



A Qualitative Analysis of Bus Simulator Training on Transit Incidents – A Case Study in Florida

June 2013

PROJECT NO.

FDOT BDK85 Task Work Order #977-07

PREPARED FOR

Florida Department of Transportation



Disclaimer

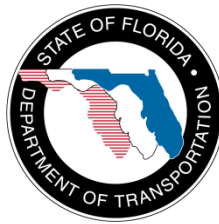
The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the Department of Transportation University Transportation Centers Program and the Florida Department of Transportation, in the interest of information exchange. The U.S. Government and the Florida Department of Transportation assume no liability for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation.

A Qualitative Analysis of Bus Simulator Training on Transit Incidents – A Case Study in Florida

FDOT BDK85 Task Work Order #977-07

Prepared for:



Florida Department of Transportation
Elizabeth M. Stutts, Grant Programs Administrator

Prepared by:



USF Center for Urban Transportation Research
Amber Reep, Senior Research Associate
Lisa Staes, Program Director
Victoria Perk, Senior Research Associate

Final Report

June 2013

Metric Conversion

SI* Modern Metric Conversion Factors as provided by the Department of Transportation, Federal Highway Administration <http://www.fhwa.dot.gov/aaa/metricp.htm>

Length

SYMBOL	WHEN YOU	MULTIPLY BY	TO FIND	SYMBOL
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km

Area

SYMBOL	WHEN YOU	MULTIPLY BY	TO FIND	SYMBOL
in ²	square inches	645.2	square	mm ²
ft ²	square feet	0.093	square meters	m ²
yd ²	square yard	0.836	square meters	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.59	square	km ²

Length

SYMBOL	WHEN YOU	MULTIPLY	TO FIND	SYMBOL
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi

Area

SYMBOL	WHEN YOU	MULTIPLY BY	TO FIND	SYMBOL
mm ²	square	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
ha	hectares	2.47	acres	ac
km ²	square	0.386	square miles	mi ²

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

Technical Report Documentation Page

1. Report No. BDK85 977-07	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle: A Qualitative Analysis of Bus Simulator Training on Transit Incidents- A Case Study in Florida		5. Report Date June 2013	
		6. Performing Organization Code	
7. Author(s) Amber Reep, Lisa Staes and Victoria Perk		8. Performing Organization Report No. NCTR 77701/BDK85 977-07 U.S. DOT DTRS98-G-0032	
9. Performing Organization Name and Address National Center for Transit Research Center for Urban Transportation Research University of South Florida 4202 E Fowler Avenue, CUT 100, Tampa, FL 33620-5375		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. FDOT BDK85 977-07	
12. Sponsoring Agency Name and Address Research and Innovative Technology Administration U.S. Department of Transportation, Mail Code RDT-30 1200 New Jersey Ave, SE, Room E33, Washington, DC 20590-0001 Florida Department of Transportation Research Center 605 Suwannee Street, MS 30, Tallahassee, FL 32399		13. Type of Report and Period Covered Final Report 12/23/08-05/30/13	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract The purpose of this research was to track and observe three Florida public transit agencies as they incorporated and integrated computer-based transit bus simulators into their existing bus operator training programs. In addition to the three Florida case study agencies, four transit agencies outside Florida were contacted and interviewed on their experiences with the use of bus simulators in their operator training programs. The Research Team asked agencies to provide any relevant data they may have collected to track the performance of the simulator training to allow for a more robust discussion of safety improvements that may have resulted. The report also provides insight from the transit agencies' perspectives on how their simulators are utilized, and offers important perspective on lessons learned and best and model practices.			
17. Key Words Simulator, training, bus operator training		18. Distribution Statement	
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 59	22. Price

Acknowledgments

This report was prepared by the National Center for Transit Research, at the Center for Urban Transportation Research, University of South Florida, through the sponsorship of the Florida Department of Transportation. The Research Team would like to sincerely thank the Florida Department of Transportation's Elizabeth Stutts and Robert Westbrook for their oversight, management, and support of this research effort, as well as their commitment to operator training in the state of Florida.

FDOT Project Manager

Elizabeth Stutts, Grant Programs Administrator

Contributors and Reviewers

The Research Team would like to acknowledge and thank the dedication and commitment of Broward County Transit (BCT), the City of Tallahassee's mass transit system (StarMetro), and Volusia County's public transit system (VOTRAN).

The following agency personnel were instrumental and showed laudable resolve in the collection of data for this research effort: Raymond Burger, Robert Fossa, and Craig Collins from BCT; Rosemary Bosby and Ron Garrison from StarMetro, and Bill Mayer, P.J. Doyle, and Pat Del Carlo from VOTRAN.

The Research Team would also like to recognize Santiago Osorio with the Metropolitan Transit Authority of Harris County (Metro), Gregory Brady with the York Regional Transit/Viva (YRT/Viva), William Cameron with the Massachusetts Bay Transportation Authority (MBTA) and Jim Dhom with the Champaign Urbana Mass Transit District (CUMTD) for their participation in this research effort.

Finally, the Research Team would like to recognize Dan Stogner from Doron Precision® and Louis Maiello and Mike McLelland, FAAC Incorporated, who provided documentation and contact and background information about the simulators, their installation, and training.

Executive Summary

Transit bus simulators offer computer-generated, 3D environments that are representative of actual operational conditions through the use of high fidelity graphics and computer monitors integrated into a realistic fixed-route and/or paratransit bus operator station/cab. These simulators offer a virtual environment which includes urban, suburban, and rural geographic regions and industrial, commercial, and highway areas to replicate a realistic, transit-specific driving experience. Many of the simulators allow for customizable virtual environment options and features, but generally include buildings, regional/native foliage, intersections, traffic lights, roadway signs, vehicle traffic, bus stops, and transfer centers. Additionally, transit simulators include extensive libraries of scenarios that offer operators various challenges related to decision making, reaction time, and judgment, each designed to accomplish one or more specific training goal and/or objective.

The purpose of this research was to track and observe three Florida public transit agencies, as they incorporated and integrated computer-based transit bus simulators into their existing bus operator training programs. It was anticipated that the simulator training information, along with the collection of empirical incident and training data, could be compared to determine if there were measurable impacts to driver performance, safety, incidents, and accidents.

Researchers coordinated with the Florida Department of Transportation (FDOT) and three case study participants: Volusia County's public transit system (VOTRAN), Broward County Transit (BCT), and the City of Tallahassee's public transit system (StarMetro), to collect data related to operator training, accidents, incidents, employee turnover and retention, and overall performance. The length of time that data was collected at each agency varied due to the date of the simulator installation at each location. The range of the data collection period was from one to five years.

In addition to the three Florida case study agencies, several transit agencies outside Florida were contacted and interviewed on their experiences with the use of bus simulators in their operator training programs. The Research Team also asked these agencies to provide any relevant data they may have collected to track the performance of the simulator training to allow for a more robust discussion of safety improvements that may have resulted. Through electronic correspondence and telephonic interviews, agencies provided valuable insight into how their simulators are utilized, and offered important perspectives on lessons learned and best and model practices.

The transit agencies who participated in this study are unwavering in their confidence in the value of simulator training. The premise of learning by practicing skills and experiencing mistakes before interacting with the "real world" offers transit operators a safe and innovative way to test new skills and teach, reinforce, and build existing skills. Transit agencies regard simulators as an innovative, interactive method of training that enables them to provide theory-based approaches to the challenges of operating a bus, by offering strategic demonstration and practice-based methods instruction.

Simulation-based training provides opportunities for operators to develop competencies through practice in a computer-generated environment that is representative of actual operational conditions. Transit agencies report that simulators allow their operators to effectively:

- Acquire, practice, and develop skills
- Rehearse reactions to situations
- Improve decision making skills
- Review their learning experience with the benefit of replay and reflection.

The simulators also permit transit agency trainers and safety staff to assess and evaluate operator performance. These assessments allow for learning opportunities and frank discussions between trainers and operators concerning procedural and operational performance and problem resolution.

While there is substantial qualitative information on the intrinsic benefits of bus simulator supported operator training, there are numerous factors that can impact quantifying those benefits and their measurement. Throughout this research effort, several common issues presented themselves as barriers for measuring the quantitative impact of simulator training. These factors include, but are not limited to:

- The level of upper management support of simulator programs
- Funding
- Training staff resolve and commitment to using the simulators
- Employee turnover and retention rates
- Significant changes in route structures
- General organizational changes
- Training standards and consistency
- Simulator integration periods and adaptability.

While there are quantitative elements provided, the study has a qualitative focus, due to the extenuating conditions and challenges previously mentioned. These conditions are clearly defined throughout the study, and have added valuable insight to the challenges facing public transit agencies. These challenges are of great significance to the public transportation industry and cast light on the need for future research including:

- Practices to improve employee retention rates
- Identification of model bus simulator training integration practices
- General training practices and standards recommendations
- Recommended definitions for preventable and non-preventable incidents
- Prevailing training department structures and staffing model practices and continuity planning.

Table of Contents

Disclaimer	ii
Metric Conversion.....	iv
Technical Report Documentation Page	v
Acknowledgments	vi
Executive Summary.....	vii
Table of Contents	ix
List of Figures	x
List of Tables	xi
Abbreviations and Acronyms.....	xii
Chapter 1: Overview	1
Background Statement	1
Study Method	2
History of Simulator Training	3
Research on Benefits of Simulator Training.....	4
Use of Simulator Training by Florida’s Transit Systems.....	7
The Simulator Environment - Geo-Specific Database Modeling	7
General Simulated Software Environmental Description and Features	8
General Simulated Hardware Environmental Description and Features	8
Chapter 2: Florida Case Studies	10
Case Studies	10
Operator Training Programs.....	11
Chapter 3: Case Studies – Other	25
Other Transit Systems using Bus Operator Simulators	25
Summary	34
Chapter 4: Agency Considerations.....	35
Simulator Integration Considerations	35
Chapter 5: Conclusions	38
Summary	38
References.....	40
Appendix A....	A1
Appendix B....	B1

List of Figures

Figure 1-1. Transit Bus Simulator Systems 550Bus™ and 460Bus™.....	9
Figure 2-1. StarMetro's Simulator Training Facility.....	12
Figure 2-2. VOTRAN's Simulator Training Facility.....	16
Figure 2-3. VOTRAN's Simulator Training Facility.....	17
Figure 3-1. Champaign Urbana Mass Transit District Simulator Training Facility (Metro Magazine).....	32
Figure 4-1. Technology Integration Planning Model(TIP Model).	36

List of Tables

Table 1-1. Simulator Model Type and Number by Agency	7
Table 2-1. StarMetro Bus Operator Training (Annual Averages).....	13
Table 2-2. StarMetro Total Accident/Incidents by Type.....	14
Table 2-3. StarMetro Motorbus Collisions.....	15
Table 2-4. StarMetro Motorbus Collisions Identified as Preventable	15
Table 2-5. VOTRAN Bus Operator Training (Annual Averages).....	17
Table 2-6. VOTRAN Total Accident/Incidents by Type.....	18
Table 2-7. VOTRAN Motorbus and Demand-Response Collisions	19
Table 2-8. VOTRAN Motorbus and Demand-Response Collisions Identified as Preventable ..	20
Table 2-9. BCT Bus Operator Training (Annual Averages)	22
Table 2-10. BCT Total Accidents/Incidents.....	22
Table 2-11. BCT Motorbus Collisions	23
Table 2-12. BCT Motorbus Collisions Identified as Preventable	23
Table 3-1. Houston Metro Motorbus Collisions.....	27
Table 3-2. Houston Metro Motorbus Collisions Identified as Preventable	28
Table 3-3. MBTA Motorbus Collisions	30
Table 3-4. MBTA Motorbus Collisions Identified as Preventable.....	31
Table 3-5. CUMTD Bus Operator Training (Annual Averages)	32
Table 3-6. CUMTD Motorbus Collisions Reported as Major Incidents in the NTD	33
Table 3-7. CUMTD Motorbus Collisions Identified as Preventable	33

Abbreviations and Acronyms

APTA	American Public Transportation Association
BCT	Broward County Transit
CDL	Commercial Driver's License
CMV	Commercial Motor Vehicle
CUMTD	Champaign Urbana Mass Transit District
CUTR	Center for Urban Transportation Research
DORON	Doron Precision®
FAAC	FAAC Incorporated
FDOT	Florida Department of Transportation
FAMU	Florida Agriculture and Mechanical University
FSU	Florida State University
MBTA	Massachusetts Bay Transportation Authority
METRO	Metropolitan Transit Authority of Harris County
NTD	National Transit Database
STARMETRO	City of Tallahassee's mass transit system
TIP	Technology Integration Planning
USF	University of South Florida
VOTRAN	Volusia County's public transit systems
YRT/Viva	York Regional Transit/Viva

Chapter 1: Overview

Background Statement

Due to tremendous needs and enabled by ever advancing technology, computer-generated simulation training tools have been widely used for many years. Historically, this technology was predominantly utilized for military and aviation-related training applications. As computer-generated simulation technologies became more readily available and as computer system theory and cybernetics used to operate simulation became more understood, the use of simulators became more prevalent. This technology is now used to provide training in many applications and environments from police, fire, and emergency medical vehicle driver training to private industrial applications, including training for large machinery, truck operators and healthcare industry professionals. Computer-based simulator training models real-life or hypothetical situations, so that students can learn from their actions and reactions in a virtual, but safe, reality.

While the use of simulator technology continues to grow, there are still those who debate the existence of measurable benefits to their use, particularly when compared to the capital costs associated with the procurement of these systems. There is limited evidence available within the transit industry that the cost/benefit ratio supports their purchase and application. However, qualitative input from transportation agencies that have used these technologies supports their application. In addition, there is sufficient qualitative research on the effectiveness of simulators in the training provided by the aviation industry, as an example.

While computer-based simulation has been very well established in the aviation industry,¹ the use of simulators to train bus operators in the public transportation industry is less pervasive, with simulators more typically used by larger transit agencies that have greater access to resources.²

Beyond their use as a training tool, simulators provide other significant benefits including performance optimization (as it relates to system safety, vehicle engineering and testing, and remedial training) and the ability to conduct training-related functional assessments.

In 2001, the Florida Department of Transportation (FDOT) and the Center for Urban Transportation Research (CUTR) began to work with transit properties throughout the United States to investigate the feasibility, functionality, and cost/benefits of implementing training simulators throughout Florida. As a result of this effort, a simulator training model was developed which focused on a regional approach to simulator training and utilization. Early in the development stages of a regional simulator program, insufficient funding stymied the project development, although interest and need continued to grow. Following that interest, several transit properties throughout Florida identified innovative, new funding

¹ J. Orlansky, J. String, Cost-effectiveness of Flight Simulator for Military Training, Use and Effectiveness of Flight Simulators (IDA Paper No. P-1275), vol. I Institute for Defense Analysis, Arlington, VA (1977)

² Technology & Management Systems, Inc., *Effective Practices to Reduce Bus Accidents*, Transit Cooperative Research Program, National Research Council, 2001

mechanisms which afforded them the opportunity to purchase simulators. By July 2007, several of Florida's public transit properties were in the initial stages of purchasing, installing, and implementing simulators and incorporating them into their training programs for new operators, as well as refresher and remedial training programs.

However, important questions still remained unanswered—what kind of measurable impact, if any, will simulators have on bus incidents and safety? Is there evidence that bus operators who have taken the simulator training learned the target skills they performed in the simulated environment? And, is there evidence that simulator trained operators are transferring what they learned into real life, on-the-road situations, and has this led to improved driving performance?

The objective of this research project was to study the impact of simulator training on transit incidents.

Study Method

In order to determine the impacts associated with the use of simulator training for transit bus operators and the efficacy of this training, the research strategy included the following:

- An examination of the history of simulator training in both transit and other industries;
- A summary of how simulators are being incorporated into the training curriculum employed by Florida's public transit agencies;
- Analysis, tracking and trending of transit incident data prior to and after the procurement and integration of training simulators; and
- An identification of any impacts that were realized through the use of simulators.

The study method included the collection of incident data (provided by the agencies) from StarMetro in Tallahassee, VOTRAN in Volusia County, and Broward County Transit (BCT) in Broward County. This effort included the gathering, input, and analysis of simulator training data reported by these properties into a database. The data collected through these efforts were loaded into the FDOT Bus Incident Database, to assist with the analysis. The data collection was intended to quantify the following:

- Key components, elements, and factors of transit bus accidents and incidents;
- Effects of simulator training on the frequency and severity of accidents and incidents (i.e., the reduction of chargeable accidents, decrease in the need to provide remedial training, and long term transit agency benefits that include lower insurance premiums, reduction of risk, and loss reduction and prevention); and
- Resultant changes and benefits of simulator training.

To supplement the data collected from the transit agencies, collision data from the National Transit Database (NTD) were also examined. The Research Team had access to a comprehensive database of all collisions reported as "Major Incidents" from 2002 through

2012 for all NTD reporting agencies in the U.S. According to NTD definitions, a collision is reported as a Major Safety Incident if it meets at least one of the following³:

- A fatality (30 days or less from the collision and not due to natural causes)
- An injury requiring immediate medical attention away from the scene
- Property damage greater than or equal to \$25,000
- Evacuations due to life safety reasons (imminent danger)

Information on the major incidents relevant to this study includes the type of collision (angle, head-on, other front impact, rear-ended, rear-ending, side impact, and sideswipe), what the transit vehicle collided with (another motor vehicle, a person, or a fixed object), and a description of the incident. The description field is open-ended and can contain widely varying degrees of detail. However, the detail was usually sufficient for the Research Team to make a determination about whether a particular collision was preventable. In classifying an incident as preventable, researchers relied on the description provided in the NTD, agencies' definitions of "preventable," and the Research Team's own judgment and expertise. The method for determining preventability was consistent for all transit agencies included in this study. Thus, those collisions determined to be preventable in nature were separated from those determined to be not preventable for purposes of this study. Other, less serious collisions that would be reported as Non-Major Incidents or Other Safety Occurrences not Otherwise Classified (OSONOC) in the NTD were not included in this task, as those types of incidents are simply tallied monthly by the agencies and no detail is provided about them. The examination of NTD data resulted in a comparison of the more serious preventable collisions (based on the fact that they were classified as major incidents) from before and after the implementation of simulator training.

Service supply data in the form of vehicle revenue miles from the NTD were also used along with the number of collision incidents to calculate a common measure of transit safety. The number of revenue miles between collisions provides an estimate of how often such collisions occur and would be expected to increase as the number of collisions decreases (and vice versa). Preliminary (i.e., not "closed-out") 2012 data on revenue miles are available for the Florida transit agencies included in this study. However, for those transit agencies in this study that are not located in Florida, no 2012 service supply data are available; data are only available through 2011.

History of Simulator Training

Vehicle simulation technologies first appeared in the early 1960s and were archaic, consisting of analogue computers and primitive displays.⁴ However, the use of the technology to study driver behavior and to a limited degree, as a supplemental training aid, has existed since that time. The use of vehicle simulators for transit operator training has really only appeared within the last ten years. Today, vehicle simulators have advanced

³ National Academy Press, *National Transit Database 2013 Safety and Security Reporting Manual*, Office of Budget and Policy, Federal Transit Administration, p. 40 (2013)

⁴ R.W. Allen, T.J. Rosenthal, M.L. Cook, *A Short History of Driving Simulation*, in *Handbook of Driving Simulation for Engineering, Medicine and Psychology*, CRC Press, Boca Raton, Florida (2011)

significantly, providing high fidelity driving simulations with the availability of 360 degree field of vision; realistic cabs (including the ability to replicate transit bus cabs by vehicle manufacturer); locally developed scenarios with streetscapes (representing the operating environment within which a transit agency operates) and the ability of a trainer to alter an environment, including the introduction of other vehicles and pedestrians; and motion delivery that is most often experienced through the operator's seat.

Research on Benefits of Simulator Training

While there has been limited research conducted on the effectiveness of simulator training within the transit industry, there has been research performed that documents the effectiveness of this training within other industries.

In *Simulator Training of Novice Drivers: A Longitudinal Study*, 554 teenage drivers in California were trained at five different locations with three simulator configurations. The simulators ranged from a low fidelity single-monitor, desktop application to an instrumented vehicle cab. The authors found that in the two years following the training, participants who had been trained on higher fidelity simulator configurations had significantly lower crash rates than conventionally-trained novice drivers. The authors offered that the ability to transfer learned driving simulator skills to behind-the-wheel experiences may have influenced the effectiveness of the higher fidelity simulators.⁵

In *Simulation-Based Driver and Vehicle Crew Training: Applications, Efficacy and Future Directions*, the research objective was to determine if there is evidence to support the assumption that simulator training for drivers and vehicle crew training is effective. The researchers reviewed a litany of journal articles and research reports that examined the use of simulator training and the success of these programs. In addition, the authors also utilized research of the training efficacy of simulation in the aviation and medical industries to assist in the development of simulation training system design characteristics and guidelines for performing evaluations of these systems.

The Research Team studied simulator training programs and outcomes to determine if there is specific evidence to conclude that trainees learn various target skills while performing these activities and if these skills are readily transferred to on-vehicle, real life situations, with improved performance. The skills that were reviewed included those considered "procedural," such as vehicle control; "higher-order cognitive skills," which included an evaluation of these systems to improve vehicle operator perceptions of hazards; and team-based vehicle crew training that is used to improve interpersonal skills.

In *Simulators and Bus Safety: Guidelines for Acquiring and Using Transit Bus Operator Simulators* (TCRP Report 72, 2001), guidance is provided on how to use simulators effectively for bus operator training. The report does not attempt to quantify the effectiveness of simulators, but provides conclusions on incorporation into existing training programs. One major conclusion was that a transit agency should not just drop a simulator

⁵ R.W. Allen, G.D. Park, M.L. Cook and D. Fiorentino, *Simulator Training of Novice Drivers: A Longitudinal Study*, *Advances in Transportation Studies*, Vol. 27, pp. 51-68, University Roma Tre, July 2012

into an existing training program. Getting the best use from a simulator requires adjusting the overall bus operator training program and matching the capabilities of simulation to the training needs of the bus operators.

In "Mobile Driver Training Simulators,"⁶ this technical brief provides information about the advantages of using simulators and how they work, discusses simulator types and manufacturers, and describes study findings indicating that the use of simulators decreases crash rates. TCRP Report 72 was the primary reference document for this technical brief.

Chapter 3 of *A Challenged Employment System: Hiring, Training, Performance Evaluation, and Retention of Bus Operators, A Synthesis of Transit Practice*,⁷ is devoted to bus operator training. It is a synthesis of public transit operator practices resulting from a survey conducted in 2000 of 75 transit agencies in the U.S. and Canada with over 100 employees. Unlike most other references that provide recommendations for bus operator training, this report described what transit agencies actually do. In recognition of this, the following summary of this document provides a bit more detail. Many newer documents referenced this report.

The document reported that 63 percent of new hires come from a non-transit background and, according to concerned transit agencies, "...must frequently be taught professional driving skills from the ground up."⁸ New hire training programs were reported to be between 10 and 60 days. Factors influencing the length of training included size of the system; scope of equipment; prior trainee experience driving a commercial motor vehicle (CMV); whether trainees learn to drive all routes or just some; and choice of focus on different training elements. Agencies with training of longer duration reported higher voluntary turnover rates. The report offered some possible reasons for this but these reasons were not further explored.

The survey conducted for the synthesis found variation of focus among transit agencies on the types of training provided. The following are the percentages of surveyed transit agencies that provide training in various competencies.

100% Safe driving practices
96% Knowledge of and adherence to policy and procedure
96% Radio communications
96% Schedule adherence
93% Interpersonal interactions with customers
93% Knowledge and handling of fares
93% Serving customers with disabilities
93% System (area) knowledge

⁶ National Rural Transit Assistance Program, *Mobile Driver Training Simulators*, 2008.

⁷ Transit Cooperative Research Program, *A Challenged Employment System: Hiring, Training, Performance Evaluation, and Retention of Bus Operators – A Synthesis of Transit Practice*, TCRP Synthesis 40, Project J-7, Topic SF-7, pg. 17, Transportation Research Board, National Research Council, 2001.

⁸ Ibid.

82% Customer support
71% Interpersonal interactions with peers and staff
61% Personal health and fitness for duty

61% Written communication
57% Organizational knowledge

The survey found that competencies were primarily measured with observation/checklist, and written tests. Less used techniques were peer assessments, probationary operative statistics, observation with pass/fail criterion, training turnover, computer based training, computer tests, and simulators.

The document also reported on methods used to accomplish training. All survey respondents reported that they provide in-classroom training for all newly hired bus operators, 96 percent provide training time on in-service buses, and 31 percent use some type of simulation. Training is provided by varying combinations of trainers. These include a full-time professional trainer on the transit agency staff, a bus operator who is qualified to train, and in-service bus operators. Classroom training is usually provided by a full-time professional trainer on the transit agency staff. In-the-bus (not in service) training is usually provided by full time training staff or a bus operator trainer. Training provided on the bus while in service is usually provided by an in-service bus operator. Training by simulation is usually provided by full time training staff.

New York City Transit and the Metropolitan Transit Authority studied simulator effectiveness and reported a reduced accident rate and a reduced training washout rate as a result of using simulation. Many other transit agencies reported using simulation training at this time.

The report provided examples of training of various public transit agencies. For example, San Diego Transit uses interactive CD-ROM driver training programs that test comprehension. At the end of each module, the program loops back to any subject matter pertaining to those questions missed by the student until the student answers all questions correctly. At the time of this report, these programs were available through the National Transit Institute (NTI) and it was reported that over 150 transit agencies were using them. At the time, San Diego Transit was also working with NTI to develop training to help students pass their CDL test. Major elements of other training programs addressed:

- Consistency between training and real life bus operation experience.
- Establishing cross-functional teams, including union representatives, to review training competencies and design.
- Combining the training manual and the policy manual into one integrated handbook.
- Incorporating adult learning research into training design, such as providing materials for different learning styles.
- Using fully interactive and semi-interactive simulator technology to enhance training effectiveness and cut costs over time.

Use of Simulator Training by Florida's Transit Systems

Accident prevention is a priority for public transportation agencies in the United States. The practices that are used to prevent accidents and promote safe driving traditionally fall into one of three categories: human resources, management, and operations.⁹ Bus operator simulators uniquely cross over into all three categories and provide public transportation agencies a practical, assessable and enhancement-based training tool.

In mid-to-late 2000, several Florida public transit systems embarked on a mission to incorporate computer-generated bus simulators into their agencies' training programs. Each of these agencies evaluated and procured their simulators independently, and funding for procurement also varied. Additionally, over the course of this multi-year research project, installation and start-up dates at each site ranged from approximately one-six years. The overarching objective for all the agencies was similar and focused on integrating the bus simulator as a tool for enhancing the effectiveness of operator training and retraining. While each agency operated independently with regard to evaluation, procurement, and integration, their overall training goals for the simulators are similar and include supplemental:

- Basic Skill Development
- Annual Refresher Program Training
- Corrective Actions / Remedial Tools Training

Table 1-1 shows the simulator brand, model number and type, and number of models operated at each of the case study sites. All three agencies procured and incorporated Doron Precision® Model Type 460Bus™ Driving Simulators and two of the case study sites, StarMetro and VOTRAN used Doron Precision® Model Type 550Bus™ Driving Simulators.

Table 1-1. Simulator Model Type and Number by Agency

Doron Precision® Model Type	Number of Simulator Models		
Agency	BCT	STARMETRO	VOTRAN
460Bus™ Driving Simulator	3	2	1
550Bus™ Driving Simulator	0	1	1

The Simulator Environment - Geo-Specific Database Modeling

Replicating a real-world driving environment into a simulated 3D virtual world is referred to as geo-specific database modeling.¹⁰ The simulator manufacturer used by all three case study sites, Doron Precision®, incorporated many important elements into the simulated

⁹ Technology Management Systems Inc., *Effective Practices to Reduce Bus Accidents* (Transportation Cooperative Research Program Report 66), Transportation Research Board of the National Academies, Washington, D.C. 2001

¹⁰ X. Yan, M. Abdel-Aty, E. Radwan, X. Wang, P. Chilakapati, "Validating a driving simulator using surrogate safety measures," *Accident Analysis & Prevention*, January 2007

environment to replicate a realistic, transit specific driving experience including urban, suburban, rural geographic regions and industrial, commercial, and highway areas. The simulation environments are comprised of many customizable options and features, but generally include buildings, regional/native foliage, intersections, traffic lights, roadway signs, vehicle traffic, bus stops, and transfer centers. Additionally, the simulators include extensive libraries of scenarios that offer operators various challenges related to decision making, reaction time, and judgment, each designed to accomplish one or more specific training goal and/or objective.

General Simulated Software Environmental Description and Features

The Microsoft Windows™ based simulator software includes several bus vehicle dynamic models to replicate different bus sizes and types. Simulated driving surfaces include various roadway materials and conditions such as pavement, grass, gravel, and dirt/sand with traction, with integrated sound variations on each surface to replicate both dry and wet conditions. Weather conditions are also customizable and include clear, variable fog settings, rain, and snow/ice options. Lighting conditions are another adaptable feature and can be tailored to represent time-of-day sequences such as: day, night, or dawn/dusk and sun glare (sunset and sunrise).

The software environment is carefully linked and functions in tandem with the vehicle's cab by providing controlled, immediate performance-based feedback to the operator such as vehicle sounds, ambient noise (like weather), and physical seismic-like vibrations, pulsations and sensations. These seismic-like features are used to replicate the physical sensation a driver experiences when a vehicle hits an object such as cars, roadway rumble strips, signs, and other vehicles.

General Simulated Hardware Environmental Description and Features

The bus simulators are carefully designed and are facsimiles of full sized, fixed route bus cab enclosures and are comprised of actual and/or representative parts and components of real transit buses. Specifically, the simulator includes a bus operator seat, radio, active steering wheel, seat belt, foot pedals, vehicle control panels, transmission selector, and other appropriate operational controls, gauges, indicators, and switches. Of critical importance, all sight lines and angles required to safely operate a bus are accurately preserved for presentation to the operators in the simulated environment.

The Doron 460Bus Driving Simulator, used by two case study sites, includes four large surround screen displays that provide a continuous horizontal visual field-of-view of at least 220 degrees. The Doron 550Bus Driving Simulator used by all three case study sites include three large surround screen displays that provide a continuous horizontal visual field-of-view of at least 190 degrees. Simulated mirror displays are integrated into the screens through software programming and are adjustable by the operator in real time.

550Bus™



460Bus™



Figure 1-1. Transit Bus Simulator Systems 550Bus™ and 460Bus™.

Chapter 2: Florida Case Studies

Case Studies

In order to assess and document the effectiveness of simulator training for bus operators, three case study sites in Florida were identified, including: StarMetro in Tallahassee, Florida; VOTRAN, in South Daytona, Florida; and Broward County Transit in Pompano Beach, Florida. In addition to the collection of simulator training details and data, the Research Team also compiled and reviewed:

- General training practices and standards;
- Agency-specific parameters for defining preventable and non-preventable incidents;
- Employee turnover and retention rates (when available);
- Ridership changes; and
- Training department structures and staffing.

Both quantitative and qualitative data collection methods were employed for this research effort. At a minimum, quarterly and in some cases monthly accident, incident, and simulator training data were electronically submitted to the Research Team by the case study agencies. This data, along with information collected on periodic site visits and telephone conversations with case study agencies, were inputted into the Bus Accident/Incident Tracking database. The database was created by the Research Team using Microsoft® Access and is available to transit agencies at no-cost to assist in them in the gathering and querying of information.

The Research Team relied on data collected and forwarded by case study site agencies. However, supplemental data were collected from case study sites when necessary to fill gaps for analysis and monitoring. There were innate gaps and weaknesses in the data collected, some of which could not be overcome with available supplemental data. The data was not always reported in a timely or regular manner and in some cases, the responsibility for reporting the data to the Research Team shifted to different staff during the course of the study.

To supplement the data collected directly from the agencies, the Research Team compiled and analyzed NTD data on collisions reported as major incidents by these agencies for the two years prior to the implementation of simulator training through the end of the 2012 calendar year. As discussed previously in the Study Method section of this report, the NTD made available to the Research Team contained a relatively high level of detail on these collisions, including the type of collision, what the transit vehicle collided with, and a description of the incident. Information on injuries and fatalities was also available. While the incident descriptions varied in detail from agency to agency (and year to year, depending on who might be responsible for entering such information into the NTD), the level of detail was mostly sufficient to make a determination about whether the transit bus operator could have prevented the referenced collision. In categorizing an incident as preventable, the Research Team relied on the description provided in the NTD, the agencies' definitions of "preventable," and their own judgment and expertise. The analysis then

focused on the trends, if any, in the number of preventable collisions reported as major incidents before and after the implementation of simulator training. The NTD data for each agency and the corresponding analysis and discussion are provided within each agency's section presented below.

Operator Training Programs

The public transit industry, as a whole, does not have a standard approach to bus operator training. However, in 2007 the American Public Transportation Association (APTA) published "Recommended Practice for Transit Bus Operator Training," as a training roadmap for public transportation agencies nationwide. The APTA document provides guidelines for transit bus operator training and qualifications and recommends their use by individuals or organizations that:

- Operate transit vehicles
- Contract with others to operate transit vehicles
- Influence how transit vehicle operators are trained
- Develop transit vehicle operator training programs

The APTA "Recommended Practice for Transit Bus Operator Training" document does not address the use of bus operator simulators. However, it does provide details about specific competencies related to training content and general recommendations including:

- Regulatory: federal, state, and local regulations that impact transit operations
- Agency-specific: local agency requirements that impact transit training
- Customer service: meeting the needs of the public and customers
- Technical: operator skills needed to safely operate a transit vehicle
- Safety and security: includes all elements related to safety and security for the operator and the public

All three agencies that participated in this research effort used APTA's recommended practices as a guide during the development of their transit operator training programs, but customized specific course content, duration, and intervals based on their own agency's needs and fiscal strategies. In addition to traditional training, the agencies are utilizing the simulator "Bus Training Program Scenario Progression" training guide suggested by Doron that includes a series of exercises and lesson plans, with various sequences within the following scenarios:

- Orientation
- Skills exercises (covering basic Commercial Driver's License (CDL) test topics)
- Evasive driving
- Defensive driving

A summary of each agency is provided below, which describes in detail their experiences with their simulators including training information, lessons learned, benefits, and challenges.

StarMetro

StarMetro is the city-owned and operated bus service for Tallahassee, Florida, providing fixed route and demand response dial-a-ride services. StarMetro also operates 10 routes on the campuses of Florida State University (FSU) and Florida Agriculture and Mechanical University (FAMU). StarMetro is the Community Transportation Coordinator (CTC) for Leon County.

StarMetro began integrating bus simulators into their bus operator training program in December 2010. However, full integration of simulator training did not occur until May 2012. From 2010 through 2012, 141 bus operators received simulator training. StarMetro opted to have their manufacturer offer training sessions delivered to their staff over time (one year period). StarMetro's dedicated simulator training facility is shown in Figure 2-1.



Figure 2-1. StarMetro's Simulator Training Facility.

Table 2-1 details the number of hours and type of training offered at StarMetro. Currently, the agency provides 80 hours of traditional classroom training to new bus operators, with the curriculum focusing on safety, security, operations, customer service, and City of Tallahassee policies and procedures. Classroom training is followed by 160 hours of over-the-road training, where operators have an opportunity to observe experienced operators drive, as well as practice in-service operations. Twenty hours of simulator training is interspersed into new operator training. StarMetro also provides a total of 44 hours of extensive, post-accident/incident bus operator training, which includes both classroom training and simulator training. Additionally, the agency provides comprehensive and consistent periodic refresher training including operator skills building training for new equipment, return to duty training for operators who have been out of service for an extended period of time, and/or basic refresher training every couple years (which includes defensive driver training).

Table 2-1. StarMetro Bus Operator Training (Annual Averages)

Hours of Training					
	Classroom Training	Over the Road Training	Simulator Training (460Bus™)	Simulator Training (550Bus™)	Total
New Bus Operator Training	80	160	5	15	260
Post-Accident/ Incident Bus Operator Training	24	0	10	10	44
Remedial/Refresher Training	0	16	10	10	36

Table 2-2 illustrates the number and type of accidents at StarMetro for 2008 through 2012, using data provided by the agency. StarMetro experienced a spike in accidents in 2011, which is attributed to overall organizational route “decentralization” (described as a move away from traditional “hub and spoke” route structures that are commonly used by public transit systems, to a grid system which reduced the number of routes from twenty six to twelve). While the number of buses (38) that operated in service remained the same, the bus routing was drastically altered and operated on new roadways. This route structure change produced an anomaly in StarMetro’s accident rates related to the scope of this project and unfortunately, made it difficult to correlate simulator training and safety data.

The number of overall StarMetro accidents decreased significantly in 2012. While the timeline of this decrease occurred immediately following the simulator training of all of StarMetro’s operators, the length of time that the simulators were being utilized at that stage is not extensive enough to draw a quantitative conclusion or correlate a clear link between the data sets. However, based on interviews with key operational and safety staff, and comparing accident data to simulator training data, conclusions can be qualitatively inferred, including the practical effects that simulator training has on agency accident rates, including the potential for improved incident rates.

While Table 2-2 illustrates the ebb and flow related to StarMetro’s accidents, there were notable changes in their overall preventable and non-preventable rates during the two years that the simulators were in use. StarMetro defines preventable accidents as “one which occurs because the employee fails to act in a reasonably expected manner to prevent it.” Conversely, they define non-preventable accidents, as “an accident that an employee could not have avoided involvement, by reasonable defensive driving practice.” In 2012, StarMetro’s non-preventable rate decreased by 34 percent and their preventable rates decreased by 37 percent. However, when these rates are compared to preventable/non-preventable accidents related to pre- and post-simulator training, there are no conclusive findings related to the impact of this training on accidents/incidents.

Table 2-2. StarMetro Total Accident/Incidents by Type

Accidents/Incidents				
	Contact with Another Vehicle	Fixed Object	Rear End Collisions	Total
2008	52	18	20	90
2009	56	9	17	82
2010	58	13	10	81
2011	68	17	17	102
2012	32	7	3	42

Source: StarMetro

Tables 2-3 and 2-4 provide further insight by presenting information on those collisions reported as major incidents by StarMetro in the NTD from 2008 to 2012 (a subset of those presented in Table 2-2). According to the NTD, collisions must meet certain thresholds to be classified as major safety incidents.¹¹ Table 2-3 shows the total collisions reported as major incidents, as well as the number of those determined to be preventable by the transit vehicle operator based on the incident description in the NTD. As seen in Table 2-3, in 2008 and 2010, StarMetro did not have any collisions reported as major incidents in the NTD. Further, there were only two years with any preventable major incident collisions: 2009 with one collision and 2011 with two. One injury was associated with the collision in 2009, and there were two injuries and one fatality resulting from the two preventable collisions in 2011. The numbers of revenue miles between total collisions and between preventable collisions, common measures of transit safety that provide insight into the frequency of such collisions, are also presented in Table 2-3. Similar to the data reported by the agency, review of NTD's data reveals an increase in revenue miles between collisions in 2012 which is a reflection of StarMetro's overall decrease in accidents.

¹¹ Office of Budget and Policy, Federal Transit Administration, *National Transit Database 2013 Safety and Security Reporting Manual*, p. 40, January 2013.

**Table 2-3. StarMetro Motorbus Collisions
(Reported as Major Incidents in the NTD)**

Year	Total	Total Preventable	Preventable Collisions		Revenue Miles Between	
			Injuries	Fatalities	Total Collisions	Preventable Collisions
2008	0	n/a	n/a	n/a	n/a	n/a
2009	3	1	1	0	655,589	1,966,766
2010	0	n/a	n/a	n/a	n/a	n/a
2011	3	2	2	1	706,757	1,060,135
2012	1	0	n/a	n/a	2,140,799	n/a

Source: National Transit Database

Table 2-4 provides additional information on the major incident collisions identified in the NTD for StarMetro from 2008 to 2012 that were characterized as preventable. (NTD has a category for "rear-ended," whereby another vehicle collides with the rear of the transit vehicle. Any collision in which the transit vehicle was rear-ended was determined to be not preventable for purposes of this study, and so there is no such information in Table 2-4). As shown in the table, the collision in 2009 occurred when the transit operator rear-ended another vehicle. The two collisions in 2011 were head-on and "other" front impact, respectively. The relatively low number of collisions reported as major incidents by StarMetro during these years precludes any statistical identification of a linear trend in these types of incidents.

**Table 2-4. StarMetro Motorbus Collisions Identified as Preventable
(Reported as Major Incidents in the NTD)**

Year	Collision With			Collision Type					
	Motor Vehicle	Person	Fixed Object	Rear-Ending	Angle	Head-On	Side	Sideswipe	Other Front Impact
2008	--	--	--	--	--	--	--	--	--
2009	1	--	--	1	--	--	--	--	--
2010	--	--	--	--	--	--	--	--	--
2011	1	1	--	--	--	1	--	--	1
2012	--	--	--	--	--	--	--	--	--

Source: National Transit Database

There were a number of peripheral issues that affected the use of simulators at StarMetro, which also directly affected a thorough analysis of their training and accident data. From 2011-2012, StarMetro experienced an operator turnover rate of approximately 40 percent, with an average length of employment rate for bus operators of a little over seven years. This turnover issue also extended to their training department, which resulted in a 50 percent reduction of staff (from two to one). In response to their Training Department

staffing issue, StarMetro instituted a plan in January 2013 to train their supervisors and certain, high performing bus operators, to be expert simulator trainers. It is StarMetro's expectation that by using key training staff, they will be able to continue to deliver effective bus operator simulator training to their operations staff. StarMetro is also spreading their simulator manufacturer-provided training over time. This strategic decision means that new, additional staff can receive training and the existing staff can practice and test the simulator between training sessions. StarMetro's staff recommends this training delivery method and believes it contributes to a smooth integration process.

StarMetro describes the simulators as an invaluable tool to train their new drivers, and believes that ultimately, the integration of these simulators into their existing training curriculum will help to improve their safety performance.

VOTRAN

VOTRAN, located in Daytona Beach, Florida provides transportation to all urban areas of the county, with a fleet of 55 fixed route buses, four trackless trolleys and 44 paratransit vehicles. VOTRAN is also the CTC for Volusia County and is responsible for the coordination of transportation services for the transportation disadvantaged in all areas of the county. VOTRAN's staff includes approximately 200 employees and is operated by McDonald Transit, a professional transportation management firm based in Ft. Worth, Texas.

Figure 2-2 is a photo of VOTRAN's training simulator. The simulator training room is dedicated to only simulator training, and the building that houses the simulator serves as a regional training center for transit operations and maintenance (Figure 2-3).



Figure 2-2. VOTRAN's Simulator Training Facility.



Figure 2-3. VOTRAN's Simulator Training Facility.

VOTRAN's database contains 361 data sets which include reported accidents and incidents, and operators who received simulator training, as well as those operators who have been required to complete post-accident simulator training. While the bulk of VOTRAN's database represents both fixed-route and paratransit bus operators, there are also dispatchers and a few maintenance department staff members represented in the datasets.

VOTRAN has one dedicated trainer who oversees the simulator facility and provides training to all necessary staff. Table 2-5 shows the type and number of hours of training offered to operators. VOTRAN uses the bus simulators to supplement their existing training for new bus operators, post-incident training, and remedial training. While VOTRAN labored with simulator training integration initially, their current training standard includes 80 hours of traditional classroom training, followed by 200 hours of over-the-road training and 4 hours of simulator training. In total, VOTRAN provides 288 hours of new bus operator training. The agency's training curriculum is comprehensive and delves into all the important elements of vehicle operations, customer relations, and emergency management.

Table 2-5. VOTRAN Bus Operator Training (Annual Averages)

Hours of Training					
	Classroom Training	Over the Road Training	Simulator Training (460Bus™)	Simulator Training (550Bus™)	Total
New Bus Operator Training	80	200	4	4	288
Post-Accident/Incident Bus Operator Training	1	1	4	4	10
Remedial/Refresher Training	1	2	4	4	9

Over the study period, VOTRAN provided simulator training to 361 bus operators. VOTRAN reported that while they received manufacturer training upon installation, they struggled to incorporate the simulators into their existing training programs. This initially stymied the use of the simulators, but they now indicate that the simulators have been well received by the majority of their bus operators. While a number of operators (approximately 20 percent), experienced motion related conditional problems, VOTRAN's trainer was able to help most of them combat these issues through a variety of proven strategies including reducing the amount of time bus operators were in the simulator and lowering the room temperature. However, approximately 3% of the operators were not able to overcome the challenges associated with motion sickness, and did not complete the simulator training.

One of VOTRAN's most challenging issues in general, which also proved to be the epicenter of problematic issues related to simulator training, is operator retention/turnover. VOTRAN's turnover rates average over 56 percent for new bus operators over the study period and their average length of employment is less than six years. This turnover rate is relatively high compared to some nationally reported averages of 10.9 percent.¹² The issue of bus operator turnover made it impractical to quantify conclusions related to the effectiveness of simulators at VOTRAN, based on any longitudinal data. However, other important system data related to safety, accidents, incidents, operator retention and operator turnover were collected and analyzed. The collection of this data, along with interviews and general observations, has led to the development of practical qualitative findings.

Table 2-6 presents the number of accident by type and year at VOTRAN. While VOTRAN experienced a spike in the number of incidents related to transit doors closing on passengers in 2011, these incidents are not represented in Table 2-7, and were determined to be isolated events. It is important to note that in 2011, VOTRAN changed the way they grade, report, and document accidents.

Table 2-6. VOTRAN Total Accident/Incidents by Type

Accidents/Incidents				
	Contact with Another Vehicle	Fixed Object	Rear End Collisions	Totals
2008	34	21	13	68
2009	26	17	16	59
2010	37	16	16	69
2011	52	19	24	95
2012	37	18	19	74

Source: VOTRAN

VOTRAN's accidents fluctuated from 2008-2012, due to a number of extraneous factors including the previously mentioned retention issues, as well as a reported ridership increase

¹² Moffat, G., Ashton, A., Blackburn, D. *A Challenged Employment System: Hiring, Training, Performance Evaluation, and Retention of Bus Operators*, Transportation Cooperative Research Program Synthesis 40, Transportation Research Board of the National Academies, Washington, D.C. 2001

of 13-16 percent annually. This is an important consideration when determining accident rates because increases of this scale make it important to not just review the number of accidents, but also the accidents per revenue mile. The NTD defines revenue miles as “the miles a transit vehicle travels while in revenue service. A transit vehicle is in revenue service when the vehicle is available to the public with the expectation of carrying passengers”¹³

Tables 2-7 and 2-8 present information on collisions reported as major incidents by VOTRAN in the NTD from 2006 to 2012 for both its motorbus and demand-response modes (a subset of the data in Table 2-6). Table 2-7 shows the total collisions reported as major incidents, as well as the number of those determined to be preventable based on the incident description in the NTD. As evidenced in Table 2-7, the only preventable collision during this time period was in 2006. This collision involved the motorbus mode and only the operator was injured. Further, the numbers of revenue miles between total collisions and between preventable collisions (where applicable), are also included in Table 2-7. These are common measures of transit safety that provide insight into the frequency of such collisions.

**Table 2-7. VOTRAN Motorbus and Demand-Response Collisions
(Reported as Major Incidents in the NTD)**

Year	Total	Total Preventable	Preventable Collisions		Revenue Miles Between	
			Injuries	Fatalities	Total Collisions	Preventable Collisions
2006	6	1	1	0	888,060	5,328,359
2007	6	0	n/a	n/a	884,478	n/a
2008	2	0	n/a	n/a	2,405,442	n/a
2009	6	0	n/a	n/a	757,581	n/a
2010	2	0	n/a	n/a	2,262,989	n/a
2011	4	0	n/a	n/a	1,115,376	n/a
2012	1	0	n/a	n/a	4,630,394	n/a

Source: National Transit Database

It must be mentioned that NTD implemented a reporting change beginning in 2008. Prior to 2008, the injury threshold for reporting a major incident was two injuries. Beginning in 2008, this threshold was lowered to just one injury. As expected, this increased the number of incidents being reported beginning in 2008. To properly compare the incidents over time, only the incidents that would have also been reported beginning in 2008 were included in the totals for 2006 and 2007. This was done by sorting the incidents based on the number of injuries and also accounting for the other reporting thresholds.

Table 2-8 provides additional information on the one preventable major incident collision identified in the NTD for VOTRAN in 2006. This particular incident occurred when the

¹³ http://www.ntdprogram.gov/ntdprogram/pubs/NTST/2008/HTML/Transit_in_the_US.htm

motorbus collided with another motor vehicle and it was classified as front impact collision. The absence of any other collisions reported as major incidents by VOTRAN during these years precludes the statistical identification of any linear trend in these types of more serious incidents.

NTD also has a category for “rear-ended,” whereby another vehicle collides with the rear of the transit vehicle. Any collision in which the transit vehicle was rear-ended was determined to be not preventable for purposes of this study, and so there is no such information in Table 2-8.

VOTRAN defines a preventable accident as “one in which the employee failed to do everything reasonable to prevent it, whereas a non-preventable accident is defined as “one in which the employee was clearly not at fault.” VOTRAN uses the National Safety Council’s (NSC) guide to build and maintain an effective accident control system.

Table 2-8. VOTRAN Motorbus and Demand-Response Collisions Identified as Preventable (Reported as Major Incidents in the NTD)

Year	Collision with			Collision Type					
	Motor Vehicle	Person	Fixed Object	Rear-Ending	Angle	Head-On	Side	Sideswipe	Other Front Impact
2006	1	--	--	--	--	--	--	--	1
2007	--	--	--	--	--	--	--	--	--
2008	--	--	--	--	--	--	--	--	--
2009	--	--	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--	--	--
2011	--	--	--	--	--	--	--	--	--
2012	--	--	--	--	--	--	--	--	--

Source: National Transit Database

While there is no specific quantitative evidence of the benefits of simulator training on either preventable or non-preventable accidents that occurred at VOTRAN before and after simulator training, the data reveals a diminutive (1%) decrease of non-preventable accidents between 2008-2012. However, because the decrease is marginal and influenced by several extraneous factors, it is not possible to provide any conclusive inferences.

VOTRAN describes the simulated environment as a tool in helping operators gain and understand the fundamental skills of operating a bus, resulting in better performance and more highly trained personnel who are better prepared for the challenges they will face as bus operators. They are pleased that the simulated environment provides scenario-based training that is less risky and more cost effective than on-the-road operations.

Broward County Transit (BCT)

Broward County Transit (BCT) is the public transit agency that serves 1.8 million people in the metropolitan area of Broward County, Florida. BCT operates 42 fixed routes and assists 18 municipalities in the capital and/or operational costs of 50 community bus routes in Broward County. BCT's fixed route, community bus, and paratransit systems provide over 40 million trips annually.¹⁴ BCT is the Community Transportation Coordinator for Broward County.

In April 2011, the Research Team began collecting data from BCT immediately following the installation of three Doron 460 bus simulators. At the time the simulators were being installed, significant changes occurred within BCT's training program, including the retirement of a number of employees within their training program, resulting in underutilization of their simulators. This substantial loss of personnel resulted in inconsistencies in the collection, tracking, and analysis of data. While BCT has made strides to replace its training department personnel, the absence of an experienced training staff impacted this research effort. While BCT's simulator training program was reactivated in February 2012, the data available to the Research Team were limited and provided inadequate information for extensive data analysis.

Table 2-9 provides specific detail about BCT's bus operator training program. BCT provides an average of 360 hours of training to new bus operators, including traditional classroom, over-the-road, and simulator training. The agency provides 90 hours of traditional classroom training to new bus operators, with the curriculum focusing on safety, security, operations, customer service and agency specific policies and procedures. Classroom training is followed by 260 hours of over-the-road training, where operators have an opportunity to observe experienced operators drive, as well as practice in-service operations. Ten hours of simulator training is interspersed into new operator training. Currently, BCT is not providing remedial/refresher training, due to several issues associated with staffing and budget constraints. However, the agency does provide a total of four hours of post-accident/incident training which is comprised of classroom, over-the-road, and simulator training.

¹⁴ Broward County Transit (BCT) FY 2013 Transit Development Plan (TDP) Annual Update, August 2012

Table 2-9. BCT Bus Operator Training (Annual Averages)

Hours of Training					
	Classroom Training	Over the Road Training	Simulator Training (460Bus™)	Simulator Training (550Bus™)	Total
New Bus Operator Training	90	260	10	n/a	360
Post-Accident/Incident Bus Operator Training	1.5	2.0	.5	n/a	4
Remedial/Refresher Training	0	0	0	0	0

BCT provided the total number of accidents and preventable accidents for the years 2008 through 2012, as shown in Table 2-10. The accidents listed in Table 2-10 encompass all accidents whether or not there were injuries, and also include those that were reported in the NTD. While the table shows that the absolute number of preventable accidents has increased from 2008 to 2012, it is more instructive to examine these preventable occurrences as a ratio to the total number of accidents.

Table 2-10. BCT Total Accidents/Incidents

Year	Preventable Accidents	Total Accidents	Ratio of Preventable to Total Accidents
2008	103	602	0.17
2009	99	564	0.18
2010	140	590	0.24
2011	147	621	0.24
2012	180	704	0.26

Source: Broward County Transit provided the numbers of preventable and total accidents

As in the previous two case studies, Tables 2-11 and 2-12 include additional information on collisions reported as major incidents by BCT in the NTD from 2008 to 2012 (a subset of the data in Table 2-10). The collisions in these two tables represent directly-operated motorbus service for BCT. Table 2-11 shows the total collisions reported as major incidents, as well as the number of those determined to be preventable based on the incident description. Table 2-11 shows no particular trend in these major incidents from 2008 to 2012, with the number of preventable collisions ranging from 7 to 10 during this time. Further, the number of total injuries to all parties resulting from these collisions ranged from 12 in 2011 to 23 in 2010; there were no fatalities. In addition, the numbers of revenue miles between total collisions and between preventable collisions are also included in Table 2-11. From 2008 to 2012, revenue miles between total collisions and preventable collisions have been generally decreasing, indicating a slight increase in the number of these collisions per revenue mile of service. It should be noted, however, that there are not enough data points to statistically identify a trend in the number of preventable collisions.

**Table 2-11. BCT Motorbus Collisions
(Reported as Major Incidents in the NTD)**

Year	Total	Total Preventable	Preventable Collisions		Revenue Miles Between	
			Injuries	Fatalities	Total Collisions	Preventable Collisions
2008	42	9	16	0	334,536	1,561,168
2009	46	7	15	0	301,706	1,982,638
2010	50	10	23	0	280,984	1,404,919
2011	67	8	12	0	198,930	1,666,036
2012	61	10	16	0	221,777	1,352,841

Source: National Transit Database

Table 2-12 summarizes some additional information on these preventable collisions identified in the NTD for BCT during this time period. As mentioned previously, NTD also has a category for "rear-ended," whereby another vehicle collides with the rear of the transit vehicle. For purposes of this study, any collision identified as "rear-ended" was determined to be not preventable, and so there is no such information in Table 2-12. Most collisions reported between 2009 and 2012 were with another motor vehicle. Five collisions with "person" were reported during this period (in 2010 and 2011, the preventable collisions with a person were actually with bicyclists). Table 2-12 also shows that the number of rear-ending collisions, whereby the transit vehicle collides with the rear of the vehicle in front of it, remained relatively stable at three collisions each in 2009, 2011, and 2012, with four such collisions in 2008 and 2011.

**Table 2-12. BCT Motorbus Collisions Identified as Preventable
(Reported as Major Incidents in the NTD)**

Year	Collision with			Collision Type					
	Motor Vehicle	Person	Fixed Object	Rear-Ending	Angle	Head-On	Side	Sideswipe	Other Front Impact
2008	8	--	1	4	3	1	--	1	--
2009	6	1	--	3	3	--	--	1	--
2010	9	1	--	4	4	1	--	1	--
2011	6	2	--	3	--	--	3	1	1
2012	9	1	--	3	--	1	6	--	--

Source: National Transit Database

It is important to note that BCT had significant staffing issues in their training department during the study period, with the majority of their training staff retiring. These trainers had been the driving force behind the simulator training program, and their departure from the industry was evident at BCT, and made it incredibly difficult for the Research Team to collect information.

While BCT hired new trainers, their focus was on traditional classroom and over-the-road training. Unfortunately, because of staffing and timing issues, the agency did not incorporate their simulators during the period associated with research gathering related to this project. However, previously the simulators played a significant role in simulator training at BCT. The agency's training staff believed that as a training tool, the simulators served as an intervention tool that helped with problem-based issues, and resolution. BCT's training staff sees the simulators as providing ideal opportunities for operators to practice fundamental and complex driving skills.

Chapter 3: Case Studies – Other

Other Transit Systems using Bus Operator Simulators

In an effort to collect additional information to validate qualitative information associated with this research, the Research Team contacted four transit agencies that use bus simulators in their bus operator training programs, including:

- Metropolitan Transit Authority of Harris County (Houston Metro), Houston, Texas
- York Regional Transit/Viva (YRT/Viva), Richmond Hills, Ontario, Canada
- Massachusetts Bay Transportation Authority (MBTA), Boston, Massachusetts
- Champaign-Urbana Mass Transit District (CUMTD), Urbana, Illinois

Since these transit agencies were not included in the original project scope and annual data was not collected from them, quantitative data specific to their simulator training activity was not readily accessible. However, the Research Team did conduct telephone interviews with representatives from these agencies and utilized electronic correspondence to gather follow-up information. In addition, as with the three Florida transit systems in the case studies, representative NTD data for the three U.S. systems were compiled and analyzed for years before and after the implementation of simulator training.

The information obtained from these selected public transit agencies identified potential success factors, indicators, and best practices related to the effectiveness of bus simulators. The following section describes the experiences of Houston Metro, YRT/Viva, MBTA, and CUMTD in the installation and use of simulators in their operator training programs. Also presented are the lessons learned and the details of simulator usage, including:

- Overview of training programs
- Use and integration of simulators
- Challenges
- Lessons learned
- Benefits

Houston Metro

Houston Metro has been using two FAAC, Incorporated MB-2000-V8 simulators since 2002. Metro uses simulators for new bus operator, refresher, remedial, and post-accident training. They currently provide a total of 114 hours of new bus operator training that includes: classroom (90 hours), over-the-road (20 hours), and simulator (4 hours). Remedial/refresher (4.5 hours) and post-accident (4.5 hours) training are also offered and provide an additional 9 hours each of classroom and over-the-road training, and 2.5 hours of simulator training.

Research and information collected and analyzed from both FAAC Incorporated and Doron Precision® support many of Metro's conclusions related to improving bus operator decision making and driving skills. Both manufacturers provide literature and best practice

techniques to their clients to ensure success in these areas. The recommendations provided include:

- Practical, consistent use and training
- Effective encouragement and engagement by trainers during training sessions
- Support and promotion by all levels of management

Tables 3-1 and 3-2 present information on collisions reported as major incidents by Houston Metro in the NTD from 2002 to 2012 for its directly-operated motorbus services (excluding services provided with motorcoach vehicles). In this study, an attempt was made to collect data prior to the implementation of simulator training, which in Metro's case, was in 2002. However, the Research Team did not have access to NTD safety data prior to 2002; as such, the data in Tables 3-1 and 3-2 begin with 2002. While NTD data cannot be examined for years prior to the simulator training, it could be expected that the number of preventable collisions (reported as major incidents) might decline in the years since the training has been used. However, the data in Table 3-1 show no identifiable trend in the number of these preventable collisions over the years 2002 to 2012. Because there are enough data points (years) to statistically identify a linear trend if one existed, a regression analysis was performed using the number of incidents as the dependent variable and the year (time) as the independent variable. It was found that the coefficient on the independent variable was not statistically significant (at even the 10 percent level of significance), which means that there is no linear relationship in the number of preventable collisions reported as major incidents in NTD over this time period. A limit to this analysis is that the Research Team did not have access to the total number of accidents or collisions during this time period. While no trend could be identified for the occurrences of preventable collisions reported as major incidents in the NTD, it cannot be concluded that such a trend does not exist when all collisions are considered.

Table 3-1 also shows that the number of injuries to all parties resulting from the identified preventable collisions ranged from 12 in 2004 to a high of 62 in 2003. In addition, there was a total of three fatalities associated with the preventable collisions during this time, all involving pedestrians.

As noted earlier, NTD implemented a reporting change beginning in 2008. Prior to 2008, the injury threshold for reporting a major incident was two injuries. Beginning in 2008, this threshold was lowered to just one injury. As expected, this increased the number of incidents being reported beginning in 2008. To properly compare the incidents over time, the incidents that would have also been reported beginning in 2008 were included in the totals for 2002 through 2007. This was done by sorting the incidents based on the number of injuries and also accounting for the other reporting thresholds.

Finally, it should be noted that service supply data (revenue miles) for Houston Metro were not yet available for 2012. Therefore, the measures of revenue miles between total collisions and between preventable collisions in Table 3-1 could not be computed for 2012.

**Table 3-1. Houston Metro Motorbus Collisions
(Reported as Major Incidents in the NTD)**

Year	Total	Total Preventable	Preventable Collisions		Revenue Miles Between	
			Injuries	Fatalities	Total Collisions	Preventable Collisions
2002	63	10	31	0	600,155	3,780,976
2003	76	13	62	0	489,466	2,861,493
2004	25	2	12	0	1,448,518	18,106,479
2005	42	8	23	0	789,292	4,143,784
2006	35	7	15	1	893,988	4,469,938
2007	49	8	33	0	624,599	3,825,668
2008	56	14	33	1	551,694	2,206,777
2009	43	8	20	0	745,296	4,005,967
2010	30	6	16	0	1,080,089	5,400,446
2011	33	9	21	0	988,663	3,625,097
2012	49	8	34	1	n/a	n/a

Source: National Transit Database

Table 3-2 provides additional details on the preventable collisions identified in Table 3-1. Most collisions were with another motor vehicle, and only three were with persons. Prior to 2008, there was no category for "fixed object," it was simply "other." So, the collisions in that column of Table 3-2 for the years through 2007 were "other," and beginning with 2008 they were with a "fixed object" (there is still a category for "other" but none of these collisions were included in that category from 2008 to 2012). Similarly, it should be noted that the categories for collision type shown in Table 3-2 are the current NTD categories as of 2008. For the years 2002 through 2007, the Research Team used the incident descriptions to sort the collisions into the current categories. For example, the rear-ending collisions identified in Table 3-2 for the years 2002 to 2007 were originally categorized as "back" collisions.

As discussed in the previous section, NTD also currently has a category for "rear-ended," whereby another vehicle collides with the rear of the transit vehicle. Any collision in which the transit vehicle was rear-ended was determined to be not preventable for purposes of this study, and so there is no such information in Table 3-2.

**Table 3-2. Houston Metro Motorbus Collisions Identified as Preventable
(Reported as Major Incidents in the NTD)**

Year	Collision with			Collision Type					
	Motor Vehicle	Person	Fixed Object/ Other	Rear-Ending	Angle	Head-On	Side	Sideswipe	Other Front Impact
2002	10	--	1	4	--	--	3	1	2
2003	12	--	1	8	--	--	1	1	2
2004	2	--	--	1	--	--	--	--	1
2005	8	--	--	1	--	--	4	2	1
2006	4	1	2	2	--	--	--	--	5
2007	7	--	1	4	2	--	--	--	2
2008	10	1	3	3	6	4	--	--	1
2009	7	--	1	3	3	1	--	--	1
2010	6	--	--	3	1	--	--	--	2
2011	9	--	--	4	--	--	2	1	2
2012	6	1	1	2	--	--	4	--	2

Source: National Transit Database

Metro has determined that their simulators are a great training aid for building and improving operator decision making skills. They have built a simulator training program that is ongoing and consistent, a strategy they believe is important for program effectiveness. They emphasized that there has been great internal support of simulator training by upper management, and they consider this support an essential ingredient for realizing the full benefits of simulator training.

YRT/Viva

YRT/Viva provides local bus and rapid transit services in nine municipalities, and operates more than 120 regional routes, with connecting services to the City of Toronto and the Region of Peel. In addition, Mobility Plus provides door-to-door, shared-ride accessible public transit service for people with disabilities.

YRT/Viva has one FAAC MB-2000-V8 model simulator which was installed in July 2011. YRT/Viva uses this simulator to train new bus operators (2 hours) and provide post-accident (1 hour), incident (1 hour), and remedial/refresher training (1 hour). The five hours of simulator training supports 122 total hours of bus operator training including classroom and over-the-road training. Simulator training is also interspersed with 16 hours of total remedial/refresher training, 4 hours of "minor" post-accident/incident training, and 8 hours of "major" post-accident/incident training.

While YRT/Viva does not collect simulator training data, they have indicated that they have observed positive tendencies using the simulators. Organizational units/garages that use the simulator as part of their new hire, post-collision, and refresher training programs have noticed a reduction in close proximity related collisions. YRT/Viva has also observed that

operators are transitioning to air brake vehicles with more ease, and generally need less time to build their skills for this transition.

Because only U.S. transit agencies report to the NTD, no additional data was available for YRT/Viva.

MBTA

MBTA is the nation's 5th largest mass transit system. It serves 176 cities and towns within eastern Massachusetts and maintains 183 bus routes, two of which are Bus Rapid Transit lines, three rapid transit lines, five light rail (Central Subway/Green Line) routes, four trackless trolley lines, and 13 commuter rail routes.

In 2008, MBTA purchased two MB2000 simulators from FAAC Inc. Full simulator integration into MBTA's training programs did not come to fruition until January 2009. MBTA began a recertification program in 2010 for all veteran bus operators. Specifically, MBTA uses the recertification program as an opportunity to replicate actual accidents, and uses these scenario-based exercises as training opportunities.

Information on collisions reported as major incidents by MBTA from 2006 to 2012 in the NTD for its directly-operated motorbus services is provided in Tables 3-3 and 3-4. As in Houston Metro's case, there are arguably enough data points (years) to statistically identify a linear trend in the number of preventable collisions reported as major incidents, if one existed. Similar to Houston Metro's case, a regression analysis performed using the number of incidents as the dependent variable and the year (time) as the independent variable found no linear relationship in the number of preventable collisions classified as major incidents in NTD over this time period. Also similar to Houston, the Research Team did not have access to the total number of accidents or collisions during this time period, which limited this analysis. While no trend could be identified for the occurrences of preventable collisions reported as major incidents in the NTD, it cannot be concluded that such a trend does not exist when all collisions are considered.

Table 3-3 also shows that the number of injuries to all parties resulting from the identified preventable collisions ranged from only 2 in 2010 to 30 in 2012. In addition, there were two fatalities resulting from the preventable collisions during this time, both involving bicyclists.

As noted earlier, NTD implemented a reporting change beginning in 2008. Prior to 2008, the injury threshold for reporting a major incident was two injuries. Beginning in 2008, this threshold was lowered to just one injury. As expected, this increased the number of incidents being reported beginning in 2008. To properly compare the incidents over time, the incidents that would have been reported beginning in 2008 were included in the totals for 2006 and 2007. This was done by sorting the incidents based on the number of injuries and also accounting for the other reporting thresholds.

Finally, it should be noted that service supply data (revenue miles) for MBTA were not yet available for 2012. Therefore, the measures of revenue miles between total collisions and between preventable collisions in Table 3-3 are not available for 2012.

**Table 3-3. MBTA Motorbus Collisions
(Reported as Major Incidents in the NTD)**

Year	Total	Total Preventable	Preventable Collisions		Revenue Miles Between	
			Injuries	Fatalities	Total Collisions	Preventable Collisions
2006	16	4	10	0	1,525,312	6,101,250
2007	22	6	29	0	1,120,294	4,107,745
2008	21	5	9	0	1,152,108	4,838,852
2009	15	3	4	0	1,588,299	7,941,493
2010	4	1	2	0	5,974,905	23,899,620
2011	12	4	13	0	1,981,141	5,943,423
2012	32	12	30	2	n/a	n/a

Source: National Transit Database

Table 3-4 provides additional details on these identified preventable collisions. As expected, most collisions were with another motor vehicle, and only three were with persons (bicyclists). As discussed previously, prior to 2008, there was no category for “fixed object,” it was simply “other.” So, the collisions in that column of Table 3-2 for the years through 2007 were “other,” and beginning with 2008 they were with a “fixed object” (there is currently still a category for “other” but none of these collisions were included in that category from 2008 to 2012). Similarly, it should be noted that the categories for collision type shown in Table 3-2 are the current NTD categories as of 2008. For the years 2006 and 2007, the Research Team used the incident descriptions to sort the collisions into the current categories. For example, the rear-ending collisions identified in Table 3-4 for the years 2006 and 2007 were originally categorized as “back” collisions.

Again, as mentioned previously in this report, NTD also currently has a category for “rear-ended,” whereby another vehicle collides with the rear of the transit vehicle. Any collision in which the transit vehicle was rear-ended was determined to be not preventable for purposes of this study, and so there is no such information in Table 3-4.

**Table 3-4. MBTA Motorbus Collisions Identified as Preventable
(Reported as Major Incidents in the NTD)**

Year	Collision with			Collision Type					
	Motor Vehicle	Person	Fixed Object/ Other	Rear-Ending	Angle	Head-On	Side	Sideswipe	Other Front Impact
2006	4	--	--	2	--	--	--	--	2
2007	3	1	2	2	--	--	1	1	2
2008	3	--	2	1	1	2	--	1	--
2009	2	--	1	1	1	1	--	--	--
2010	1	--	--	--	1	--	--	--	--
2011	4	--	--	2	--	--	2	--	--
2012	8	2	2	4	--	--	5	--	3

Source: National Transit Database

While integration of MBTA simulators took approximately a year, they find that the simulators add value to their training programs, and believe that the agency has seen a small decrease in the number of preventable accidents each year because of this training. Based on their experience, MBTA believes that simulator-based performance is not an indicator of overall operator performance, and has learned that the simulators should be used as a tool for training, discussion, and practice. MBTA did caution that simulators should not be used as the primary mechanism for evaluating an operator's performance.

CUMTD

CUMTD serves the cities of Champaign, Urbana, Savoy, and the University of Illinois. CUMDA has 19 fixed routes as well as demand response services that include paratransit.

CUMTD began using two FAAC Inc. simulators in 2010 (Figure 3-1). According to a *Passenger Transport* article ("Public Transportation Training Goes High-Tech," February 2013) the agency engaged in two full years of testing, training, and assimilation before they fully integrated the use of the simulators into their training program.¹⁵ CUMTD's bus operator training program is very extensive, with new bus operators receiving well over 400 hours of training including four hours of simulator training (Table 3-5). Simulator training is also interspersed into CUMTD's refresher, review, and post-accident/incident training. CUMTD has a Summer Review Training Program (when demand for university service is greatly reduced) for all existing operators that serves as their general refresher training program.

¹⁵ Passenger Transport, *Public Transportation Training Goes High-Tech*, February 2013



Figure 3-1. Champaign Urbana Mass Transit District Simulator Training Facility (Metro Magazine).

Table 3-5. CUMTD Bus Operator Training (Annual Averages)

Hours of Training					
	<i>Classroom Training</i>	<i>Over the Road Training</i>	<i>Simulator Training MB1500 (2)</i>	<i>In-Service Line Instruction</i>	<i>Total</i>
New Bus Operator Training	41.75	160.50	4.00	200.00	406.25
Post-Accident/Incident Bus Operator Training	2.50	3.00	1.00	0.00	6.50
6 month Refresher for new operator	2.75	4.00	0.75	0.00	7.50
Summer Review for existing operators	3.00	4.50	0.25	0.00	7.75

CUMTD reports that in 2004, accidents of operators in their first year of employment accounted for 35 percent of the agency's total accidents. CUMTD hopes that accidents involving first year operators will continue to decline as a result of simulator training.

Information on motorbus collisions classified as major incidents by CUMTD in the NTD from 2008 to 2012 is provided in Tables 3-6 and 3-7. The data in Table 3-6 indicate a relatively low number of total and preventable collisions reported as major incidents. There were no collisions identified as preventable in 2008. Further, no fatalities were associated with the identified preventable collisions. It should also be noted that service supply data (revenue miles) for CUMTD were not yet available for 2012. Therefore, the measures of revenue miles between total collisions and between preventable collisions in Table 3-6 are not shown for 2012. As with Houston and MBTA, the Research Team did not have access to the total

number of accidents or collisions during this time frame, which limited this analysis. While no trend could be identified for the occurrences of preventable collisions reported as major incidents in the NTD, it cannot be concluded that such a trend does not exist when all collisions are considered.

Table 3-6. CUMTD Motorbus Collisions Reported as Major Incidents in the NTD

Year	Total	Total Preventable	Preventable Collisions		Revenue Miles Between	
			Injuries	Fatalities	Total Collisions	Preventable Collisions
2008	3	n/a	n/a	n/a	892,187	n/a
2009	5	2	1	0	547,175	1,367,937
2010	6	3	3	0	467,107	934,215
2011	5	2	2	0	558,156	1,395,389
2012	6	1	1	0	n/a	n/a

Source: National Transit Database

Table 3-7 provides additional details on the collisions identified as preventable. A total of four collisions were with another motor vehicle, three were with a person (one pedestrian, one person attempting to board, and one bicyclist), and one was with a fixed object. Only one collision, in 2011, was rear-ending, according to Table 3-7. The small number of data points is not sufficient for statistically identifying any linear trends in these types of collisions over this time period.

Again, as mentioned previously in this report, NTD also currently has a category for “rear-ended,” whereby another vehicle collides with the rear of the transit vehicle. Any collision in which the transit vehicle was rear-ended was determined to be not preventable for purposes of this study, and so there is no such information in Table 3-7.

**Table 3-7. CUMTD Motorbus Collisions Identified as Preventable
(Reported as Major Incidents in the NTD)**

	Collision with			Collision Type					
	Motor Vehicle	Person	Fixed Object/ Other	Rear-Ending	Angle	Head-On	Side	Sideswipe	Other Front Impact
2008	--	--	--	--	--	--	--	--	--
2009	1	--	1	--	1	--	--	1	--
2010	1	2	--	--	2	1	--	--	--
2011	1	1	--	1	--	--	1	--	--
2012	1	--	--	--	--	--	1	--	--

Source: National Transit Database

The agency views simulators as a savings resource and according to the agency's training staff, the use of the simulators better prepare operators by allowing them to make mistakes without the associated costs and consequences of accidents in the real world.¹⁶

Summary

This section focused on four transit agencies outside Florida that utilize bus operator simulators: Houston Metro, York Regional Transit/Viva, MBTA in Boston, and Champaign Urbana Mass Transit District. For the three agencies that operate in the U.S., data from the NTD were used to examine the occurrences of preventable collisions identified as major safety incidents. A limit to the analysis in this section relates to the fact that NTD major incidents represent only a subset of the total number of accidents or collisions that occur each year. Thus, while no trends in the number of preventable collisions could be identified among these major incidents, it cannot be concluded that no such trends exist if the total numbers are considered.

Based on telephone interviews and electronic correspondence, it is clear that the public transit agencies included within this study believe that there are intrinsic benefits of simulator training including, but not limited to, training related cost savings in time and fuel, and improved safety performance.

¹⁶ *Passenger Transport, Public Transportation Training Goes High-Tech*, February 2013

Chapter 4: Agency Considerations

Simulator Integration Considerations

The purchase and integration of transit bus simulators is a considerable undertaking. While the procurement and installation of simulators is unified and well planned for by most transit agencies, the actual integration of the simulator into the comprehensive training program has historically not been planned as well. Establishing a thoughtful technology and training integration plan is critical to the successful use of simulators at a public transit agency. A comprehensive integration plan, along with the support from upper management and other internal departments, will help ensure methodical assimilation and usage, which will result in establishing measurable success and return on the initial capital investment. An integration plan will also assist in forming long term planning goals and strategies.

In almost all of the case study sites, technology and training integration proved to be major challenges. However, a recently developed education and technology integration model is available that provides a comprehensive approach for these efforts. The *Technology Integration Planning Model*¹⁷ (TIP Model), which is illustrated in Figure 4-1, has five phases, and each phase suggests a guideline for integration planning and development based on the agencies response to key questions. This plan serves as a strategic framework for proper integration of the simulator or other technologies applications. The TIP Model shows agencies how to create an environment in which technology can effectively enhance training. The model addresses how agencies can deal with obstacles associated with integrating technology into curriculum instruction.

Phase 1 requires the agency to answer the following question “What problem will the simulator address?” and based on the response, the agency should estimate the impact the simulator will have on training and consider the required effort and associated expenses.

Phase 2 plans for the identification of outcomes, objectives, and assessments of the simulator training program. The agency must clearly identify each of these parameters early in the planning process to ensure their ability to acquire measurable benefits.

Phase 3 is perhaps the most important phase, and addresses strategies for design and integration. In this phase, the agency must identify what kinds of instructional methods are needed related to outcomes, objectives, and assessments, and clearly delineate how the simulator can support these methods. It is important in Phase 3 to also identify staff resources and responsibilities, development of a timeline for trainer training, and development of a realistic timeline for phased or full integration.

¹⁷ Roblyer & Doering, “Integrating Educational Technology into Teaching,” Allyn & Bacon, Boston, MA, 2013

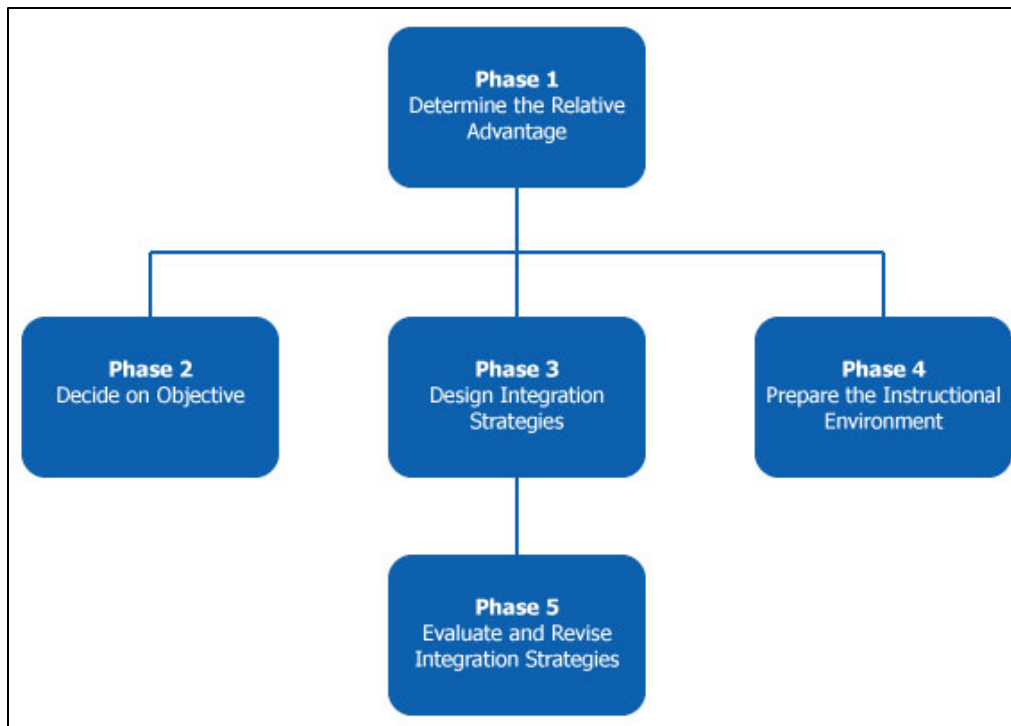


Figure 4-1. Technology Integration Planning Model¹⁸ (TIP Model).

The main element of TIP is Phase 4, and requires the agency to identify how the simulator should be incorporated to support instruction and learning. This is a critical element to identify because it will determine how, what, where and when the simulator will be used, and will serve as the key element of the technology and training integration plan.

The final phase, evaluation and revision of integration strategies, addresses the evaluation of the simulator training program, and serves as a self-assessment tool. The agency can identify if their objectives were achieved, if instructional strategies could improve results, and if the integration of the simulator has been successful. These steps in Phase 5 allow for the re-mapping of the agency's overall technology integration plan. This is a focal element of the TIP because it fosters opportunity to revisit and improve existing plans based on agency specific experiences.

While the overall context of the Technology Integration Planning Model is broad in nature, it functions as a viable framework for transit agencies to use as a tool for technology and training integration of simulators. Based on the experiences of many of the transit agency case study participants, it is clear that this planning piece should be considered in the simulator purchase plan and incorporated as model practice for long term planning and integration.

¹⁸ Ibid.

In addition to technology and training integration, the other lessons learned by many of the case study participants included the need to plan for both operator and simulator trainer turnover. The cost of employee turnover is extensive to transit agencies, and the reasons for turnover are vast and far reaching, but an agency's ability to plan for and compensate for trainer turnover can directly impact the effectiveness, and usefulness of the simulator. Without proper strategic planning, the effective use of simulators decreases. The development of a continuity plan can be an essential element of a successful simulator training program and agencies need to have succession planning for training positions, so that institutional skills and capacity are not lost when trainers leave.

Chapter 5: Conclusions

Summary

Transit simulators are becoming more prevalent in the transit industry nationally. From an operator's perspective, simulation affords the ideal opportunity to practice skills in a safe environment that will help master skills and hone driving techniques. From the agency's perspective, having operators use simulation-based technology increases competency levels, and confidence, while improving practical decision making skills.

This research represents the first qualitative analysis of the use and impacts of bus simulators in operator training. It includes a comprehensive description of bus simulator training at three Florida transit systems and four non-Florida transit systems. By all accounts, the transit systems included in this study that utilize such simulators find them to be invaluable training tools, and report positive impacts on the safety of their bus operations. The agencies regard simulators as an innovative, interactive method of training that enables them to offer theory-based approaches to the challenges of operating a bus while developing competences through practice in a computer-generated environment that is representative of actual operational conditions. The agencies are steadfast in their acceptance of simulators as valuable, supplemental training tools that help operators:

- Acquire, practice and develop skills
- Rehearse reactions to situations
- Improve decision making skills
- Review learning experience with the benefit of replay and reflection

The simulators also permit transit agency trainers and safety staff to assess and evaluate operator performance (limited). These assessments allow for genuine and interactive discussion and learning opportunities between trainers and operators, including procedural and operational performance and resolution based discussions.

Unfortunately, the quantitative data available for most of the transit systems examined as part of this study did not allow the Research Team to statistically identify any trends in the numbers of preventable collisions over time, due to the relatively short time frames for analysis, very low numbers of collisions, or both, and significant employee turnover. For two of the systems outside Florida, Houston Metro and MBTA in Boston, there were enough data points, both in terms of number of years analyzed and number of collisions; however, statistically no trends are detectable. Further, for those agencies included in this study that operate outside Florida, no additional data were available beyond the collisions reported as major incidents in the NTD. Collisions reported as major incidents in the NTD represent only a subset of the total numbers of collisions at these systems. Therefore, for those three non-Florida systems (there are no NTD data for York Regional Transit/Viva), it cannot be concluded that no trends in preventable accidents or collisions exist unless the total numbers of such occurrences are considered.

Further, it should be noted that there is always some degree of randomness in the occurrence of more serious collisions (usually reported as major incidents in the NTD), although a decline in the preventable occurrences would be expected after additional training, such as bus simulator training, is implemented. Also, another fact that must be considered is that, even though statistical trends are not identifiable in the data used in this study, it is evident from the examination of the NTD data that the more serious collisions (reported as major incidents) are relatively rare occurrences, as seen by the numbers of these collisions per revenue mile of service.

An additional consideration that must be noted in the use of any NTD safety data (as well as nearly all safety data reported by transit systems) is that these data are self-reported by the agencies, and are generally not audited. While FTA outlines very specific reporting requirements for its NTD Safety and Security reporting, there can still be some differences among agencies in how well these occurrences are reported. The most diligent reporters will show higher numbers of incidents at their transit systems.

While the qualitative analysis contained in this report supports the use of bus simulators in operator training, quantitative results must wait for a more complete data set. Certainly, the passage of time will increase the amount of data available, but it is also important that agency reporting become more consistent and complete. Future research can attempt to overcome data limitations. For example, it is more likely that statistical trends can be identified by providing more data points for analysis. This can be accomplished by conducting similar research after more years have passed since simulators were implemented. The more years of data, the more likely a statistical trend in the number of collisions and/or preventable collisions will emerge.

Additionally, many of the points addressed as lessons learned, which served throughout the report as peripheral issues related to this research effort, are truly significant daily challenges for transit agencies across the U.S. and should be considered for future research, including:

- Practices to improve employee retention rates and succession plans for trainers
- Identification of model bus operator simulator integration practices
- General training practices and standards recommendations
- Practices and standards of the collection of performance-related data
- Recommended preventable and non-preventable incidents definitions, and
- Prevailing training department structures and staffing model practices and continuity planning.

Finally, it is evident that comprehensive procurement plans, a technology integration plan, and a continuity plan are fundamental, critical components of a simulator training program and need to be incorporated as minimum elements by transit agencies when purchasing bus simulators. These comprehensive plans will help the agency plan, measure, improve, identify, enhance, and realize the benefits of transit operator training simulators.

References

- Allen, R.W., G.D. Park, M.L Cook and D. Fiorentino, "Simulator Training of Novice Drivers: A Longitudinal Study," *Advances in Transportation Studies*, Vol. 27, pp. 51-68, University Roma Tre, July 2012.
- Allen, R.W., T.J. Rosenthal, M.L. Cook, "A Short History of Driving Simulation, *Handbook of Driving Simulation for Engineering, Medicine and Psychology*," CRC Press, Boca Raton, Florida, 2011.
- Allen, Wade, George Park, Scott Terrace and John Grant, "Detecting Transfer of Training Through Simulator Scenario Design: A Novice Driver Training Study," *Proceedings of the Sixth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design*, pp. 203-210, 2011.
- Broward County Transit (BCT), FY 2013 Transit Development Plan (TDP), Annual Update, August 2012.
- Countermarsh, Barry, Kelley MacDonald, Sally Shoop, "Assessing the Transfer of Simulator Trained Skills to Real Vehicle Control," *Proceedings of the Sixth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design*, pp. 562-568, 2011.
- Hayes, Robert T., John W. Jacobs, Carolyn Prince & Eduardo Salas: "Flight Simulator Training Effectiveness: A Meta-Analysis," *Military Psychology*, 4:2, 63-74, November 2009.
- Mayora, Jose Pardillo, "A Human Factor-Based Approach for the Effective Use of Driving Simulators and E-Learning Tools in Driver Training and Education," *Proceedings European Conference on Human Centered Design for Intelligent Transport Systems*, pp. 205-215, 2008.
- Moffat, G., Ashton, A., Blackburn, D., "A Challenged Employment System: Hiring, Training, Performance Evaluation, and Retention of Bus Operators," *Transportation Cooperative Research Program Synthesis 40*, Transportation Research Board of the National Academies, Washington, D.C., 2001.
- Morgan, Justin, Scott Tidwell, Myra Blanco, Alejandra Medina, Richard Hanowski, & Olu Ajayi, "Driver Opinions of Simulator-Based Commercial Driver Training," *Proceedings of the Sixth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design*, pp. 129-135, 2011.
- National Academy Press, "National Transit Database 2013 Safety and Security Reporting Manual," Office of Budget and Policy, Federal Transit Administration, p. 40, 2013.

National Rural Transit Assistance Program, "Mobile Driver Training Simulators," 2008.

National Transit Database, Federal Transit Administration, "Transit in the United States," Retrieved from http://www.ntdprogram.gov/ntdprogram/pubs/NTST/2008/HTML/Transit_in_the_US.htm.

Office of Budget and Policy, Federal Transit Administration, "National Transit Database 2013 Safety and Security Reporting Manual," p. 40, January 2013.

Orlansky, J., J. String, "Cost-effectiveness of Flight Simulator for Military Training, Use and Effectiveness of Flight Simulators," (IDA Paper No. P-1275), Vol. I, Institute for Defense Analysis, Arlington, VA, 1977.

Passenger Transport, "Public Transportation Training Goes High-Tech," February 2013.

Robin, Jerry, "Validation of Simulation Technology in the Training, Testing, and Licensing of Tractor-Trailer Drivers," Federal Motor Carrier Safety Administration, Office of Research and Technology, 2000.

Roblyer & Doering, "Integrating Educational Technology into Teaching," Allyn & Bacon, Boston, MA, 2013.

Technology & Management Systems, Inc., "Effective Practices to Reduce Bus Accidents," Transit Cooperative Research Program Report 66, Transportation Research Board of the National Academies, National Research Council, Washington, DC, 2001.

Transit Cooperative Research Program, "Simulators and Bus Safety: Guidelines for Acquiring and Using Transit Bus Operator Simulators," TCRP Report 72, Transportation Research Board, National Research Council, Washington, DC, 2001.

Yan, X., M. Abdel-Aty, E. Radwan, X. Wang, P. Chilakapati, "Validating a Driving Simulator Using Surrogate Safety Measures," Accident Analysis & Prevention, January 2007.

Appendix A

460Bus™
Interactive Bus Driving Simulator System

OVER 25,000 SIMULATORS
DELIVERED IN 60 COUNTRIES.

THE 460BUS IS COST-EFFECTIVE
AND EXPANDABLE TO ACCOMMODATE
A GREATER NUMBER OF TRAINEES.

DORON DRIVING SIMULATION
SYSTEMS – THE INDUSTRY'S LOWEST
OPERATING, MAINTENANCE, AND
LIFE-CYCLE COSTS.



EXPERIENCE

Over 30 years experience in driving simulation and ongoing collaboration with transit and traffic safety experts has resulted in the development of this cost effective curriculum-rich driver training system.

INNOVATION

The 460Bus is a complete, "driver training simulation system" which includes a professionally developed and extensive library of scenarios, each designed to accomplish one or more specific training objectives. It forms the basis for a high quality, standardized training program for both new and experienced bus operators.

RESULTS

Doron's Transit customers report lower training costs, lower wash-out rates, lower collision rates, and improved safety.





DORON
PRECISION SYSTEMS, INC.

DORON PRECISION SYSTEMS, INC. • 174 Court St. • P.O. Box 400 • Binghamton, NY 13902
tel: 607.772.1610 • fax: 607.772.6760 • email: sales@doronprecision.com • web: www.doronprecision.com

550Bus™

Interactive Driving Simulation System

OVER 2000 DRIVING SIMULATION SYSTEMS DELIVERED IN 60 COUNTRIES.

DORON'S COMPREHENSIVE CURRICULUM PROVIDES ADVANCED TECHNIQUES, FUEL MANAGEMENT TRAINING AND INCREASED SAFETY AWARENESS.

DORON DRIVING SIMULATION SYSTEMS - THE INDUSTRY'S LOWEST OPERATING, MAINTENANCE, AND LIFE-CYCLE COSTS.



EXPERIENCE

Over 33 years experience in driving simulation and ongoing collaboration with transit and traffic safety experts has resulted in the development of this cost-effective, curriculum-rich driver training simulation system.

INNOVATION

The 550Bus is a complete, "driver training simulation system" that includes a professionally developed extensive library of scenarios, each designed to accomplish one or more specific training objectives, including CDL training exercises. It forms the basis of a high quality, standardized training program for both new and experienced operators.

RESULTS

Customers report lower training costs and increased profit margins resulting from shorter training times, lower collision rates, increased fuel management efficiency, and improved safety when using Doron simulation systems in their training program.



DORON PRECISION SYSTEMS, INC. • 150 Corporate Dr. • P.O. Box 400 • Binghamton, NY 13902
tel: 607.772.1610 • fax: 607.772.6760 • email: sales@doronprecision.com • web: www.doronprecision.com

Appendix B

MILITARY FIRE/EMS POLICE AIRPORT **BUS** RAIL



Bus Operator Simulators



www.faac.com

Realistic training for a host of transit vehicles.

Our versatile simulator designs have resulted in training systems that can be used for basic skills development, refresher activities, annual certification, and remedial lessons.

Our customers have improved their safety performance by as much as 64% for preventable accidents and improved the washout rate for new hire operators by 85%.

Key Benefits

- Reduce collisions
- Reduce on-board injuries
- Effective forward planning
- Ensure pedestrian safety during turns
- Mastery of mirror usage techniques
- Avoid conflicts at intersections
- Service stops without difficulty
- Promote passenger comfort
- Improve fuel economy
- Resolve temporary obstructions to eliminate "blind spots"



Fixed Route Bus



Demand Service

Multi-modal solutions

Multi-modal solutions present the unique work environment and appropriate controls associated with fixed route bus and demand services. The accuracy of the presentation within the driver's arms for each distinct driving discipline promotes positive training consistency throughout the learning process. Tests will be performed the same whether training occurs within the classroom using the simulator or over the road using the service vehicle.



Smart features for the most effective training.



Award Winning

FAAC's award-winning Transit Simulators are designed exclusively to serve the transit industry. The MB-2000 delivers a fully customized training experience. Real working physical mirrors are combined with lessons that emphasize the purpose and proper use of each mirror to accomplish critical training objectives. Cabs can be configured to match the precise layout of controls, indicators, gauges, and switches as found in your actual fleet vehicles. The most expansive and accurate field of view — geometrically correct through 350 degrees — enables trainees to look past ninety degrees to observe key reference points.

The FAAC MB-4500 Bus Simulator is designed to give both new and veteran operators a meaningful training experience. Coupled with our computer-based training system that lets trainees learn basic skills at their own pace, the MB-4500 delivers training episodes that mimic real-life hazards and risk concerns.

- Expansive field of view (accurate)
- Adjustable front mirrors
- Choice of generic or replica cabs



Dynamic Instructor Operating Station

- Intuitive IOS
- Exclusive jump back, replay, and re-drive student scenarios
- Instructor driving option for authorized vehicle and spontaneous hazards
- Remote logged control
- Instructor lesson plan tool
- Joystick control of pedestrians, vehicles, bicycles and other objects
- Helicopter mode with joystick control

Meet Training Objectives

- Safe, effective, efficient, objective and consistent training
- Basic, advanced and remedial driver/operator training
- Vehicle operations knowledge
- Mirror usage
- Mitigate risks
- Safe movement
- Student knowledge of rules and regulations
- Diagnosis and corrective action
- Direct activities to address most pressing concerns





The FAAC Difference

FAAC is dedicated to the highest fidelity in modeling and simulation technology, providing real experience for your operators in life-like virtual environments. Understanding your training objectives and budget, FAAC works with you to develop your optimal training solution.

FAAC supports a comprehensive in-house team, including software developers, engineers, digital graphic artists, technical staff and professional program managers. We focus on a customer-for-life philosophy to understand, develop, deliver and maintain your specific training solution.

Service, Support and Customer Resources

FAAC has a "customer for life" philosophy. We understand the importance of training and operational readiness. FAAC offers unsurpassed service and support:

- Turnkey Delivery
- Dependable, Reliable and Fast
- Online User Community
- User Conferences
- Train the Trainer Program
- Subject Matter Experts

Interactive Learning

- New and veteran operators can work online at their own pace
- Interactive training content that will be reinforced on the simulator
- Pre-built or customized curriculum solutions
- Multi-media approach enables effective knowledge transfer



1225 DAK VALLEY DRIVE • ANN ARBOR, MICHIGAN • 48108
734.761.5856 • WWW.FAAC.COM