels of safe performance among commercial driving students. The current FMCSA simulation evaluation program could be a model for this approach. The interventions of interest, such as driving simulation, could be submitted to a set of experimental controls to measure particular safety effects. Several instances of this kind of approach are described in the body of the report, albeit with less rigor than one would want for a formal investigation.

If an experimental design model could be developed and protocols designed, vendors, experimentalists, training operations, and users would have a common method to evaluate any kind of instructional intervention. A key feature of this approach is that a specific set of measurable objectives for training outcomes must be established. Once this is accomplished, than various approaches, devices, and products can be tested to see how well they meet either some or all of the objectives. Studies could be paid for by normal sources (government grants and contracts, industry grants) or by various potential stakeholders in the process

Table A-1. Research approaches.

MACRO	MICRO
Massive field study	Series of experiments on specific training interventions
Take your subjects where you find them. Large N	Controlled laboratory setting Volunteer subjects Small N
Need and state cooperation • As many jurisdictions as possible • Track each participant for at least 6 months	Candidate CBI programs • Vendors provide products—pay for third-party testing • Industry selects candidates that have minimum standards
Need 6 months identifying subjects (informed consent, agreement to release records, self-reporting protocols)	Establish end of course standards (beyond CDL) based on industry/government consensus
6 months of data collection beyond the 6 months	6 months initial data collection
15-month study *after* states are on board	1 year study

(simulator and training material vendors). It would be similar to the Food and Drug Administration model for testing new drugs.

These two approaches would retrieve quite different results. One would produce, at best, some general findings about the effects of various formal training programs on traffic safety. The other would produce empirical data to support the acceptance or rejection of various instructional techniques for improving the specific performance of commercial drivers.

APPENDIX B

Commercial Vehicle Operator Training Survey

COMMERCIAL VEHICLE OPERATOR
TRAINING SURVEY

First, tell us about your company:

Are you primarily a: Carrier__ School__Transit Agency__Charter Bus Company__

Scheduled Bus Company__School Bus Company__Other (please explain)

Do you train: CDL Class A__CDL Class B__CDL Class C __

Endorsements: HAZMAT__Passenger__Doubles/Triples__Tanker__School Bus__

Remedial training__ Refresher training__ Specialized training (please explain)

Do you include air brake training? YES__ NO__

How many students did you train in: 2002 _____2003________2004_______ 2005_______
So far, in 2006______

Of all of these students, how many went on to receive a CDL? _____________

Do you have any certifications (PTDI, State, Association)? YES__ NO__

If yes, please list them:

Now, tell us some specifics about your training program:

What is your primary method for classroom training?
Lectures__Films/videos__CBT__Web-based training__Textbooks__
What other methods do you use in the classroom?
Lectures__Films/videos__CBT__Web-based training__Textbooks

What is your primary method for skills training?

Restricted In-vehicle driving # of hours___________
Simulation # of hours___________
Demonstrations # of hours____________
On the Road driving # of hours___________
Other (please describe____
____
____

Do you obtain training materials from one or more vendors? YES__ NO__
If YES, please list:

VENDOR	MATERIALS/PRODUCTS
______________________	____
______________________	____
______________________	____
______________________	____

Please rate the effectiveness of each training method you use. Use the following scale:
1=not effective, 2=marginally effective, 3=effective, 4=very effectively, 5=most effective

Lectures	______________________
Films/videos	______________________
CBT	______________________
Web-based training	______________________
Textbooks	______________________
Restricted In-vehicle driving	______________________
Simulation	______________________
Demonstrations	______________________
On the Road driving	______________________

Tell us about the records you keep:

Student records: Course evaluations__ Written test scores__ Performance test scores__ CDL pass/fail__
Post-licensing driving records__

Instructor records: Course evaluations__ Driving records__ Train the trainer training__ Length of service__

We believe that training leads to safer drivers. However, there isn't a lot of hard evidence that this is true. We would like to know if you have any records or data that show that your graduates have better safety records than drivers who have not had your training. Please share as much as you can with us.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation