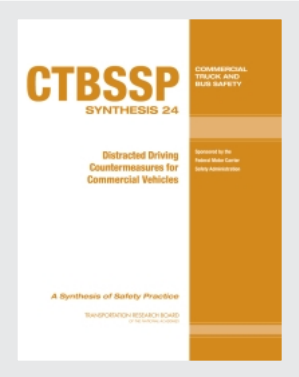

Distracted Driving Countermeasures for Commercial Vehicles

DETAILS

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COMMERCIAL TRUCK AND BUS SAFETY SYNTHESIS PROGRAM

CTBSSP SYNTHESIS 24

Distracted Driving Countermeasures for Commercial Vehicles

A Synthesis of Safety Practice

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COMMERCIAL TRUCK AND BUS SAFETY SYNTHESIS PROGRAM

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

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

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

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

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

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

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

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

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The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the National Research Council, or the Federal Motor Carrier Safety Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

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FOREWORD

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

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The CTBSSP, administered by the Transportation Research Board, was authorized in late 2001 and began in 2002 in support of the FMCSA's safety research programs. The program initiates several synthesis studies annually that address issues in the area of commercial truck and bus safety. A synthesis report is a document that summarizes existing practice in a specific technical area based typically on a literature search and a survey of relevant organizations (e.g., state DOTs, enforcement agencies, commercial truck and bus companies, or other organizations appropriate for the specific topic). The primary users of the syntheses are practitioners who work on issues or problems using diverse approaches in their individual settings.

This synthesis series reports on various practices; each document is a compendium of the best knowledge available on measures found to be successful in resolving specific problems. To develop these syntheses in a comprehensive manner and to ensure inclusion of significant knowledge, available information assembled from numerous sources is analyzed.

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

PREFACE

By Donna L. Vlasak
Senior Program Officer
Transportation
Research Board

The purpose of this synthesis was to report the state of research and practice with the intent of examining both distractions, as well as any protective (safety enhancing) effects of particular devices. Distracted driving for commercial drivers was defined as attending to tasks not directly related to operating the vehicle.

A literature review was conducted to assess recent research and current issues. The primary focus was to further understand driver distraction. It consisted of reports and analyses available from academic, government, and industry sources. Because available truck and bus technology capabilities have been changing dramatically over the last 10 to 15 years, literature cited here was published within that time frame. The information is included in the following sections: the nature of distracted driving, driver tasks unique to professional drivers, countermeasure technologies and their effectiveness, and operational strategies and recommended practice. As driver distraction was found to be an extremely

complex issue with much of the historical research presenting conflicting results, considerably more research is suggested to fully understand the physical, cognitive, and emotional attributes of driver distraction.

Based on the results of the literature review, a screening survey was developed to identify fleet managers willing to participate in structured interviews to understand their view of distracted driving and countermeasures they have put in place to reduce the risk of crashes related to distraction. The response size was small; there were 34 survey responses from motor carriers with 21 follow-up structured interviews conducted, with large and small fleets represented. There were 13 survey responses from large and small fleet motor coach representatives. Survey responses were primarily subjective responses to subjective questions and although not a representative sample of the larger population, still revealing because of the comparative information they provide. It was concluded that understanding how distraction types affect driving performance is important to improving the efficacy of countermeasures in triggering monitoring devices.

Richard Bishop, Bishop Consulting, Micah Lueck and Daniel Murray, American Transportation Research Institute, and Darrell Bowman, Bowman Consulting, with the support of Gene Bergoffen, MaineWay Services, Inc., collected and synthesized the information and wrote the report. The Commercial Truck and Bus Safety Synthesis Program Oversight Committee members are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

DISTRACTED DRIVING COUNTERMEASURES FOR COMMERCIAL VEHICLES

SUMMARY

Driver distraction for all vehicle types is an area of concern across the surface transportation industry, as indicated by Transportation Secretary Ray LaHood at the 2010 Distracted Driving Summit. Calling distracted driving an "epidemic," he characterized it as "unsafe, irresponsible, and, in a split second, its consequences can be devastating." The rise of basic cell phone use—itself a major potential source of distraction—has been followed by the rapid proliferation of smart phones, aftermarket navigation systems [e.g., global positioning systems (GPS)], and iPad-type devices, all of which are more text-oriented, leading to the added issue of texting while driving.

In addition to the basic driving task, the nature of operating a commercial truck or motor coach may introduce additional distractions, relating to areas such as weigh-in-motion systems and passenger interactions.

Reporting the state of research and practice was the purpose of this synthesis study, drawing on the large body of research that has focused on the many facets of distracted driving, as well as through structured interviews with fleet representatives and manufacturers of related products. The intent was to examine both distractions as well as any protective (i.e., safety-enhancing) effects of particular devices.

The specific goals of the study were to: (1) review related literature, with a particular focus on countermeasures for driver distraction; (2) survey motor carrier and motor coach managers to identify fleet managers willing to participate in the structured interview portion of the project; (3) identify, through structured interviews with fleet managers, current and potential tactics and training methodologies to aid motor carriers and drivers in avoiding crashes through awareness of dangerous actions and possible countermeasures; and (4) identify gaps in knowledge and research needs.

For purposes of this synthesis study, distracted driving for commercial drivers was defined as *attending to tasks not directly related to operating the vehicle*. Integrated displays and controls implemented by the vehicle manufacturer were considered as part of vehicle operation. This was also true of reading and comprehending roadside signage. Therefore, the specific distraction sources examined were:

1. Internal sources
   - Vehicle-based: communications devices, aftermarket active safety systems, onboard entertainment systems, GPS navigation systems, and dispatching devices; and
   - Job-based: passenger interactions in buses and trucks.

2. External sources
   - Weigh-in-motion or vehicle-in-motion inspections.

Based on the results of the literature review, a screening survey was developed that was distributed to motor carrier and motor coach managers. The survey garnered 34 responses from motor carriers, with large and small fleets represented. Based on the willingness of some

survey respondents, 13 follow-up interviews were conducted as structured interviews to understand fleet manager views of distracted driving and review any countermeasures they have put in place to reduce the risk of crashes related to distraction.

There were 13 responses from the motor coach representatives, with large and small fleets represented. No follow-up interviews were arranged.

Distraction is a cause for concern for all commercial drivers. As to the sources of distraction, researchers have found eyes-off-road to be a more compelling measure than the nature of the distraction. Relating this to hand-held cell phones, manual tasks are noted as risky. With respect to hands-free phones, research findings are inconclusive. Notably, texting is especially risky. Regarding job-related electronics, lock-out features, those designed to shut down cell phones or screens when a truck is in motion, are increasingly available to fleets.

The following conclusions were based on the literature review, surveys, and interviews.

Although the combination of driver monitoring and collision warning has been shown to be effective in mitigating the effects of distraction, there exists the possibility of a driver "gaming" or rigging the system and engaging in more secondary tasks owing to the presence of a support system, creating an opposite effect.

As to the human interface, the vehicle industry can potentially benefit from advances in human–machine interface from the consumer electronics industry. Research studies have increased the knowledge base as to the interaction between drivers and support systems, which will be important to the good design of these systems.

As to best practices at the company level, clarity within the organization as to safety culture and clear messages is important. At the employee level, careful hiring, thorough training, attending to wellness, driver rewards, and remedial practices when incidents occur are all important pieces of the puzzle.

For motor carrier representatives, there was wide agreement that driver distraction from all sources is a significant safety issue. In terms of behaviors, personal activities (e.g., eating and grooming) are seen as major distraction sources, as well as reaching for objects and map reading. Talking, texting, and dialing on a hand-held phone were also seen as distracting. As to which types of devices are distracting, personal electronic devices received the strongest response. Job-related devices and GPS navigation systems also received many responses. Approximately one-quarter of the group believed that aftermarket active safety systems were a source of distraction.

External to the company, the motor carrier industry respondents strongly supported laws prohibiting cell phone use while driving. Internal to the company, these same respondents believed that having a strong safety culture was the most important countermeasure. Participation in national programs such as a Responsible Care program was noted as being part of establishing a strong safety culture, from which a distracted driving policy can be derived. In addition, the FMCSA Compliance, Safety, Accountability initiative was reported by some as being helpful. The structured interview discussions indicated that larger fleets are more likely to have clear cell phone use policies. In the group interviewed, some smaller fleets prohibited cell phone use, whereas others discouraged it or had no policy.

Careful hiring, plus clear employee policies and consequences for violations, were also seen as very important. Post-incident coaching was strongly supported as well.

Internal to the vehicle, the strongest response was to implement "lock-out" functions on company devices when the vehicle is being driven, although for some fleets blanking the screen would interfere with navigation. Other features enable a driver to receive messages

relayed by computer voice through the vehicle speakers or allow for a single button push to inform the dispatch that the driver is currently on the road. In two of the structured interviews it was noted that managers use performance bonuses to encourage compliance with distraction policies.

There was strong support for banning the use of all personal communications devices, using active safety systems, and ensuring the careful and nondistracting placement of aftermarket devices in the driver area. There was strong opposition to the use of hand-held cell phones by drivers, and opinions were mixed as to allowing hands-free cell phones.

With regard to automatic video monitoring, several managers noted that these systems help to enforce compliance and augment their ride-along observations; some barriers noted were shipper prohibitions to having any cameras enter their facilities and cost. The greatest driver acceptance issues have arisen regarding automatic video monitoring. Although these systems only record based on trigger events, the perception can persist within the driver ranks that they are constantly being watched. One manager sees these driver misconceptions as "a fact of life."

All three modes of communicating information to the driver (audible, visual, and haptic) by means of devices not integrated into the vehicle, are seen as effective. Audible alerts were viewed as the most effective, and the use of graded warnings was strongly supported.

As a final point, it was noted that it is difficult to place strong prohibitions on commercial motor vehicle drivers alone and not the general public—if a distraction is dangerous for any driver it is dangerous for every driver. With regard to automatic video monitoring, several managers noted these that systems help to enforce compliance and augment their ride-along observations.

CHAPTER ONE

INTRODUCTION

PROJECT OVERVIEW

Driver distraction for all vehicle types is an area of concern across the surface transportation industry, as indicated in 2010 by Transportation Secretary Ray LaHood, who called it an "epidemic" and characterized it as "unsafe, irresponsible, and, in a split second, its consequences can be devastating." The increased use of basic cell phones has been followed by the rapid proliferation of smart phones, aftermarket navigation systems [e.g., global positioning systems (GPS)], and iPad-type devices, all of which are more text-oriented, presenting the added issue of texting while driving.

The automotive industry has been an active participant in implementing distracted driving countermeasures for its customers. Owing to the different market dynamics for commercial trucks and motor coaches, it is possible that cell phones and other devices have proliferated without commensurate countermeasures. Furthermore, the nature of operating a commercial truck or motor coach may introduce additional distractions, relating to areas such as weigh-in-motion and passenger interactions.

In addition, the net effect of in-vehicle communications devices needs to be taken into account. For example, cell phones are enablers for the Amber Alert program, and the provision of traffic mobility information through 511 systems and hands-free devices have been shown to have a protective (i.e., safety-enhancing) stimulative effect on drivers (Olson et al. 2009).

To assess the state of research and practice in this respect was the purpose of this synthesis study, which drew on the large body of research that has focused on the many facets of distracted driving, as well as through structured interviews with fleet representatives and manufacturers of related products.

This safety synthesis project focused on both truck and bus drivers.

The goals of the study were to: (1) review related literature, with a particular focus on countermeasures for driver distraction; (2) survey motor carrier and motor coach managers to identify fleet managers willing to participate in the structured interview portion of the project; (3) identify, through structured interviews with fleet managers, current and potential tactics and training methodologies to assist motor carriers and drivers in avoiding crashes through the awareness of dangerous actions and possible countermeasures; and (4) identify gaps in knowledge and research needs.

For the purposes of this synthesis study, distracted driving for commercial drivers was defined as attending to tasks not directly related to operating the vehicle. Integrated displays and controls implemented by the vehicle manufacturer were considered as part of vehicle operation. This was also true of reading and comprehending roadside signage; therefore, the specific distraction sources examined were:

- Internal sources
  - Vehicle-based—communication devices, aftermarket active safety systems, onboard entertainment systems, GPS navigation systems, and dispatching devices; and
  - Job-based: interactions of passenger in buses and trucks.
- External sources
  - Weigh-in-motion or vehicle-in-motion inspections.

APPROACH

The study began with a literature review to assess recent research and current issues. Based on the results of the literature review, a screening survey was developed that was distributed to motor carrier and motor coach managers. The screening survey identified those fleet managers who were willing to participate in the structured interview portion of the project. Interviews were held with these fleet managers to understand their views of distracted driving and any countermeasures they have put in place to reduce the risk of crashes related to distraction. The conclusions of this report were developed from the literature review, screening survey results, and structured interviews.

CHAPTER TWO

LITERATURE REVIEW

A literature review was conducted to identify and summarize findings relating to commercial truck and bus driver distraction research conducted thus far. The literature reviewed in this task consisted of reports and analyses available from academic, government, and industry sources. The review was conducted primarily through Internet searches of online databases, publications, and other industry resources. The reports identified have been summarized and are described in the following sections:

- The nature of distracted driving.
- Driver tasks unique to professional drivers.
- Countermeasure technologies and their effectiveness.
- Operational strategies and recommended practices.

The primary focus of this review was to examine and further understand driver distraction and its impact on commercial vehicle safety. Because available truck and bus technology capabilities have been changing dramatically since the mid-1990s, the literature cited herein was published since that time.

LITERATURE REVIEW METHODOLOGY

Literature searches were performed using websites, academic databases, books, trade press publications, and articles. The following databases were used to conduct the reviews:

- Transportation Research Information Database (TRID): The largest online bibliographic database of transportation research, containing more than 900,000 records of published research.
- Business Source Premier: Features the full text for more than 2,200 journals. Full text is provided back to 1965, and searchable cited references back to 1998.
- LexisNexis: Provides access to many popular articles as well as some scholarly works. There is also access to congressional records, court decisions, and government statistical reports.

These databases were searched using a variety of topic-related key words and phrases, often in combinations to improve focus. Key words included commercial motor vehicles, trucking, motor coaches, commercial drivers, safety, safety management, risk management, operations management, driver distraction, driver tasks, driver workload, distraction countermeasures, safety culture, safety climate, crash reduction, driver training, and driver supervision.

NATURE OF DISTRACTED DRIVING

A wide range of studies have addressed distracted driving and it continues to be a very active research topic. Studies of most relevance to this project are summarized here for the general driver population; the next section addresses commercial vehicle drivers specifically. The issues can be grouped into the following topics.

Detailed Definition of Distracted Driving

Pettitt et al. (2005) developed a comprehensive definition of distraction that accounts for all key components. In this definition, driver distraction occurs:

- When a driver is delayed in the recognition of information necessary to safely maintain the lateral and longitudinal control of the vehicle (the driving task) (Impact).
- Owing to some event, activity, object, or person, within or outside the vehicle (Agent).
- When a device that compels or tends to induce the driver's shifting attention away from fundamental driving tasks (Mechanism).
- By compromising the driver's auditory, biomechanical, cognitive, or visual faculties or combinations thereof (Type).

Problem Extent—How Does Distracted Driving Relate to Crash Risk?

McEvoy et al. (2005) examined crash data for cell phone use before a crash and found that crash likelihood was four times greater if drivers had used their phones in the minutes before a crash. Backer-Grøndahl and Sagberg (2009) noted that, based on more recent crash data, driver distraction plays a role in between 8% and 25% of crashes. ZoomSafer (2011a) conducted a general survey of 500 business managers and noted that, although 32% of all companies surveyed have had instances of crashes linked to driver distraction, trucking had a higher occurrence (between 41% and 53% of companies) of distraction-related crashes.

Traditional Distraction versus Electronic Devices

Backer-Grøndahl and Sagberg (2009) factored in exposure rates to determine the relative crash risk of various types of distraction. Looking at billboards, searching for addresses, and moving objects in automobiles were identified as having the highest relative risk. Molino et al. (2009) reviewed literature addressing the effects of electronic billboards and found a 5 to 1 ratio of studies showing negative effects. Based on a driver survey, NHTSA (2010) identified the most common forms of distraction to be talking to passengers, radios/music, eating and drinking, and using a cell phone (in that order). Klauer et al. (2010) analyzed naturalistic driving data from the 100-car study to analyze the crash risk of simple, moderate, and complex secondary tasks. Although simple tasks had no effect, moderate tasks such as talking and listening on a hand-held device increased crash risk by a factor of 1.3. Complex tasks such as dialing a hand-held device increased risk by a factor of 2.1. Another survey asked drivers to assess the degree to which distraction relates to crash involvement. The results were found to have some consistency with an analysis of the 100-car data: 30% of the time a situation outside the vehicle was responsible for the distraction, whereas objects inside the car were the cause 20% of the time. Among other factors, cell phone use was responsible for 2% of the distractions.

Rakauskas and Ward (2005) examined the level of driver distraction associated with cell phone use, alcohol impairment, and in-vehicle tasks (such as pushing a button), and found that the particular in-vehicle tasks selected were more distracting than the cell phone conversations. Royal (2003) describes a NHTSA survey of distracting behaviors across 4,010 drivers. Looking for an object inside the car was the most common answer; only 2% of the responses dealt with technology, noted as being primarily radio. For participants involved during in a crash in the previous five years, only 0.6% attributed the cause to cell phone use. Cades et al. (2011) cites multiple sources to argue that eyes-on-road distractions impair the driver, whether they relate to electronic devices or conversations with passengers.

When Do Drivers Choose to Engage in Distracting Behaviors?

Lerner et al. (2008) examined *when* drivers are willing to take a risk and engage in nondriving-related tasks. The study found their willingness to do this is related more to task issues and lifestyle than driving issues, and also noted that drivers were unlikely to plan ahead for either technology usage or delay usage until the driving demands were relatively low.

How Does Distraction Relate to Driving Performance?

Hancock et al. (2003) studied individuals driving on a test track who were presented with a dual task to create a distraction. The results showed that drivers braked later when engaged in a distraction task; however, they also braked harder, indicating individuals in these conditions may stop sooner rather than later when a distraction is present. However, Morgan et al. (2011) reviewed driving performance parameters as they relate to distraction and found there were more lane deviations, less consistent and slower speeds, and poorer responses to emergencies. The study also noted that drivers allocate part of their cognitive resources to the secondary task, resulting in a form of "tunnel vision" such that they do not scan the road scene as well. Rakauskas et al. (2004) employed a driving simulator to assess the relationship between distraction and three levels of conversation difficulty on a cell phone. Reviewing speed, lateral tracking, crash avoidance, and mental workload it was found that speed was, on average, slower during conversation. No significant decline in safety measures was noted for any of the various levels of conversation difficulty; however, the researchers concluded that this relationship could be examined further.

Smith et al. (2005) examined a variety of visual tasks to determine which types of visual stimuli present a threat. The study revealed that, as the visual task complexity increased, the inter-vehicle distance from the vehicle ahead increased; additionally, given similar eye glance patterns of two secondary tasks, longer lasting secondary tasks present a greater crash risk. They concluded that, assuming similar eye glance patterns, as the time to complete a secondary task increases a safety threat becomes more imminent.

Are Hands-Free Devices Safer Than Hand-Held Devices?

The World Health Organization (WHO) (2011) examined a wide range of literature to conclude that, although using a mobile phone is detrimental to driving, it is not clear that hands-free phones are safer. Additionally, in a review of four experimental studies (Burns et al. 2002; Consiglio et al. 2003; Pattern et al. 2004; Törnros and Bolling 2005, 2006) pertaining to cell phone conversations during driving-related activities, Ishigami and Klein (2009) generally found that both hands-free and hand-held phones, as compared with the experimental controls, impaired detection reaction times but not vehicle lane keeping tasks. This meta-analysis of cell phone research also found that, particularly with hands-free phones, drivers slow down when conversing on a cell phone (Ishigami and Klein 2009). Ishigami and Klein (2009) attributed this slowing effect to a compensatory behavior for maintaining performance for keeping the vehicle in the lane. A more inclusive meta-review of 30 experimental and epidemiological studies, including the 10 studies reviewed by Ishigami and Klein (2009), found similar trends (National Safety Council 2010). In the McEvoy et al. (2005) study, both hands-free and hand-held phones were determined to increase risk, with no difference found in risk depending on the type of phone. Conversely, an examination of naturalistic driving data of commercial vehicle drivers found that talking or listening on a hands-free phone (i.e., driver talking

through a headset) provided a significant protective effect (odds ratio of 0.4), similar to the talking or listening to a citizen's band (CB) radio (odds ratio of 0.6), therefore decreasing the risk of a safety-critical event (Olson et al. 2009). Olson et al. (2009) suggested that dialing a phone requires substantial visual attention, taking the driver's eyes off the forward roadway, whereas listening or talking on the phone engages the driver and may provide an alerting mechanism (FMCSA 2009).

The contrasting conclusions from these studies are the result at least in part from the different approaches used to obtain the results. The fundamental difference between Ishigami and Klein (2009) and Olson et al. (2009) is the level of experimenter manipulation; where experimental studies are tightly controlled, naturalistic studies continuously capture data from drivers under normal driving texts without experimenter intervention. The McEvoy et al. (2005) study interviewed drivers who were hospitalized after a crash and researchers examined these drivers' cell phone records to determine if a cell phone had been used up to 10 min prior to the crash. By contrast, Olson et al. (2009), by examining naturalistic driving data, were able to examine the events that occurred seconds before the safety-critical event and distinguish the risk of the manual phone manipulation as compared with the driver's phone conversation.

As WHO (2011) recommends, there continues to be a need for more research to understand the degree to which cell phone subtasks (e.g., visual/manual demands and conversation demands) contribute to driver impairment.

How Risky Is Text Messaging While Driving?

WHO (2011) concluded that text messaging is a considerable risk. Drews et al. (2009) used a driving simulator to show a greatly increased crash rate from text messaging.

Section Summary

Although a few topics are clear, there remain areas that require further research. The studies reviewed indicated a clear link to an increased risk of being involved in safety-critical events as a result of cell phone use while driving. Although the degree of risk is not clear, the risk from texting and dialing appears to be significantly greater. This result must be tempered with work showing the significant risk associated with nonphone distraction sources. Driving performance apparently does change when drivers are distracted; however, the consequences of this are not yet well understood given the contradictory results noted. Although some early research indicated that hands-free phones are no less risky than handheld phones, more recent work examining naturalistic driving data shows a protective effect in using hands-free phones.

Citation Summaries

Backer-Grøndahl, A. and F. Sagberg, "Relative Crash Involvement Risk Associated with Different Sources of Driver Distraction," presented at the First International Driver Distraction and Inattention Conference, Gothenburg, Sweden, Sep. 28–29, 2009.

The authors introduce three types of research on driver distraction. First, there are experimental (e.g., simulator) or naturalistic studies that show the effects of distraction on driving behavior. Next, there are prevalence studies that use crash databases to show that driver distraction plays a role in between 8% to 25% of crashes. Finally, there are crash risk studies that improve on the former by factoring in exposure rates (i.e., how often the driver population engages in distracting behaviors).

This study took the latter approach by recruiting 4,307 crash-involved driver participants and determining relative crash risk through quasi-induced exposure. The most frequently occurring distractions were talking with passengers and attending to children in rear seats; however, the distractions with the highest relative risk were looking at billboards outside, searching for addresses, and moving objects inside the car. Lower on the list were talking with passengers, attending to children in the rear seats, and adjusting a music device or radio tuner.

Cades, D.M., S.R. Arndt, and A.M. Kwashniak, "Driver Distraction Is More Than Just Taking Eyes Off the Road," *ITE Journal,* July 2011, pp. 26–33.

The authors synthesize previous research to make the case that, although eyes-off-road distraction is clearly a safety hazard, distractions occurring with eyes-on-road also carry a significant potential for driver impairment. They cite research showing that eyes-on-road drivers when presented with distractions do not necessarily perceive or encode objects they are looking at, are less likely to respond to traffic events, make riskier judgments regarding gaps in traffic, and are slower to respond to safety-critical events. Furthermore, the studies cited show that these drivers have smaller fields of view and thus do not scan as wide a range of the traffic scene. The types of distractions introduced in the studies included electronic devices as well as conversations with passengers. The authors assert that a high cognitive workload of the type associated with electronic in-vehicle devices may reduce the driver's ability to process visual information available in the roadway environment.

Drews, F.A., H. Yazdani, C.N. Godfrey, J.M. Cooper, and D.L. Strayer, "Text Messaging During Simulated Driving," *Human Factors: The Journal of the Human Factors and Ergonomics Society,* Vol. 51, 2009, pp. 762–770.

The authors used a laboratory study involving a driving simulator to evaluate the driving performance of 40 participants engaged in a single task (i.e., driving) versus a dual task (i.e., driving and text messaging). Participants in the dual task experimental group took their eyes off the road an average of 5 s to engage in texting activities and were involved in six times as many accidents as their control group counterparts. The texting drivers also took significantly longer to respond to brake lights ahead and demonstrated poor forward and lateral control of the simulator vehicle.

Although these results were in line with findings from naturalistic studies, the severity of distraction effects may differ because simulator participants are aware they are being studied in a laboratory environment, and college student participants may differ in meaningful ways from professional truck drivers.

FMCSA, *Driver Distraction in Commercial Vehicle Operations,* Tech Brief, Publication No. FMCSA-RRR-09-045, FMCSA, Washington, D.C., 2009.

This tech brief provides a summary of the Olson et al. (2009) study.

Hancock, P.A., M. Lesch, and L. Simmons, "The Distraction Effects of Phone Use During a Crucial Driving Maneuver," *Accident Analysis and Prevention,* Vol. 35, 2003, pp. 501–514.

In this study, dual tasks were examined where individuals were required to respond to an in-vehicle telephone and make stopping decisions. A total of 42 participants were included in the study that resulted in a final sample of 36. Participants completed the driving tasks on a one-fifth-mile loop-shaped track. A combination of distraction and stopping conditions were presented in addition to a controlled environment as follows:

- Control—Driving only,
- Distracter only,
- Stopping only, and
- Distracter and stopping.

Younger participants tended to approach the intersection faster than their older peers, but there were no gender differences. In terms of brake response time, participants braked significantly slower when a distraction task was presented. Older drivers drove much more slowly than their younger counterparts during a distraction. The study concluded that the older groups as well as females tended to be more affected by distractions than the other groups (younger and male). Results also indicated that participants would brake harder in the presence of a distraction, which in turn stopped the vehicle sooner. Therefore, the research suggests that individuals may indeed stop sooner rather than later when a distraction is present.

Ishigami, Y. and R. Klein, "Is a Hands-free Phone Safer Than a Handheld Phone?" *Journal of Safety Research,* Vol. 40, No. 2, 2009.

The authors conducted a review of experimental, observational, and epidemiological studies pertaining to the use of cell phones and driving-related activities. In most instances, hands-free communication was found to be as hazardous (or no less hazardous) to driving skills as using hand-held phones. This was true in nondriving studies, simulated driving studies, field driving studies, and epidemiological studies. In some cases, the authors concluded that hands-free devices were *more* dangerous than hand-held phones because the driver underestimates the threat and does not attempt to counteract potential negative effects (e.g., reaction time).

Klauer, S.G., F. Guo, J. Sudweeks, and T.A. Dingus, *An Analysis of Driver Inattention, Using a Case-crossover Approach on 100-car Data: Final Report,* Report No. DTNH22-00-C-07007, National Highway Traffic Safety Administration, Washington, D.C., 2010.

The authors analyzed the 100-Car Study database using logistic regression to identify behaviors that increased crash risk. They focused on three types of secondary tasks: complex, moderate, and simple. Examples of simple secondary tasks included adjusting a radio or other vehicle manufactured devices, talking to a passenger(s) in an adjacent seat, talking or singing with no passenger present, drinking, smoking, and thinking. As a group, these simple secondary behaviors were found not to increase crash risk.

Next, the authors looked at moderate secondary behaviors, including talking and listening or other hand-held device activities, inserting or retrieving a compact disc, reaching for objects, grooming and other hygiene activities, eating, and looking at something outside of the vehicle. As a group, moderate secondary behaviors increased the crash risk 1.3 times, compared with no secondary behaviors.

Finally, complex secondary behaviors included dialing a hand-held device; locating, reaching, and answering a hand-held device; reading; live animals or insects in the vehicle; reaching for a moving object; and applying makeup. As a group, drivers engaged in complex secondary tasks were 2.1 times more likely to be involved in a crash than drivers who did not perform these tasks.

Lerner, N., J. Singer, and R. Huey, *Driver Strategies for Engaging in Distracting Tasks Using In-vehicle Technologies,* Report No. HS DOT 810919, National Highway Traffic Safety Administration, Washington, D.C., 2008.

Rather than conduct another study demonstrating the link between driver distraction and safety-critical events, the authors investigated *when* drivers are willing to take a risk

and engage in nondriving-related tasks. A focus group was used to become familiarized with the types of in-vehicle technologies commonly used, followed by an on-road study in which drivers kept a log of how willing they would be to engage in certain behaviors at specified points along predetermined routes. Findings showed that driver willingness was associated more with task-related motivations and lifestyles than with driving-related issues such as roadway or traffic characteristics. Drivers were also not very likely to plan ahead for their technology use or delay use until road conditions and driving demands were low.

McEvoy, S.P., M.R. Stevenson, A.T. McCartt, M. Woodward, C. Haworth, P. Palamara, and R. Cercarelli, "Role of Mobile Phones in Motor Vehicle Crashes Resulting in Hospital Attendance: A Case-crossover Study," *BMJ,* Vol. 331, 2005, pp. 1–5.

Cell phone activity was examined for defined intervals before and after a crash. The sample consisted of 456 participants. Researchers concluded that crash likelihood was four times higher for participants that had used their phone within 10 min before the crash. There were no differences of crash likelihood between gender, age, or cell phone type. Both hands-free and hand-held cell phone use resulted in an elevated crash risk.

Although this study found an increased crash risk associated with cell phone use, it was suggested that enforcing laws that limit use may be difficult. Bluetooth technology has become increasingly prevalent in newer vehicles to promote hands-free cell phone use. However, the research in this study did not find a difference of crash likelihood between hands-free or hand-held devices. The presence of Bluetooth technology may encourage more people to use cell phones while driving thus contributing to an increase of crashes.

Molino, J.A., J. Wachtel, J.E. Farbry, M.B. Hermosillo, and T. M. Granda, *The Effects of Commercial Electronic Variable Message Signs* (*CEVMS*) *on Driver Attention and Distraction: An Update,* Report No. FHWA-HRT-09-018, Federal Highway Administration, Washington, D.C., 2009.

The authors reviewed literature addressing whether commercial electronic variable message sign displays (e.g., electronic billboards and digital billboards) act to distract drivers and reduce driving safety. That is, as the outdoor advertising industry is moving in the direction of making billboards more attention-grabbing, is this causing drivers to substantively shift their attention away from the road? Empirical studies were reviewed and, although results were somewhat mixed, there was a 5 to 1 ratio of studies finding some negative driver safety effects as opposed to no effects of billboards.

From a mental workload perspective, it can be concluded that drivers have a finite amount of capacity to focus on driving plus some spare capacity (i.e., a buffer that allows drivers to focus some attention on nondriving tasks). The surplus capacity is reduced or eliminated as the driver takes on additional demands (e.g., fixed hazards such as dangerous road layouts or transient hazards such as bad weather) and so it makes sense to prohibit billboards or other distracters from locations that already have known fixed hazards (e.g., sharp turns or difficult intersections). Further research must be conducted to review the effect of sign idiosyncrasies (e.g., information density, font size, message content, and dynamic messages) that could play a role in the severity of distraction. The authors present a list of independent and dependent variables that could be studied, as well as the research strategies that might be employed. Table 3 in the study's appendix outlines the associated advantages and disadvantages of the various field and lab approaches.

Morgan, J.F., T.E. Trimble, D.S. Bowman, S. Baker, R. Pickett, D. Murray, and G. Bergoffen, *Synthesis of Literature Relating to Cellular Telephone/Personal Digital Assistant Use in Commercial Truck and Bus Operations,* Report No. FMCSA-RRR-11-015, Federal Motor Carrier Safety Administration, Washington, D.C., 2011.

This article reviewed four aspects of driving performance that have empirically been shown to be harmed by driver distraction. First, lateral control of a vehicle is impaired by distraction, with distracted drivers experiencing more unintentional lane departures; greater variability in the vehicle's position inside the lane; and sharper, more frequent steering wheel inputs and corrections, compared with undistracted drivers. Second, distraction has been shown to be detrimental to longitudinal (i.e., speed) control of the vehicle, with distracted drivers typically struggling to maintain a constant speed; this greater variability in speed is accompanied by a lower average speed than undistracted drivers. Third, distracted drivers have slower reaction times to unanticipated safety-critical events and are less likely to identify these events compared with undistracted drivers. Finally, the article describes how workload is also negatively affected by distraction, because distracted drivers must divide their cognitive resources between required driving and extraneous demands; as a result, distracted drivers attempt to compensate by focusing almost entirely on the central visual field ahead, as opposed to performing normal visual scanning of the entire roadway, again increasing the odds that they will fail to identify safety-critical events.

National Safety Council, *Understanding the Distracted Brain—Why Driving While Using Hands-free Cell Phones Is Risky Behavior,* White Paper, 2010 [Online]. Available: distracteddriving.nsc.org.

As cell phone usage has increased over the past 15 years, the National Safety Council estimates that 25% of vehicle crashes can now be attributed to cell phone use, which amounts to 1.6 million crashes and 645,000 injuries. More than 80% of drivers admit to talking on their cell phones

while operating a vehicle, whereas 18% admit to texting while driving. To counteract this trend, more than 200 state bills were introduced in 2009, along with an Executive Order signed by President Obama.

The National Security Council suggests that the reason cell phones present such a distraction is because drivers do not realize that talking on the phone takes cognitive resources away from the road. In addition to this cognitive explanation, cell phones can be incrementally distracting when they cause a driver to take his or her eyes off the road and/or hands off the wheel. Using a hands-free device is seen as a solution by the general public (as well as current state laws and company policies); however, the report noted that research has accumulated to demonstrate that these devices are no better (and potentially worse) than talking on hand-held phones. The human brain processes information sequentially and does not multitask—as a result, drivers encounter inattention blindness ("looking" but not "seeing") when talking on the phone. Because they are not aware of this deficit, research has found that hands-free drivers are less likely to see high and low relevant objects; visual cues; exits, red lights, and stop signs; navigational signage; and the content of objects. These findings are unique to hands-free talking compared with talking with in-vehicle passengers. Adult passengers in the front seat can actually have a protective effect on crash risk, because they share awareness of the driving situation.

As a result, the authors report that cell phone users (handheld or hands-free) are four times more likely than nonusers to be involved in an accident. The report suggests that widespread education efforts are necessary, as well as comprehensive company policies and state laws banning all cell phone use. In addition, policies and laws will require strong enforcement by companies and the law, respectively. Finally, new technologies capable of blocking cell phone capabilities are another avenue worth exploring.

NHTSA, *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices,* 6th ed., National Highway Traffic Safety Administration, Washington, D.C., 2011.

This guide was created as a reference to help State Highway Safety Offices select empirically proven countermeasures when addressing major highway safety problem areas, including distracted and fatigued driving. The authors begin by discussing the nature of distracted and fatigued driving, pointing out the relative difficulty of effectively countering these problem areas, because they are in large part societal issues dependent on lifestyle patterns and choices. To date, most research has centered on cell phones, despite the prevalence and severity of other distracters. Cell phones are likely singled out because they require the attention of multiple senses (i.e., *vision:* locating the phone; *touch:* holding or dialing the phone; *sound:* listening to the party at the other end of the phone; and *speech:* talking to the other party), not to mention the cognitive capacity needed to understand and communicate.

In 2002, NHTSA surveyed 4,010 drivers to identify the most common forms of distraction, which included (from most common to least common) talking to passengers, changing radio stations or looking for music, eating or drinking, using a cell phone, dealing with children in the back seat, and reading a map or directions.

In addition, NHTSA surveyed drivers to assess the degree to which distracted driving contributed to crash involvement, as seen from the survey participant's perspective. It is noted that survey findings were likely underreported owing to response bias and, indeed, a follow-up study (the 100-car naturalistic driving study), found that nearly 80% of the 82 recorded crashes and 65% of the 761 near crashes involved drivers who took their eyes off the road just prior to the incident. Still, there was a degree of consistency between the naturalistic study findings and NHTSA's survey concerning which distractions most frequently lead to safety incidents. In both studies, roughly 30% of the time something outside the car was responsible for the distraction, whereas objects inside the car were responsible closer to 20% of the time. The latter included other passengers (19% in this survey; 11% in the naturalistic driving study) and cell phone use (2% of the time in both studies).

Olson, R.L., R.J. Hanowski, J.S. Hickman, and J. Bocanegra, *Driver Distraction in Commercial Vehicle Operations,* Report No. FMCSA-RRR-09-042, Federal Motor Carrier Safety Administration, Washington, D.C., 2009.

This study examined data from two previous naturalistic driving studies to calculate the odds ratios and population-attributable risk estimates for distracting tasks present in commercial vehicle operations. When combined, these datasets included 203 commercial drivers, 7 trucking fleets, and 16 fleet locations. These data represented approximately 3 million miles of continuously collected vehicle kinematic and video data. From these data, there were 4,452 safety-critical events (i.e., crashes, near-crashes, crash-relevant conflicts, and unintentional lane deviations) that were examined. Key findings included:

- Of these safety-critical events, 81.5% had some type of driver distraction listed as a potential contributing factor.
- Drivers were engaged in nondriving related tasks in 71% of crashes, 46% of near crashes, and 60% of all safety-critical events.
- The task "talking or listening on a hands-free phone" (i.e., driver talking through a headset) provided a significant protective effect (odds ratio of 0.4), therefore decreasing the risk of a safety-critical event.
- Tasks associated with increased risk (high odds ratios) were associated with long eyes-off-forward-roadway times.

More detail on this study is provided in the next section.

Pettitt, M., G. Burnett, and A. Stevens, "Defining Driver Distraction," presented at the 12th World Congress on Intelligent Transport Systems, San Francisco, Calif., Nov. 6–10, 2005.

The authors developed a comprehensive definition of distraction that accounts for all key components. In this definition, driver distraction occurs:

- When a driver is delayed in the recognition of information necessary to safely maintain the lateral and longitudinal control of the vehicle (the driving task) (Impact).
- As the result of some event, activity, object, or person, within or outside the vehicle (Agent).
- When something that compels or tends to induce the driver's shifting attention away from fundamental driving tasks (Mechanism).
- By compromising the driver's auditory, biomechanical, cognitive, or visual faculties, or combinations thereof (Type).

Rakauskas, M.E., L.J. Gugerty, and N.J. Ward, "Effects of Naturalistic Cell Phone Conversations on Driving Performance," *Journal of Safety Research,* Vol. 35, 2004, pp. 453–464.

A simulator was used to assess the relationship between cell phone distraction and three levels of conversation difficulty (none, easy, and difficult). Safety measures used in the study consisted of:

- Speed maintenance,
- Lane positioning maintenance,
- Crash avoidance, and
- Mental workload.

When participants held conversations while driving, results indicated more variation in acceleration and speed. Also, the average speed traveled was slower than non-conversation trials. However, the difficulty of cell phone dialogue did not result in any significant decreases in safety performance measures. It is important to note that no significant reaction time differences were found between conversation groups when a hazardous event was presented (e.g., vehicle pulling out). Researchers concluded that: (1) the complexity of cell phone conversations while driving could be examined further, (2) technology manufacturers are becoming more active in reducing distractions, and (3) policymakers could decide to focus on one driving objective (safety or convenience).

Rakauskas, M. and N. Ward, *Behavioral Effects of Driver Distraction and Alcohol Impairment,* 49th Annual Human Factors and Ergonomics Society Meeting, Orlando, Fla. Sep. 26–30, 2005.

Cell phone conversations, alcohol impairment, and common in-vehicle tasks were analyzed to determine the level of distraction associated with each. Conversations consisted of repeating a sentence, solving a verbal puzzle, or responding to a specific topic. In-vehicle tasks included pushing a button, adjusting airflow, changing temperatures, and pushing CD track buttons. Participants were assigned to either the control (received cranberry juice) or experimental (received alcohol and cranberry mixture) group. Blood alcohol content was maintained at 0.08 to represent the legal limit.

Results indicated that participants engaged in cell phone conversations or in-vehicle tasks performed worse than those without a secondary task. The control group (no alcohol) performed worse while completing the in-vehicle tasks than the intoxicated participants without any secondary tasks. It is important to note that participants were more distracted by engaging in the in-vehicle tasks than conversing on the cell phone, meaning that cell phones caused less distraction than pushing buttons in the vehicle, adjusting airflow, changing temperatures, or pushing CD track buttons.

Researchers suggested that banning hand-held cell phones may be a first step to limiting crashes, but additional studies needed to examine the specific issues associated with cell phone use while driving (e.g., in-vehicle tasks and text messaging). Also, educating the public on the risks associated with the various cell phone uses may provide a safer environment while driving.

Royal, D., *National Survey of Distracted and Drowsy Driving,* National Highway Traffic Safety Administration, Washington, D.C., 2003.

The NHTSA studied the frequency of 12 distracting behaviors that people engage in while driving. The sample consisted of 4,010 U.S. drivers, and responses received were self-reported. Each driver was asked to estimate the number of trips taken each week and the frequency of distracting activities while driving.

Participants were asked if they have had any crashes within the last five years and whether any distractions were involved. Of the participants who did have a crash resulting in damage to a vehicle, only 0.6% of crashes were attributed to cell phone use. Table 1 includes the percentage of crashes resulting from various distractions.

The study found that males were more likely to use their phone while driving than females and older participants were less likely to use technologies (make or receive calls, change the radio, use a navigation system, etc.) than younger counterparts. Of the drivers that did use cell phones while driving, the average duration of each call was approximately 4.5 min.

Generally, most of the participants supported five proposed measures to reduce the use of cell phones while driving.

TABLE 1
PERCENT OF CRASHES ATTRIBUTED TO DISTRACTION TYPES

Distraction	Percentage
Look for something outside the car	23
Dealing with children or other passengers	19
Looking for something inside the car	14
Another driver	11
Personal thoughts/thinking	5
Looking at an animal outside of the car	3
Dealing with technology (primarily radio)	2
Other distractions	23

Public awareness had the highest support at 88%, followed by only allowing hands-free or voice-activated phones (71%), insurance penalties for crashes that involve cell phone use (67%), doubled or tripled fines for traffic violations involving cell phone use, and a ban on cell phone use while driving (57%).

Smith, D.L., J. Chang, D. Cohen, J. Foley, and P. Glassco, *A Simulation Approach for Evaluating the Relative Safety Impact of Driver Distraction During Secondary Tasks,* World Congress on Intelligent Transportation Systems, 2005.

This study examined driver distraction and several secondary tasks that included:

- Visual tasks of less than 30 s (adjusting radio, dialing a cell phone);
- Complex visual tasks equivalent to one minute (map reading);
- Auditory–verbal tasks that were 1–2 min (listening to a book on tape); and
- Driving for 2 min without additional tasks.

A series of different visual tasks were measured in the study by using varying visual stimuli to determine in which cases visual stimuli present a threat. Results demonstrated that, as the visual task difficulty increased, the drivers tended to increase the amount of distance between their car and the vehicle directly in front, "falling back."

An additional finding was that, given similar eye glance patterns of two secondary tasks, longer lasting secondary tasks present a greater crash risk. This was because the lead vehicle was traveling at variable speeds (decelerating unexpectedly, etc.) and the distracted driver was less able to monitor following distance during longer secondary tasks. Therefore, assuming similar eye glance patterns, as the time to complete a secondary task increases a safety threat becomes more imminent.

World Health Organization, *Mobile Phone Use: A Growing Problem of Driver Distraction,* 2011 [Online]. Available: www.who.int/violence_injury_prevention/publications/road_traffic/en/index.html.

Reviewing worldwide road fatalities and injuries, the report noted the risk posed by distracted driving as an increasing concern to policymakers even while the extent of the problem is not well known. Intended to raise awareness about distracted driving, the report summarizes existing research. It focused primarily on mobile phone use, but also on other types of distractions. The report concluded that using a mobile phone while driving has a detrimental effect on driving behavior, and noted the lack of conclusive evidence that hands-free phones are safer than hand-held units. It further noted that text messaging while driving results in considerable physical and cognitive distraction, reducing driving performance. The authors concluded that more research is needed to understand the degree to which particular aspects of mobile phone use (dialing, talking, etc.) contribute to driver impairment.

ZoomSafer, Inc., *Measuring Corporate Attitudes About Employee Distracted Driving,* 2011 [Online]. Available: http://ZoomSafer.com/assets/Whitepapers/Survey-Results-White-Paper.pdf.

ZoomSafer, an organization that makes software to prevent distracted driving, surveyed 500 North American business managers to identify corporate attitudes and best practices related to mobile phone use among drivers. From the overall sample, which included long-haul and short-haul trucking companies; construction companies; utility companies; taxi, limo, and bus companies; sales and service companies; home and business services and government, they found that 32% of all companies have knowledge or evidence of their employees getting into vehicle crashes as a result of cell phone distractions. When focusing solely on trucking (long-haul and local/short-haul), findings showed higher rates of cell phone-related crashes (53% and 41%, respectively), but also higher levels of policy implementation (71% and 83%, respectively) and enforcement (71% and 59%, respectively).

DRIVER TASKS UNIQUE TO PROFESSIONAL DRIVERS

The number of studies addressing distracted driving for professional drivers is much less than that for drivers in general. Studies of most relevance to this project are summarized here. The issues can be grouped into the following topics.

Problem Extent—How Does Distracted Driving Relate to Crash Risk for Commercial Drivers?

Knipling et al. (2003) examined safety problem areas and found the top three to be at-risk driving behaviors, high-risk

drivers, and driver health and wellness. NHTSA (2010) showed a smaller proportion of large truck drivers and bus drivers who were distracted during a crash (8% and 6%, respectively) than is the case with passenger car drivers (11%); this has been a consistent finding over multiple years. The Large Truck Crash Causation Study (LTCCS; FMCSA 2005) found that driver inattention was the cause in 9% of fatal crashes, whereas 8% were the result of an external distraction and 2% an internal distraction; these distraction factors made it 5.1 and 5.8 times more likely for the truck driver to be at fault in a crash. Llaneras et al. (2005) conducted interviews with truck drivers and safety regulators regarding aftermarket technology for trucks. Nearly one-half of drivers admitted to "close calls" resulting from distraction.

Traditional Distraction Sources versus Electronic Devices

Hickman et al. (2010) examined 12 months of naturalistic truck and bus driver data based on the DriveCam video monitoring tool. Nondriving-related tasks requiring more visual attention were found to have had the strongest association to safety-critical events. Therefore, cell phone tasks such as dialing sharply increased the odds ratio. At the same time, talking or listening on a cell phone posed no increased risk and actually had a protective effect. The researchers caution that although these effects can be associated, cause and effect cannot be determined because of the naturalistic nature of the study. Olson et al. (2009) combined data from two naturalistic studies, resulting in three million miles of kinematic and video data. This team found tertiary tasks (i.e., tasks unnecessary to the role of driving) present in 46% to 77% of safety-critical events, noting that these are different conclusions from the LTCCS. Notably, cell phone conversations plus CB radio use was found to be protective. As with Hickman et al. (2010), it was concluded that the mean duration of eyes-off-road were associated with the severity of a safety-critical event. SmartDrive (2010) examined the most prevalent types of distractions during risky driving maneuvers, finding that having an object in hand rates highest (44%), with cell phone-talking in second place (13%). Llaneras et al. (2005) assessed specific devices, finding that multifunctional devices were viewed favorably by respondents. These can be locked out while the vehicle is in motion if the fleet chooses; however, there is wide variability as to the use of this feature. Although interactive technologies alert drivers of developing situations and can be potentially distracting to drivers, three FMCSA-sponsored studies (Murray et al. 2009a,b,c) found significant net safety benefits for active safety systems [forward collision warning (FCW), lane departure warning (LDW), roll stability control (RSC)]. This finding is bolstered by the American Transportation Research Institute (ATRI) (2003) in which carriers surveyed noted safety as the prime motivation for deploying such systems.

How Risky Is Text Messaging While Driving?

The Olson et al. (2009) study noted earlier found that risk was 23 times higher when texting compared with driving normally. This was far above the next most risky behaviors such as looking for objects or interacting with the dispatching device.

How Do Driver Practices Relate to Distraction-Related Risk?

SmartDrive (2010) conducted a study observing 14 million video events from more than 34,000 drivers and found that a small number of drivers represented the majority of the driver distraction safety problem. Although 10% of safety-critical events involved distraction, this figure was 67% for the top 5% of drivers with the highest number of distraction events. Drivers with the most recorded distractions were 7.4 times more likely to be in a crash or near a crash than drivers with the fewest recorded distractions.

Section Summary

A brief summary is provided here to encapsulate the preceding discussion. Generally speaking, commercial drivers are less prone to be in a distraction-related crash as compared with the general public. The correlation of "bad apple" commercial drivers with distraction-related safety-critical events is significant enough to enable fleet managers to adjust hiring practices and training. Nevertheless, distraction appears to be a cause for concern for all commercial drivers. As to the source of distraction, researchers have found eyes-off-road to be a more compelling measure than the nature of the distraction. Relating this to cell phones, the manual tasks are noted as risky. With respect to hands-free phones, research findings are inconclusive. Notably, texting is especially risky. Regarding job-related electronics, lock-out features are increasingly available to fleets.

Citation Summary

American Transportation Research Institute (ATRI) and Gartner G2, Inc., *Trucking Technology Survey Results Summary,* ATRI, Arlington, Va., 2003.

Onboard technology offers motor carriers insight into in-cab activities and driver (and vehicle) performance. According to a survey of 150 motor carriers, improved safety is the number one reason carriers choose to deploy such technologies. And, although a very small proportion of carriers reported installing onboard safety systems in that survey, adoption of in-vehicle technologies has certainly grown as the novelty has worn off and the benefits have been demonstrated.

FMCSA, *The Large Truck Crash Causation Study Summary Report,* Federal Motor Carrier Safety Administration, Washington, D.C., 2005.

The FMCSA and NHTSA conducted the LTCCS by investigating a nationally representative sample of 963 large truck crashes that occurred between April 2001 and December 2003.

The investigations determined that truck driver inattention was a causal factor (as opposed to an associated factor) in just 9% of fatal truck crashes; however, inattention made it 17.1 times more likely that a crash would be attributed to the truck (as opposed to a passenger vehicle or other factor). Meanwhile, 8% of crashes were attributed to truck driver external distraction (outside the cab) and 2% were attributed to truck driver internal distraction (inside the cab); respectively, these distraction factors made it 5.1 and 5.8 times more likely for the truck to be at fault in a crash.

Hickman, J., R. Hanowski, and J. Bocanegra, *Distraction in Commercial Trucks and Buses: Assessing Prevalence and Risk in Conjunction with Crashes and Near-crashes,* Report No. FMCSA-RRR-10-049, Federal Motor Carrier Safety Administration, Washington, D.C., 2010.

This study analyzed 12 months of naturalistic truck and bus driver data provided by DriveCam, whose onboard safety monitoring systems record videos of drivers and data from kinematic sensors on safety-related events. One data set included data wherein kinematic sensors were activated by nonsafety-triggered events (e.g., driving over train tracks) to serve as a baseline in calculating odds ratios. This data set included safety-triggered events and baseline events from 183 truck and bus fleets with 13,306 trucks and buses. Concerning safety events, there were 1,085 crashes, 8,375 near crashes, and 30,661 crash-relevant conflicts in the data set, compared with 211,171 baseline (nonsafety) events.

Tertiary tasks (i.e., tasks unnecessary to the role of driving) were found to have the strongest association to safety-critical events when they demanded more visual attention. Therefore, concerning cell phones, while talking or listening on a hands-free cell phone posed no increased risk (and actually had a protective effect), reaching for a phone (or headset or earpiece) or dialing, texting, e-mailing, or using the Internet sharply increased the odds of a safety-critical event.

A strength of naturalistic studies is the high ecological validity, which cannot be easily replicated through simulator studies. A weakness, however, is that, because no variables are being manipulated, cause-and-effect inferences cannot be made. That is, observation only revealed an increased association between tertiary tasks with visual components and safety-critical event occurrence. Pertaining more specifically to this study, another caveat is that the base rates of unwanted tertiary behaviors were likely much lower than would be found in the general population, because drivers knew their behaviors were being monitored and were working for carriers who were safety conscious enough to install the onboard safety monitoring devices.

Knipling, R., J. Hickman, and G. Bergoffen, *CTBSSP Synthesis 1: Effective Commercial Truck and Bus Safety Management Techniques,* Transportation Research Board of the National Academies, Washington, D.C., 2003.

This synthesis report provides a summary of safety management techniques in commercial truck and bus transportation. Twenty safety problem areas and 28 safety management techniques were identified through a literature review, discussions and interviews with industry experts, and suggestions from the TRB synthesis panel. Problem areas included both driver and vehicle issues, and safety management techniques ranged from driver recruiting and selection to advanced safety technologies.

A questionnaire was distributed to fleet safety managers and other industry safety experts through several trade associations and industry-related professional organizations to assess their relative importance. The top three problem areas for safety manager respondents were found to be at-risk driving behaviors (e.g., speeding and tailgating), high-risk drivers (all causes combined), and driver health and wellness. The three most common management techniques practiced by safety managers were continuous tracking of drivers' crashes, incidents, and violations; regularly scheduled vehicle inspections and maintenance; and hiring based on criteria related to driver crash, violation, or incident history. Each of these techniques was practiced by 90% or more of the safety manager respondents.

Based on the survey results and reviewed literature, four "safety opportunity areas" were selected for further research and discussion: driver health, wellness, and lifestyle; high risk drivers; behavioral safety management; and safety management professionalism. Several opportunities to improve safety were identified for each area:

- Driver health, wellness, and lifestyle
  - Motor carrier wellness programs.
- High risk drivers
  - Predicting crash rate based on past behaviors, and
  - Intervention programs.
- Behavioral safety management
  - Self-management programs,
  - Driver incentive programs,
  - Safety placards, and
  - On-board recording.
- Safety management professionalism
  - Certification of fleet safety practices, and
  - Certification of safety managers.

Llaneras, R.E., J.P. Singer, and R. Bowers-Carnahan, *Assessment of Truck Driver Distraction Problem and Research Needs,* Report No. DOT HS 809883, National Highway Traffic Safety Administration, Washington, D.C., 2005.

The researchers interviewed truck drivers and safety regulators to learn more about available original equipment manufacturers (OEM) and aftermarket technology options for trucks. Most research on driver distraction focuses on light vehicles, yet trucks are often the quickest to adopt new technologies. Additionally, findings from driver distraction research concerning passenger vehicles may not be fully applicable to the trucking industry, owing to myriad differences in the types of in-vehicle devices, device placement and design, or other factors associated with the nature of being a professional driver (e.g., skill, experience, and judgment). Interviewed drivers and safety personnel were optimistic that professional truck drivers make smart decisions regarding when and when not to use in-cab technology, although this was highly subjective and nearly half of the drivers still admitted to experiencing a "close call" resulting from distraction.

The authors also used task analysis to critically examine a variety of available in-truck devices and gauge the quality of their human factors design as it pertains to minimizing driver distraction. Devices included telematic systems, safety and warning devices, and navigation and fleet management systems, such as the following:

- AutoVue Lane Departure Warning System
- Bendix X-Vision (night vision system)
- Delphi Truck Productivity Computer (multifunctional device, similar to the AutoPC)
- Eaton Vorad and Smart Cruise (Adaptive Cruise Control)
- Freightliner Driver Message Center
- Freightliner Rollover Stability Advisor
- Global T-Fleet communications and tracking system
- Mack VIP display (multifunctional message center)
- MobileMax communications system (text messaging)
- Mobiuss TTS Onboard Computer
- PACCAR Driver Message Center
- People Net Wireless Fleet Solutions
- Qualcomm Fleet Advisor and MvPC (text-messaging)
- VDO FM System
- Volvo Driver Information Display and Volvo Link (text messaging).

Multifunctional devices appeared to be particularly common in the industry, and having systems that offered both text messaging and driver communication functions topped the list, both for OEM and aftermarket products. As proactive steps toward limiting distraction, many systems are customizable so that fleet safety managers can decide if they want to (completely or partially) lock out certain functions or, in the case of messaging systems, send messages with different levels of urgency and only allow the driver to read emergency messages while the vehicle is in motion. Despite these options, it varies widely between and even within fleets whether these lock-out capabilities are utilized. Finally, interviews revealed that banning technology is viewed as impractical and unwarranted, whereas the effectiveness of policies prohibiting the use of in-vehicle devices while driving is also questionable. Interviewees argued that effectiveness of these policies was contingent on enforcement and consistently applied rules (with penalties for noncompliance), whereas the key to limiting distraction from in-vehicle devices rested on enhanced designs and interfaces and reasonably applied restrictions and lock outs.

Murray, D., S. Shackelford, and A. Houser, *Analysis of Benefits and Costs of Forward Collision Warning Systems for the Trucking Industry,* Publication FMCSA-RRT-09-021, FMCSA, U.S.DOT, Washington, D.C., 2009a.

Murray, D., S. Shackelford, and A. Houser, *Analysis of Benefits and Costs of Lane Departure Warning Systems for the Trucking Industry,* Publication FMCSA-RRT-09-022, FMCSA, U.S.DOT, Washington, D.C., 2009b.

Murray, D., S. Shackelford, and A. Houser, *Analysis of Benefits and Costs of Roll Stability Control Systems for the Trucking Industry,* Publication FMCSA-RRT-09-020, FMCSA, U.S.DOT, Washington, D.C., 2009c.

Although interactive technologies alert drivers of developing situations and can be potentially distracting to drivers [e.g., forward collision warning system (FCWS) and lane departure warning system (LDWS)], it is likely that their net effect is to increase safety. These three studies sponsored by FMCSA discovered significant benefits as a result of deploying safety systems. In one study, it was determined that FCWS, if used nationally on all fleets, would prevent between 8,597 and 18,013 rear-end crashes, reducing annual injuries by 6,303 and fatalities by 103. LDWS was found to offer similar benefits, with the potential to prevent thousands of sideswipes, rollovers, and head-on collisions, with an annual reduction of 1,973 injuries and 100 fatalities. Finally, RSC systems were found capable of preventing between 1,422 and 2,037 rollovers each year, reducing the number of injuries by 1,322 and deaths by 73. For each $1 spent on deploying FCWS, LDWS, and RSCs, a return-on-investment of $1.93, $1.98, and $2.33 could be expected, respectively, with initial investments recouped within 6 to 37 months.

Olson, R.L., R.J. Hanowski, J.S. Hickman, and J. Bocanegra, *Driver Distraction in Commercial Vehicle Operations,* Report No. FMCSA-RRR-09-042, Federal Motor Carrier Safety Administration, Washington, D.C., 2009.

The researchers combined data from two naturalistic studies to identify 4,452 safety-critical events and 19,888 baseline events among 203 commercial motor vehicle (CMV) drivers from 55 trucks belonging to 7 different fleets. In total there were 3 million miles of continuously collected kinematic and video data. Tertiary tasks were determined to be present in 46.2% to 77.5% of the safety-critical events, leading to notably different conclusions from the LTCCS. Risk was especially elevated when drivers performed highly complex tertiary tasks, such as text messaging or taking their eyes off the road to rummage through a grocery bag (see Table 2).

TABLE 2
ODDS RATIOS AND 95% CONFIDENCE INTERVALS TO ASSESS LIKELIHOOD OF A SAFETY-CRITICAL EVENT WHILE ENGAGING IN TERTIARY TASKS

Task	Odds Ratio	LCL	UCL
Text message on cell phone	23.24*	9.69	55.73
Other—Complex Tertiary Task (e.g., cleaning side mirror, rummaging through a grocery bag)	10.07*	3.10	32.71
Interact with/look at dispatching device	9.93*	7.49	13.16
Write on pad, notebook, etc.	8.98*	4.73	17.08
Use calculator	8.21*	3.03	22.21
Look at map	7.02*	4.62	10.69
Use/reach for other electronic device (e.g., video camera, 2-way radio)	6.72*	2.74	16.44
Dial cell phone	5.93*	4.57	7.69
Other—Moderate Tertiary Task (e.g., opening a pill bottle to take medicine, exercising in the cab)	5.86*	2.84	12.07
Personal grooming	4.48*	2.01	9.97
Read book, newspaper, paperwork, etc.	3.97*	3.02	5.22
Put on/remove/adjust sunglasses or reading glasses	3.63*	2.37	5.58
Reach for object in vehicle	3.09*	2.75	3.48
Look back in sleeper berth	2.30*	1.30	4.07
Adjust instrument panel	1.25*	1.06	1.47
Talk or listen to hand-held phone	1.04	0.89	1.22
Eat	1.01	0.83	1.21
Remove/adjust jewelry	1.68	0.44	6.32
Other—Simple Tertiary Task (e.g., opening and closing driver's door)	2.23	0.41	12.20
Put on/remove/adjust hat	1.31	0.69	2.49
Use chewing tobacco	1.02	0.51	2.02
Put on/remove/adjust seat belt	1.26	0.60	2.64
Talk/sing/dance with no indication of passenger	1.05	0.90	1.22
Smoking-related behavior—cigarette in hand or mouth	0.97	0.82	1.14
Drink from a container	0.97	0.72	1.30
Interact with or look at other occupant(s)	0.35*	0.22	0.55
Talk or listen to hands-free phone	0.44*	0.35	0.55
Bite nails/cuticles	0.45*	0.28	0.73
Look at outside vehicle, animal, person, object, or undetermined	0.54*	0.50	0.60
Talk or listen to CB radio	0.55*	0.41	0.75
Smoking-related behavior—reaching, lighting, extinguishing	0.60*	0.40	0.89
Other personal hygiene	0.67*	0.59	0.75

Asterisk indicates a significant odds ratio.

Significant predictors of safety-critical events have asterisks placed next to their odds ratios, which inform the reader how much each behavior elevates the risk of being involved in an event. For instance, the statistically significant odds ratio estimate of 23.24 for text messaging means that drivers who engage in text messaging behind the wheel are more than 23 times more likely to be involved in a safety-critical event than drivers who do not text message behind the wheel, holding all other behaviors constant. In addition to the best estimate for the odds ratio value, the table also presents 95% confidence intervals, which indicate a range of possible odds ratio values, with 95% certainty that the true odds ratio falls between the lower confidence level and upper confidence level. Therefore, although the odds ratio estimate is 23.24 for text messaging, it may actually fall between 9.69 and 55.73, owing to statistical uncertainty. In any case, the behavior increases risk because it is always over the value of 1.00.

A protective effect (odds ratio below 1.00) was observed for several tasks, including talking and listening by means of a hands-free phone and use of the CB radio.

Olson and colleagues expanded on these findings to demonstrate that the mean duration of eye glances away from the road were associated with the severity of the safety-critical event. Odds ratios suggested that long glances of more than 2 s greatly increased the risk of a safety-critical event; not surprisingly, behaviors with the highest odds ratios in Table 2 were most often also behaviors associated with taking one's eyes off the road.

NHTSA, *Traffic Safety Facts: Distracted Driving 2009,* Washington, D.C., 2010 [Online]. Available: http://www.distraction.gov/research/PDF-Files/Distracted-Driving-2009.pdf.

Using the Fatality Accident Reporting System, NHTSA's National Center for Statistics and Analysis showed that a smaller proportion of large truck drivers and bus drivers who were distracted during a crash (8% and 6%, respectively) than is the case with passenger car drivers (11%). This is a consistent finding over multiple years.

SmartDrive, *Commercial Fleet Distracted Driving Research 2010,* 2010 [Online]. Available: http://www.smartdrive.net/documents/smartdrive-distracted-driving-report_2010.pdf.

SmartDrive Systems, a fleet safety and efficiency solutions company, has engaged tens of thousands of truck drivers in a study, known as the SmartDrive Safety program, to provide fleets a glimpse into the causes and rates of commercial driver distraction. During 2010, SmartDrive observed nearly 14 million video events from 34,466 commercial drivers who were observed through in-cab video, allowing SmartDrive to create the SmartDrive Distracted Driving Index (SDDI) as a baseline for future comparisons.

The SDDI has revealed, among other things, that a small minority of drivers represent the vast majority of distracted driving problems. That is, although the study found that roughly 10% of all safety-triggered events (e.g., sudden stops, swerves, and collisions) involved a driver engaged in distracted driving activities, this figure jumped to 67% for the top 5% of drivers with the highest number of distraction events. Comparing drivers with the most recorded distractions to drivers with the fewest recorded distractions revealed that the former group is 7.4 times more likely to be involved in a crash or near crash.

The nine most prevalent distractions discovered during risky driving maneuvers were:

- Object in hand (e.g., MP3 players, personal digital assistants, and paperwork); 44.5%
- Talking on a hand-held mobile phone; 13.4%
- Beverage; 12.7%
- Food; 10.1%
- Smoking; 9.9%
- Operating a hand-held device (e.g., texting); 9.1%
- Talking and listening on mobile phone (hands-free); 5.2%
- Using a map or navigation device; 1.0%
- Grooming and personal hygiene; 0.6%.

COUNTERMEASURE TECHNOLOGIES FOR DISTRACTION AND THEIR EFFECTIVENESS

Numerous research studies have investigated countermeasure technologies for distracted driving, and the consumer electronics industry is active as well. Publications of most relevance to this project are summarized here. The issues can be grouped into the following topics.

Combining Driver Monitoring with Driver Assistance

Lerner et al. (2008) developed a matrix that mapped 36 findings to possible countermeasures for each respective finding. Countermeasure options included public education and safety campaigns, driver training, user interface design, functional lock-out technology of electronic devices, and interactive control technology, such as driver assistance systems. (Driver assistance systems include functions such as LDW and FCW that serve to make the driver aware of safety-critical situations and therefore have the potential to compensate for driver attention lapses.) Llaneras et al. (2000) reported on the results of a NHTSA-sponsored online forum, which concluded that driver assistance systems are useful to provide additional "eyes and ears."

Several studies have addressed driver monitoring to detect distracted driving, with sensor-based collision warning systems playing a role to mitigate the momentary effects of the distraction event. The authors clearly recognize that there exists the possibility of a driver "gaming" the system and engaging in more secondary tasks knowing that there are support systems such as crash warning.

For instance, in the final report for the Intelligent Vehicle Initiative FCW field operational test, Battelle (2007) reported

that driver assistance systems helped drivers keep a safe following distance, improve reaction time, and increase awareness when distracted. Blaschke et al. (2009) evaluated options for managing distracted driving: block incoming calls when aware of a complex driving situation, warn driver of distracted conditions, or minimize negative outcomes of distraction with support systems such as LDWS. Kircher and Ahlström (2009) examined the relationship between driver assistance systems such as FCW and LDW and driver distraction countermeasures. They noted that such systems could warn drivers earlier, particularly when combined with eye tracking systems that would detect eyes-off-road conditions. Lee et al. (2000) examined the potential of FCW to mitigate driver distraction in driving simulator experiments. The study found that cognitive demands (speaking) pose a risk equal to visual distractions and that the effects could be mitigated with FCW. The authors suggest integrating detection of distraction events with FCW to issue earlier warnings, as long as this does not encourage the driver to increasingly engage in distracting activities. Donmez et al. (2008) built on earlier work to demonstrate that presenting real-time feedback to drivers on lane position resulted in fewer distracting activities. The team recommended both retrospective and real-time feedback.

As to the technological approach to detecting driver distraction, Blaschke et al. (2009) advocates eye- or head-tracking systems. By contrast, Zhang et al. (2008) describes work in the SAVE-IT program to identify decrements in driving performance as a result of visual distraction. The authors here concluded that while eye-based tracking is more accurate, head-based systems are more practical, and therefore recommended moving forward with head movement sensors.

WHO (2011) notes the potential value of technological interventions such as workload managers and LDWs; however, these technologies are seen as having a limited impact on a global basis owing to their low market penetration.

Insurance-Links Measures to Monitor Cell Phone Use

ZoomSafer (2011b) describes both an active and passive approach to cell phone use within a vehicle, in the context of usage-based insurance (UBI) techniques. The active approach connects a smartphone with a UBI device in the vehicle, such that the smartphone is automatically deactivated when the vehicle is in motion. The passive approach consists of integrating UBI data (including events during driving) with billing records from the telecommunications carrier for the cell phone, so that events can be correlated with cell phone use. Although the active approach requires a smartphone, the passive approach works with any phone.

The Importance of Good Design in Human–Machine Interfaces

NHTSA (1997) took an early look at the safety implications of cell phones, noting the cognizant risks but also highlighting the core issue of inattentiveness. The authors contend that banning devices is not the correct approach and good design is key. Volpe (2008) offers a primer on technology for traffic safety, noting that it is important to consider the human–machine interface (HMI) when developing new safety systems, to strike the right balance between driver assistance and distraction. Burns (2007) presented a Transport Canada analysis of in-vehicle devices to argue that the impetus for distraction countermeasures lies with the designers of these devices. Llaneras et al. (2000) reported on the results of a NHTSA-sponsored online forum, which concluded that clearer graphics and ergonomics are needed in vehicle cabs. The Research and Innovate Technology Administration (RITA) (2011) describes a panel consisting of consumer electronics industry members held as part of a symposium on occupationally related distracted driving. It asserted that electronic devices can distract or assist the driver, and lock-outs and similar features exist for professional drivers. They noted that technology is moving in the direction of faster touch, less touch, or no touch (speech command and control). Vollrath and Totzke (2000) conducted driving simulator experiments to determine that driving performance is at its worst with manual tasks, followed by visual tasks, and most effective during with auditory tasks, concluding that auditory interfaces should be emphasized in design and, if visual/manual tasks are needed, augment the driver with driver assistance systems.

Lee et al. (2007) described the SAVE-IT project to implement adaptive interface technology as a countermeasure to driver distraction. The team developed models that accurately detected cognitive distraction 75% to 95% of the time. Findings suggested that listening to information is less demanding than responding to questions, cognitive and visual demands are additive, and cognitive distraction is multifaceted. To the latter point, the researchers noted that cognitive distraction is composed of distinct types with different impacts on driving performance.

As to specific design measures, Lee and Hoffman (2004) examined optimum methods to warn a distracted driver. They found that graded warnings (i.e., warnings that progress from less urgent to more urgent if the driver does not respond) were better received than single-state warnings; also that haptic messages were more acceptable to drivers than auditory messages. Fuller and Tsimhoni (2009) examined issues relating to screen placement using driving simulator studies. They noted that all screens can create distraction and showed that far-away screens created more significant distraction issues than screens close to the driver. Llaneras et al. (2005) conducted interviews with commercial fleet safety managers that indicated that, although lock-out functions are available for in-cab devices, the utilization of these functions varies widely.

Section Summary

Although the combination of driver monitoring and driver assistance systems has been shown to be effective in mitigating the effects of distraction, there exists the possibly of a driver "gaming" the system and engaging in more secondary tasks owing to the presence of a support system,

creating an opposite effect. As to the human interface, the vehicle industry can potentially benefit from advances in HMI from the consumer electronics industry. Research studies have increased the knowledge base as to the interaction between drivers and support systems, which will be important to the good design of these systems.

Citation Summary

Battelle, *Final Report Evaluation of the Volvo Intelligent Vehicle Initiative Field Operational Test Version 1.3,* National Highway Traffic Safety Administration, Washington, D.C., 2007.

In 1999, the U.S.DOT partnered with Volvo Trucks North America and US Xpress to test collision warning system (CWS), adaptive cruise control (ACC), and advanced electronic braking (AdvBS) systems in a Field Operational Test of intelligent vehicle safety systems (IVSS) designed for CMVs. Concerning usability of the safety systems, most drivers agreed that CWS visual and audible signals were always easy to see and hear; different IVSS warnings (forward, side, visual, auditory) were easy to distinguish from one another (although at times difficult owing to mental or physical fatigue) and from non-IVSS systems in the truck.

Finally, although drivers found AdvBS useful in all conditions and ACC useful aside from climbing hills or sitting in heavy traffic, the perceived usefulness of CWS varied more. Specifically, CWS was found to be most useful when visibility was low (e.g., during night time, foggy conditions, heavy rain, or snow), but much more distracting in heavy traffic. Furthermore, nearly half of all CWS warnings were determined by drivers to be false positives, which they found annoying. Still, most drivers reported that neither the visual nor auditory warnings caused them to be distracted from their driving tasks, and that they did not need to look away from the road to identify what a CWS alert meant. On the contrary, it was reported that CWS and ACC helped them keep at a safe following distance, improve reaction time, and increase awareness when distracted.

Blaschke, C., B. Färber, R. Limbacher, B. Trefflich, F. Breyer, and S. Mayer, "Online Estimation of the Driver's State Enhancement of Lane-keeping Assistance," First International Conference on Driver Distraction and Inattention, Gothenburg, Sweden, Sep. 28–29, 2009.

This study evaluated three available options for managing driver distraction, including prevention, mitigation, and minimizing negative outcomes. Preventing distraction involves the utilization of driving data (e.g., road conditions, traffic, and weather) to determine a driver's capacity to handle additional information. If demand on the driver is already high, then incoming calls to the driver will be postponed or in-vehicle information systems will be locked, so as to not overload the driver.

Mitigating distraction, on the other hand, involves distraction warning systems, which issue warnings to the driver when the system detects he or she is being distracted, with the goal of bringing the driver's attention back to focusing on the road.

Finally, to minimize negative outcomes of driver distraction, the approach advocated in this paper involves using driver assistance systems that provide a safety net in instances of driver distraction (e.g., LDWS). These warning systems typically generate acoustic or haptic warnings to the driver and some advanced systems will guide the vehicle back to the middle of the lane. However, a problem with traditional in-vehicle systems is their hypersensitive false alarms (e.g., inconsequential minor deviations from the middle of the lane or unsignaled lane changes). This paper demonstrates that in-vehicle systems can be improved by using eye- and head-tracking devices to recognize when the driver is visually distracted and most likely to actually need the safety system to activate, which acts to suppress unnecessary warnings.

Burns, P.C., "Driver Distraction Countermeasures," In *Distracted Driving,* I.J. Faulks, M. Regan, M. Stevenson, J. Brown, A. Porter, and J.D. Irwin, Eds., Australasian College of Road Safety, Sydney, NSW, Australia, 2007.

Transport Canada investigated potential countermeasures that could reduce the amount of unnecessary distraction drivers face from in-vehicle telematic devices. The authors concluded that the impetus rests with product designers, who must do more to consider the distraction potential of their products and increase human factors research during product design, development, and testing phases. Essentially, designers should give first considerations to safety and usability factors, followed by device features, rather than the other way around.

Donmez, B., L.N. Boyle, and J.D. Lee, "Mitigating Driver Distraction with Retrospective and Concurrent Feedback," *Accident Analysis and Prevention,* Vol. 40, 2008, pp. 776–786.

This was a follow-up study to previous work by the authors where it was demonstrated (using a driving simulator) that drivers engaged in fewer distracting activities (i.e., looking at in-vehicle information systems instead of the road) when given real-time feedback on their driving performance (e.g., lane position). A caveat, however, is that receiving real-time feedback may act as an additional distraction and interfere with task performance.

To expand on those findings, this simulator experiment compared three feedback delivery conditions: retrospective (i.e., end of trip) feedback, combined retrospective and concurrent (i.e., real-time) feedback, and no feedback. Accelerator release times were measured following unexpected braking events by lead vehicles, and drivers in both feedback groups (retrospective and combined feedback) outperformed drivers receiving no feedback, as measured by significantly

shorter accelerator release times. Additionally, the combined feedback group also displayed significantly longer, more sustained glances to the road, leading the authors to conclude that providing drivers with both real-time and retrospective feedback on distraction state is an effective strategy for mitigating the negative effects of distraction. Although real-time feedback is immediately helpful, an advantage of retrospective feedback is that it is less transitory and can therefore be processed more fully by the driver, making it more likely to actually change long-term behavior.

Fuller, H. and O. Tsimhoni, *Glance Strategies for Using an In-vehicle Touch-screen Monitor,* Report No. UMTRI-2009-5, Transportation Research Institute, University of Michigan, Ann Arbor, 2009.

The authors consider the effects of positioning in-vehicle devices in different vehicle locations, because nonideal locations may add to driver distraction. Both visual and motor demands of nonessential tertiary tasks were considered simultaneously by means of using a touch-screen monitor to perform the tertiary task and varying the location of the monitor. Driving simulator participants were instructed to focus their efforts primarily on following a lead vehicle that was sporadically speeding up and slowing down; additionally, they were instructed to perform the tertiary task on the touch-screen monitor.

Performance on the primary task (following the lead vehicle) was worse for all participants who performed the secondary task compared with those who did not, regardless of touch-screen position. Performance on the secondary task, however, predictably varied depending on the position of the touch-screen. More difficult positions (where participants had to reach farther and look farther to the side of their normal line of sight) resulted in longer times to completion for the secondary task and more frequent glances to the monitor than when the monitor was in an ideally located position. It is therefore concluded that in-vehicle devices that require driver interactions should be placed closer to the driver, because placing them farther away takes more attention off the road.

Kircher, K. and C. Ahlström, "Issues Related to the Driver Distraction Detection Algorithm AttenD," First International Conference on Driver Distraction and Inattention, Gothenburg, Sweden, Sep. 28–29, 2009.

Most applications of driver support systems attempt to help the driver when a critical safety event is unavoidable. Improvements to FCWS, LDWS, and others could be found by providing earlier warnings, although this would further increase the number of false alarms. On the other hand, the systems could be improved by taking driver state into account and acting only when an increased risk presents itself. Options for this latter approach could include pressure-sensitive steering wheel sensors, breath analyzers, live video feeds, or automatic eye tracking.

Because eye tracking can now be done unobtrusively, the authors chose this approach and described AttenD, an algorithm for detecting visual distraction in real time based on sustained single or repetitive glances away from the road. Essentially, AttenD uses a 2-s time buffer that depletes as drivers look away from the road and replenishes when eyes come back to the road. When the buffer is empty, the driver is classified as distracted. The buffer takes into account necessary acts of driving, such as checking mirrors or the speedometer, which do not count against the buffer until after a 1-s grace period.

Logical applications of AttenD involve issuing warnings to drivers determined to be in a distracted state. One possibility is to warn drivers every time they use up their 2-s buffer, so as to train the driver not to look away from the road so often. Otherwise, the distraction information could be fused with other in-vehicle systems such as FCWS and LDWS to more accurately identify when safety-critical events are probable. In contrast to the former option, using AttenD to minimize false warnings of other safety systems will not train the driver to focus his or her attention on the road and may actually have the opposite effect, teaching the driver to trust other systems to activate warning messages when dire situations arise.

Lee, J.D. and J.D. Hoffman, "Collision Warning Design to Mitigate Driver Distraction," SIGCHI Conference on Human Factors in Computing Systems, Vienna, Austria, Apr. 24–29, 2004.

The authors evaluated what type of warning delivery system is the most effective and accepted in warning distracted drivers. Experiments were conducted requiring participants to interact with an in-vehicle e-mail system while a FCWS alerted drivers to a braking lead vehicle.

Concerning alert strategy, graded warnings (where warning intensity is proportional to threat severity) were better received than single-stage warnings (where warnings were issued in an identical fashion when a predetermined severity threshold was crossed). Concerning alert modality, haptic messages (e.g., vibrating seats) were more accepted by drivers than auditory messages.

Lee, J., M. Reyes, Y. Liang, and Y.C. Lee, *SAfety VEhicles Using Adaptive Interface Technology: Algorithms to Assess Cognitive Distraction,* Volpe National Transportation Systems Center, Cambridge, Mass., 2007.

To proactively address the issue of driver distraction, a program known as SAfety VEhicle(s) using adaptive Interface Technology (SAVE-IT) was created to identify effective countermeasures to distraction and improve on existing safety warning systems. This paper describes Task 5 of the SAVE-IT program, which attempted to develop an algorithm capable of identifying declines in driving performance as a result of cognitive distraction.

The researchers developed models that accurately detected cognitive distraction 75% to 95% of the time. Findings suggested, among other things, that listening to IVIS information is less demanding than responding to questions about it; cognitive and visual demands are additive; and cognitive distraction is multifaceted (i.e., distinct types of cognitive distraction have different impacts on driving performance).

Lee, J.D., M.L. Ries, D.V. McGehee, and T.L. Brown, "Can Collision Warning Systems Mitigate Distraction Due to In-vehicle Devices?" NHTSA Driver Distraction Internet Forum, July 5–Aug. 11, 2000.

Because driver inattention/distraction is a contributing factor in more than 60% of all vehicle rear-end collisions, this study looked at the effectiveness of a rear-end collision avoidance system, better known today as a FCWS. A driving simulator was used to determine how well drivers, distracted or otherwise, could avoid an impending collision with FCWS assistance, utilizing either early or late warnings.

The experiment found that the cognitive demands (e.g., speaking into a phone or two-way radio) that do not take a driver's hands off the wheel or eyes off the road still pose a serious risk nearly equal to that from visual distractions. However, both of these risks can be effectively mitigated with early warnings from an FCWS. The authors suggest that in-vehicle devices that distract attention away from the road be integrated or coordinated with warning systems that will detect distraction and signal imminent danger (e.g., issue earlier warnings if the driver is on the phone). An obvious caveat, however, is that drivers could become passive and overreliant on warning systems to detect critical safety events, increasing a willingness to engage in distracting activities and lowering vigilance.

Lerner, N., J. Singer, and R. Huey, *Driver Strategies for Engaging in Distracting Tasks Using In-vehicle Technologies,* Report No. HS DOT 810919, National Highway Traffic Safety Administration, Washington, D.C., 2008.

The purpose and findings of this study were cited earlier.

Based on the study's findings, the authors developed a matrix that mapped 36 findings to possible countermeasures for each respective finding. Countermeasure options included ideas related to public education and safety campaigns, driver training, user interface design, functional lock-out technology, and interactive control (i.e., Driver Assist) technology.

Llaneras, R.E., *NHTSA Driver Distraction Internet Forum: Summary and Proceedings,* National Highway Traffic Safety Administration, Washington, D.C., 2000.

A virtual online conference was held to assess the dangers associated with the massive growth in the availability of in-car devices (e.g., cell phones, navigation systems, wireless Internet, information systems, entertainment systems, and night vision systems). Benefits and safety risks are evaluated, alongside ways to measure distraction and implement user-friendly design features or solutions. Participants took issue with systems using poorly labeled and difficult to reach multifunctional controls.

From a structural standpoint, suggestions for improvement included the use of standardized steering wheel-mounted controls, graphic icons, integrated designs, and easy-to-reach, easy-to-distinguish buttons. Concerning usability, participants discussed hands-free options, lock-out functions, and speech-based or voice recognition technologies, although this was a topic of debate, because cognitive demands present similar (although somewhat lower) levels of distraction as visual or motor demands.

Although the complete automation of vehicles would generate an obvious solution to the driver distraction problem, the foreseeable future will only allow a partial realization of driverless automation technology. Two recognizable options for the present include vehicle systems that provide "additional eyes and ears" to the driver (e.g., collision warning systems) and driver assistance systems that assume some limited driving tasks (e.g., adaptive cruise control).

Llaneras, R.E., J.P. Singer, and R. Bowers-Carnahan, *Assessment of Truck Driver Distraction Problem and Research Needs,* Report No. DOT HS 809883, National Highway Traffic Safety Administration, Washington, D.C., 2005

As mentioned, multifunctional devices appear to be particularly common in the industry, and having systems that offer both text messaging and driver communication functions top the list, both for OEM and aftermarket products. As proactive steps toward limiting distraction, many systems are customizable so that fleet safety managers can decide if they want to (completely or partially) lock out certain functions or, in the case of messaging systems, send messages with different levels of urgency and only allow the driver to read emergency messages while the vehicle is in motion. Despite these options, it varies widely between and even within fleets whether these lock-out capabilities are used. Finally, interviews revealed that banning technology is viewed as impractical and unwarranted, whereas the effectiveness of policies prohibiting the use of in-vehicle devices while driving is also questionable. Interviewees argued that the effectiveness of these policies was contingent on enforcement and consistently applied rules (with penalties for noncompliance), whereas the key to limiting distraction from in-vehicle devices rested on enhanced designs and interfaces and reasonably applied restrictions and lock outs.

NHTSA, *An Investigation of the Safety Implications of Wireless Communication in Vehicles,* National Highway Traffic Safety Administration, Washington, D.C., 1997.

The authors of this study recognized that the use of a cell phone while driving may contribute to collisions. However,

it was stated that it is both the physical movement associated with dialing and holding a phone as well as the cognitive processes that coincide with the phone conversation. It was also proposed that hands-free devices may assist drivers, but may lead to longer conversations and the increased likelihood of a crash. Also, the key factor is not just using a cell phone, but driver inattentiveness while driving.

This study makes several key suggestions to improving the safety of drivers who use cell phones. The authors make it clear that cell phone-related accidents cannot decrease by simply banning the devices. Instead, in-vehicle communication systems could be developed that allow the user to wirelessly communicate with fewer distractions. In addition, some of the other recommendations included:

- Enforcing inattentive behavior issues,
- Improving the range of cell phone-related research to more specifically define the problem,
- Broadening consumer education about using a cell phone while driving, and
- Developing the most ideal in-vehicle communication systems using the National Advanced Driver Simulator.

Research and Innovative Technology Administration (RITA), "In-vehicle Technology to Address Distracted Driving," Symposium on Prevention of Occupationally-Related Distracted Driving, Johns Hopkins Education and Research Center for Occupational Safety and Health, Laurel, Md., Apr. 18, 2011.

Panelists from the consumer electronics industry described how, while technology can distract drivers (e.g., cell phones, entertainment systems, and navigation and information systems), it can also be used to help mitigate distraction. Technology of the latter classification includes lock outs (e.g., not allowing incoming calls, texts, or e-mails while the vehicle is in motion), warning notifications (i.e., when a high level of risk is detected), and other advances that reduce the amount of necessary interaction (whether visual, manual, or cognitive) drivers must engage in with on-board systems or devices.

A critical attribute of new, seemingly useful technologies is how much driver workload they require. Human factors specialists need to keep best practices in mind when designing new technologies so that they do not overload the driver and increase the possibility of distraction.

Certain types of distraction (e.g., searching for street signs) can be circumvented with hardware (GPS unit) and software (text to speech). Similarly, hands-free devices are intended to prevent distractions that would take a driver's hands off the wheel; this technology can incorporate ear buds, Bluetooth, steering wheel controls, and/or voice recognition software. Essentially, technology is moving in the direction of faster touch (e.g., predictive text, next word prediction, logic and algorithms), less touch (hybrid text and speech entry), or no touch (speech command and control).

Vollrath, M. and I. Totzke, *In-vehicle Communication and Driving: An Attempt to Overcome Their Interference,* Center for Traffic Sciences, University of Wuerzburg, Germany, 2000.

Multiple Resources Theory dictates that in-vehicle communications using different channels (i.e., manual operations, visual or auditory information processing) will differentially impact driving performance. The authors performed a mixed between–within subject driving simulator experiment to demonstrate that all three of these tertiary communication tasks cause decrements in driving performance. However, performance is at its worst with the manual operation task, followed by the visual information processing task and the auditory information processing task.

Based on these findings, the authors suggested that information should be presented to drivers acoustically whenever possible. Visual output should be avoided or else be accompanied by a driver assistance system that ensures that the vehicle maintains its lane position (e.g., LDWS). Finally, unnecessary manual operations are by far the least desirable component in terms of distraction and risk, most likely because this category typically contains some extent of visual information processing. If motor actions are required, they should be accompanied by a driver assistance system that maintains both lane position and following distance (e.g., LDWS and FCWS).

Volpe National Transportation Systems Center and Research and Innovative Technology Administration, *Technology Applications for Traffic Safety Programs: A Primer,* Report No. DOT HS 811 040, National Highway Traffic Safety Administration, Cambridge, Mass., 2008.

The authors reviewed emerging digital and communication technology that is either currently or soon to be available to improve highway safety. Highlighted traffic safety technologies include those that provide information and services to drivers, traffic operations agencies, emergency services personnel, and law enforcement professionals. Specifically, vehicle to driver, vehicle to vehicle, vehicle to and from roadside, and vehicle to and from traffic and emergency call centers are all discussed.

The report emphasizes the importance of considering the HMI when developing new safety technologies, so that the right balance is struck between delivering desired information and minimizing driver distraction. For instance, careful consideration must be given to the placement of safety devices and the manner of information delivery.

World Health Organization, *Mobile Phone Use: A Growing Problem of Driver Distraction* 2011 [Online]. Available: www.who.int/violence_injury_prevention/publications/road_traffic/en/index.html.

In this report, the challenges of assessing the extent of the distracted driving problem are noted, given the differences in police reporting and crash data coding related to distracted driving. As to countermeasures, the need for extended public awareness campaigns are seen as important to increase public understanding of the risks of driving while distracted. The potential value of technological interventions, such as workload managers and LDW, is noted but viewed as having a limited impact at this time. The report concludes by issuing a call to governments to be proactive in setting policy, using the current state of knowledge, as failure to act now could make it more difficult to address the issues at a later point.

Zhang, H., M. Smith, and R. Dufour, *A Final Report of SAfety VEhicles Using Adaptive Interface Technology: Visual Distraction,* Volpe National Transportation Systems Center, Cambridge, Mass., 2008.

This paper describes Task 7 of the SAVE-IT program, which focused on methods for identifying decrements in driving performance owing to visual distraction. Although eye-based measures are slightly more accurate in identifying distraction than head-based measures, the latter option is more practical; that is, the necessary sensors for detecting eye gaze movement are more expensive and suffer from certain limitations (e.g., interference from eyewear), whereas head-movement sensors are cheaper and easier to implement. Because most severe visual distractions are likely to be captured by head movement sensors (i.e., sustained eye gazes that are farther off to the side), the researchers suggested moving forward with this type of technology.

ZoomSafer Inc., *Beyond Telematics: Extending UBI Data to Include Mobile Phone Use While Driving,* 2011b [Online]. Available: http://zoomsafer.com/resources/#1.

ZoomSafer describes both an active and passive approach to cell phone use within a vehicle, in the context of UBI techniques. The active approach consists of UBI software resident on a smartphone (an "app"), which connects with a UBI device in the insured's vehicle. The smartphone is automatically deactivated when the vehicle is in motion, and incoming texts and messages are automatically responded to by the application to indicate the user is driving. The passive approach consists of integrating UBI data (including events during driving) with billing records from the telecommunications carrier for the cell phone, so that events can be correlated with cell phone use. Although the active approach requires a smartphone, the passive approach works with any phone.

OPERATIONAL STRATEGIES AND RECOMMENDED PRACTICES

A wide range of operational practices have been studied and put into place to address distracted driving and some recommended practices have emerged. Studies of most relevance to this project are summarized here. The issues can be grouped into the following topics.

Examination of Company Safety Practices

Hickman et al. (2007) examined behavior-based safety programs common in some industries, but which have not seen wide use within the trucking industry. Surveys of motor carrier safety managers indicated that driver observation and feedback programs, plus ride-alongs, are most important. Short et al. (2007) examined the means of mitigating distracted driving through an organization's safety culture. For instance, a strong safety culture may have internal definitions and messages related to distracted driving, which may be part of training and employee communications. The author's key point for this concept was that focus on the safety message must exist from top to bottom within the organization. Similarly, Network of Employers for Traffic Safety (NETS) (2011) describes a panel discussion of model distracted driving programs, which involved representatives from major private fleets. Panel members also discussed the importance of top management buy-in plus clearly communicating policies, including consequences for disobeying. They also reported on safety videos and post-incident coaching tools and metrics as being useful. Lueck and Murray (2011) interviewed safety executives from major carriers and identified the following common attributes of effective safety management: well-defined policies and strategies, engaged safety directors, a willingness to test new methods and systems (such as active safety), training (and remedial training for problem drivers), and direct involvement in developing company safety strategy.

Employees: Hiring, Training, and Well-Being

ATAF (1999) examined the safety practices of award-winning carriers and noted the following key factors: having satisfied employees, hiring the right people, training and monitoring these individuals, and using quality control measures. Mejza et al. (2003) identified 148 high-performing carriers with respect to safety and surveyed them as to their safety management programs and practices. Regardless of fleet size, they pointed to extensive hiring and training practices, multiple methods for evaluating those practices, and driver rewards for positive safety records. Knipling et al. (2003) examined 28 safety management techniques, the most common of which were tracking of driver's incidents, violations, and crashes; regular vehicle inspection and maintenance; and hiring based on safety criteria. They also identified four safety opportunity areas: motor carrier wellness programs, predicting crash rates based on past behaviors, behavioral safety management, and safety management professionalism. In a TRB synthesis report, Staplin et al. (2005) examined driver training programs that have the greatest potential for improving safety. Several recommended practices were noted, including minimum industry requirements for entry-level drivers, the use of

driving simulators and skid pads in training, and multimedia and video techniques.

Cell Phone Prohibition Policies

In a highway safety guide prepared for states, NHTSA (2011) gave cell phone bans a low effectiveness rating based on studies showing that cell phone use rates revert to the baseline after a year unless there is sustained enforcement of these laws. However, the Governors Highway Safety Association (GHSA) (2011) noted that cell phone bans, while their effectiveness is not entirely clear, do have some long-term effect. They called on states to enforce cell phone laws once passed and to establish assistance programs to help employers implement effective policies.

ZoomSafer (2011a) conducted a general survey of 500 business managers and noted that, although 32% of the companies have had instances of crashes linked to driver distraction, only 62% have cell policies, with 53% actually enforcing it. For trucking, depending on operational focus, the occurrence of distraction-related crashes was 41% to 53%, with 71% to 83% having policies on cell phone use, and 59% to 71% actively enforcing the policy. Hickman et al. (2010) examined truck and bus driver data from a DriveCam and found that truck and bus drivers operating with a company prohibition on cell phone use were 0.83 times less likely to use the device, whereas driving in a state that prohibited cell phone use while driving had no effect.

Section Summary

At the company level, clarity within the organization as to safety culture and clear messages are important. At the employee level, careful hiring, thorough training, attending to wellness, driver rewards, and remedial practices when incidents occur are all important parts of the puzzle. And, while the value of laws prohibiting cell phone use is not clear, at least one study has demonstrated that company prohibitions on cell phone use do inhibit a driver's use of the devices.

Citation Summary

ATAF, *Safe Returns: A Compendium of Injury Reduction and Safety Management Practices of Award-winning Carriers,* American Trucking Associations Foundations, Alexandria, Va., 1999.

This study analyzed interview and survey responses of safety managers in outstanding TL, LTL, private, and specialized fleets to identify various management "tools for success." Because safe operations feed into financial stability, productivity, and customer and employee retention, all aspects of operations were examined: hiring; training, and supervision; bonus and awards programs; maintenance and equipment; safety meetings; work environment; and accident investigations. Conclusions included the finding that satisfied and committed employees are one of the keys to safety, and employees would therefore be included in important decisions and rewarded or recognized for their performance. Safety begins with hiring the right people, training them sufficiently, supervising or monitoring them to ensure proper performance, and using quality control program to minimize the potential for safety incidents.

Governors Highway Safety Association, *Distracted Driving—What Research Shows and What States Can Do,* 2011 [Online]. Available: www.ghsa.org.

This report summarizes distracted driving research to inform states as they consider distracted driving countermeasures, concentrating on distractions produced by cell phones, texting, and other electronic devices. The report concludes that cell phone use increases crash risk, but there is no consensus on the degree of increase, and that conclusive evidence does not exist as to whether hand-held cell phone use is riskier than hands-free. As to countermeasures, the report found that laws banning hand-held cell phone use are effective initially even though the effect lessens over time; however, the laws do appear to have some long-term effect. At the same time, it noted there is no evidence that cell phone or texting bans have reduced the number of crashes. The report's recommendations include that states enact cell phone and texting bans for novice drivers, existing cell phone and texting laws be enforced, public awareness programs be implemented, and states assist employers to develop and implement distracted policies.

Hickman, J., R. Hanowski, and J. Bocanegra, *Distraction in Commercial Trucks and Buses: Assessing Prevalence and Risk in Conjunction with Crashes and Near-crashes,* Report No. FMCSA-RRR-10-049, Federal Motor Carrier Safety Administration, Washington, D.C., 2010.

This study analyzed 12 months of naturalistic truck and bus driver data provided by DriveCam, whose onboard safety monitoring systems record videos of drivers and data from kinematic sensors on safety-related events. One data set included data whereby kinematic sensors were triggered by nonsafety triggered events (e.g., driving over train tracks) to serve as a baseline in calculating odds ratios.

Truck and bus drivers operating under a fleet cell phone policy were 0.83 times less likely to use a cell phone, whereas driving in a state that prohibited cell phone use while driving had no effect on drivers' decisions to use their phones behind the wheel (odds ratio = 0.97, *ns*).

Hickman, J., R. Knipling, R. Hanowski, D. Wiegand, R. Inderbitzen, and G. Bergoffen, *CTBSSP Synthesis 11: Impact of Behavior-Based Safety Techniques on Commercial*

Motor Vehicle Drivers, Transportation Research Board of the National Academies, Washington, D.C., 2007.

This synthesis report documents various Behavior-Based Safety (BBS) strategies that reduce risky driving behaviors in CMV drivers. Several studies have reported that specific driving behaviors are significant contributing factors in many crashes.

Motor carrier safety managers were surveyed to obtain information on which strategies were currently being used, as well as their opinions on the effectiveness of those strategies. Findings from the extensive literature review and survey indicated that although BBS techniques have been widely used in other industrial workplaces, comprehensive BBS programs have not been extensively used in the trucking industry. The lack of more complete programs is most likely the result of the solitary nature of the occupation and the difficulty in observing accurate, unbiased, safety-critical behaviors.

The majority of survey participants indicated that some type of observation technique was used to assess drivers' behavior, including peer observation and feedback (63%), ride-alongs (59%), covert observations (37%), and self-observation (32%). The highest rated BBS technique by respondents was a targeted training approach and education programs directed at specific driving behaviors.

Knipling, R., J. Hickman, and G. Bergoffen, *CTBSSP Synthesis 1: Effective Commercial Truck and Bus Safety Management Techniques,* Transportation Research Board of the National Academies, Washington, D.C., 2003.

This synthesis report provides a summary of safety management techniques in commercial truck and bus transportation. Twenty safety problem areas and 28 safety management techniques were identified through a literature review, discussions and interviews with industry experts, and suggestions from the TRB synthesis panel. Problem areas included both driver and vehicle issues, and safety management techniques ranged from driver recruiting and selection to advanced safety technologies.

A questionnaire was distributed to fleet safety managers and other industry safety experts through several trade associations and industry-related professional organizations to assess their relative importance. The top three problem areas for safety manager respondents were found to be at-risk driving behaviors (e.g., speeding and tailgating), high-risk drivers (all causes combined), and driver health and wellness. The three most common management techniques practiced by safety managers were continuous tracking of drivers' crashes, incidents, and violations; regularly scheduled vehicle inspections: and maintenance and hiring based on criteria related to driver crash, violation, or incident history. Each of these techniques was practiced by 90% or more of the safety manager respondents.

Based on the survey results and reviewed literature, four "safety opportunity areas" were selected for further research and discussion: driver health, wellness, and lifestyle; high-risk drivers; behavioral safety management; and safety management professionalism. Several opportunities to improve safety were identified for each area:

- Driver health, wellness, and lifestyle
  - Motor carrier wellness programs.
- High risk drivers
  - Predicting crash rate based on past behaviors, and
  - Intervention programs.
- Behavioral safety management
  - Self-management programs,
  - Driver incentive programs,
  - Safety placards, and
  - On-board recording.
- Safety management professionalism
  - Certification of fleet safety practices, and
  - Certification of safety managers.

Lueck, M.D. and D.C. Murray, *Predicting Truck Crash Involvement: A 2011 Update,* American Transportation Research Institute, Alexandria, Va., 2011.

Recognizing the responsibilities and roles that motor carriers can play in managing driver behavior, ATRI interviewed safety executives from major reputable carriers to identify effective industry strategies that could potentially help prevent and mitigate dangerous driver behaviors. The interview questions were designed to solicit information on safety programs, tools, and training strategies that effectively target identified problem behaviors and events.

Based on surveys and in-depth interviews conducted with these safety directors, it became clear that safety-oriented trucking companies had several common attributes. These included:

- Clear, documented, and well-distributed policies and strategies relating to specific driver behaviors and events;
- Accessible and engaged safety directors and managers; a willingness to test and/or use different training tools and onboard safety systems; and
- Direct involvement in the development or customization of company safety programs and policies.

During the interview process each of the carriers also emphasized that proactive safety measures, such as initial and orientation and sustainment training, are key lynchpins

to ensuring that negative safety incidents do not occur. The value of these safety programs, however, must be complemented by remedial safety training programs that mitigate a problem driver behavior after a negative safety incident has occurred.

Mejza, M.C., R.E. Barnard, T.M. Corsi, and T. Keane, *Best Highway Safety Practices: A Survey of the Safest Motor Carriers About Safety Management Practices,* Federal Motor Carrier Safety Administration, Washington, D.C., 2003.

This study used federal safety ratings to identify 148 high-performing carriers. Researchers then surveyed these companies' safety management programs and policies, including detailed questions about carrier, driver, and vehicle-related practices. Most questions centered on hiring, training, and supportive or motivational activities. Some of their survey findings were disaggregated by fleet size into three categories: small (1–24 trucks), medium (25–94 trucks), and large (95+ trucks); however, they all pointed toward extensive hiring and training practices, multiple methods for evaluating those practices, and a wide array of rewards to encourage drivers to have positive safety records. For instance, more than 90% of good carriers reported verbally praising safe drivers, whereas 72% used public recognition and 66% used cash rewards.

Network of Employers for Traffic Safety (NETS), "Elements of Model Distracted Driving Programs," Symposium on Prevention of Occupationally-Related Distracted Driving, 2011.

NETS panel members (e.g., ExxonMobil, Coca-Cola, and Johnson and Johnson) representing 52,000 fleet vehicles and 1 billion miles driven discussed key topics related to addressing distracted driving, including cell phone use policies, implementation and sustainability, technology, and critical success factors. From a 2010 NETS benchmarking report, 93% of NETS members have a cell phone policy in place, 40% have a total ban in place, 57% permit only hands-free use, and 2% ban only texting. When policy violations occur, 67% of NETS members discipline the driver and 21% terminate him or her.

Panel members discussed the importance of clearly communicating distracted driving policies so that all employees are educated and fully aware of the issue, as well as consequences for disobeying the policy. Buy-in and total support from top management is crucial, and good behaviors must be reinforced to create a strong safety culture. Some useful strategies include using safety videos and safety information available on the company's website. Additionally, companies can be prepared to deal with incidents by having a post-incident coaching tool (or metric) that addresses potential distraction issues that could have played a role in the safety-critical event.

NHTSA, *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices,* 6th ed., National Highway Traffic Safety Administration, Washington, D.C., 2011.

This guide was created as a reference to help State Highway Safety Offices select empirically proven countermeasures when addressing major highway safety problem areas, including distracted driving. As part of the analysis the authors describe the use, effectiveness, costs, and implementation time required for each prospective countermeasure, citing the most recent and accurate literature, where relevant.

Empirical support for the ratings listed here can be found in NHTSA's guide (see Table 3). For instance, cell phone laws are given a poor rating because studies show cell phone use among drivers returning to baseline levels within a year of a law going into place, unless the law was accompanied by sustained, tough enforcement targeting violators. Likewise, general laws and company policies are ineffective if they simply send a generic "stay alert" message. Drivers already know what behaviors are not smart, but they will continue to occasionally engage in them unless they are strictly monitored and held accountable.

Short, J., L. Boyle, S. Shackelford, B. Inderbitzen, and G. Bergoffen, *CTBSSP Synthesis 14: The Role of Safety Culture in Preventing Commercial Motor Vehicle Crashes,* Transportation Research Board of the National Academies, Washington, D.C., 2007.

The authors reviewed methods for improving safety culture through changes in an organization's safety policies, values, attitudes, and norms. Although the safety culture concept is much broader in scope than individual safety issues, the problem of distracted driving can likely be mitigated through an organization's safety culture.

The research indicated that an organization with a strong safety culture will identify distracted driving issues through an awareness of organizational beliefs and behaviors and through knowledge of safety performance data and information. Once identified, aspects of distracted driving will likely be addressed in several ways within a safe culture.

First, an organization with a strong safety culture might create internal definitions and messages related to the distracted driving problem and disseminate such information throughout the company. The distracted driving message may be part of initial and ongoing training within the organization, and might also be found as part of regular safety messages that are communicated to employees. It is also likely,

TABLE 3
EXCERPT FROM NHTSA HIGHWAY SAFETY COUNTERMEASURE GUIDE

1. Laws and Enforcement

Countermeasure	Effectiveness	Use	Cost	Time
1.1 GDL requirements for beginning drivers	★★★★★†	High	Low	Medium
1.2 Cell phone laws	★★	Low	Varies	Short
1.3 General fatigue and distraction laws	★	High††	Varies	Short

† Effectiveness proven for nighttime and passenger restrictions
†† Included under reckless driving; use of explicit fatigue and distraction laws is low

2. Communications and Outreach

Countermeasure	Effectiveness	Use	Cost	Time
2.1 Fatigued or drowsy driving	★	Unknown	Medium	Medium
2.2 Distracted driving	★	Unknown	Medium	Medium

3. Other Countermeasures

Countermeasure	Effectiveness	Use	Cost	Time
3.1 Employer programs	★	Unknown	Low	Short
3.2 Medical conditions and medications	★	Unknown	Variable	Medium

Effectiveness:

★★★★★ – Demonstrated to be effective by several high-quality evaluations with consistent results
★★★★ – Demonstrated to be effective in certain situations
★★★ – Likely to be effective based on balance of evidence from high-quality evaluations or other sources
★★ – Effectiveness still undetermined; different methods of implementing this countermeasure produce different results
★ – Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise.

within a strong safety culture, that members of a trucking company's leadership disseminate information and messages to drivers on the importance of preventing distracted driving situations. The message should be delivered through other areas of the organization as well; for example, dispatchers may ask drivers if bills have been paid prior to extensive travel as a means to avoid cognitive distractions. Thus, the key point of this concept is that a safety message, such as one that addresses distracted driving, flow from the very top of the organization and be pervasive throughout the organization.

Staplin, L., K. Loccoco, L. Decina, and G. Bergoffen, *CTBSSP Synthesis 5: Training of Commercial Motor Vehicle Drivers,* Transportation Research Board of the National Academies, Washington, D.C., 2005.

This synthesis report focuses on several training tools and techniques used in existing driver training programs and identifies those that appear to have the greatest potential for improving CMV safety. A review of available literature was done to pinpoint which training techniques work (and which do not) to adequately train CMV drivers to perform in various situations. Information was also obtained from several truck driving schools and truck and bus companies to supplement the literature findings.

Several recommended practices for improving driver safety performance were identified in the report, including:

- Implementing industry-wide use of standards put forward by the Professional Truck Driving Institute as a minimum requirement for entry-level drivers and for the certification of driver trainers.
- Requiring finishing training for first seat (solo) drivers.
- Substituting multimedia instruction materials to better engage students and reduce training costs through distance learning.
- Introducing or expanding the use of driving simulators.
- Expanding the use of skid pads to train beginning drivers about stopping distances under different load configurations; to use different brake systems [including all anti-lock brake (ABS), mixed ABS, and non-ABS], and to experience the consequences of driving on a wet surface for handling and stopping the vehicle, including skid control.
- Employing videos and testimonials by experienced drivers to provide entry-level trainees with a realistic orientation to health, wellness, and lifestyle issues.

ZoomSafer, Inc., *Measuring Corporate Attitudes About Employee Distracted Driving,* 2011 [Online]. Available:

http://ZoomSafer.com/assets/Whitepapers/Survey-Results-White-Paper.pdf.

ZoomSafer, an organization that develops software to prevent distracted driving, surveyed 500 North American business managers to identify corporate attitudes and best practices related to mobile phone use among drivers. From the overall sample, which included long-haul and short-haul trucking companies; construction companies; utility companies; taxi, limo, and bus companies; sales and service companies; home and business services; and government, they found that 32% of all companies have knowledge or evidence of their employees having vehicle crashes as a result of cell phone distractions. Despite this, only 62% of the companies had a written cell phone policy in place and only 53% of companies with a policy actually enforced it, with 61% disciplining employees after a crash or incident and only 2% proactively utilizing technology to manage compliance.

When focusing solely on trucking (long-haul and local/short-haul), findings showed higher rates of cell phone-related crashes (53% and 41%, respectively), but also higher levels of policy implementation (71% and 83%, respectively) and enforcement (71% and 59%, respectively).

CHAPTER THREE

SURVEY METHODS AND RESULTS

BACKGROUND

This chapter describes the screening survey approach and provides principal results. The screening survey served to identify fleet managers willing to participate in the structured interview portion of the project. Because the sample size was small these results should not be used for unintended purposes.

The survey asked fleet managers questions about distraction-related safety problems they faced, what countermeasures they used, and the effectiveness of these practices. The survey also investigated the views of these respondents regarding various warning modes for driver assistance systems.

A general caveat regarding the survey responses is that they were primarily subjective responses to subjective questions. Another caveat is that, because this was a screening survey, the responses are not a representative sample of some larger population such as "all carrier owners/managers." In spite of these caveats, survey findings are revealing because of the comparative information they provide; for example, the perceived relative importance of various safety problems and perceived relative effectiveness of solutions.

In addition to the extensive industry outreach conducted by team member ATRI, the support of the National Private Truck Council and the American Bus Association was critical to the success of the survey. These organizations solicited survey participation by their members through e-mail requests containing links to the online survey.

The original survey is provided as Appendix A. Survey results for Motor Carriers are provided in Appendix B, and results for Motor Coaches can be found in Appendix C.

SURVEY ANALYSIS AND COMMENTARY

Description of Responding Carriers

Motor Carriers

There were 34 responses to the survey from motor carriers. Respondents typically had more than 20 years experience as a safety manager and they reported that the majority of their time is focused on safety. Large and small fleets were represented: the number of power units ranged from 7 to 31,000, with a mean of 1,666. The fleet operation type was primarily for-hire, with a substantial representation from private fleets. Both long- and short-haul operations were well-represented. As to operational mode, truckload and less-than-truckload operations were represented, with a substantial number of tanker operations, including hazmat. The responding fleets primarily use employee drivers, with a substantial number also using contract drivers in part of their operation. Twenty-one respondents volunteered to do follow-up interviews for the structured interview portion of the project.

Motor Coaches

There were 13 responses to the survey from motor coaches. Respondents typically had approximately 16 years experience as a safety manager and on average half of their time is focused on safety. Large and small fleets were represented: the number of power units ranged from 21 to 2,300, with a mean of 456. Both local and long-haul passenger transport were represented. Several respondents volunteered to do follow-up interviews for the structured interview portion of the project. However, efforts to arrange follow-up interviews were not successful.

Role of Driver Distraction in the Overall Safety Picture

Motor Carriers

There was wide agreement that driver distraction from all sources is a significant safety issue for fleet operations. Only one respondent disagreed with this statement. As to a driver's personal electronic devices causing distraction, again there was wide agreement, with two respondents disagreeing. The picture is mixed for identifying job-related devices with distraction. Several respondents believed that this is the case; however, a number were neutral and several disagreed. As to the latter, several respondents noted that their company devices do not allow interaction while the unit is moving.

In the comments, driver distraction was considered a "number one concern"; however, several noted that distractions have always been present in the truck cab; that is, "we cannot blame just the electronics." Remarks were made to discourage anything that causes a driver to "take his eyes off the road or the driver's mind away from his driving." Another respondent noted that eating and drinking while driving has increased with the advent of the 14-hour limit.

Some respondents commented that more awareness and driver training should be set as goals within carriers' safety programs, with one noting that training and policy measures to address distracted driving practices have significantly reduced their distractive driving exposure.

Although it is important to keep the driver's mind stimulated, one respondent commented "there needs to be an understanding that there is a line that can be crossed. You don't want a cab with nothing at all going on, but you need to eliminate distractions that remove the driver's concentration from his driving duties. Removing CB radios, other radios, and sources of entertainment would tend to lull the driver into boredom and sleep. This opinion comes from my experience as a driver."

Company culture and driver relations come into play as well. One respondent noted that "technology has created the issue and truly needs to assist in solving this problem. Cell phones are of particular interest for safe driving. Monitoring drivers for these distractions is certainly possible; however, it becomes an issue with big brother watching over a driver. As a private fleet with low turnover, the company culture will suffer if the right balance between monitoring, safety, and trust is not achieved."

Motor Coaches

Although the means for motor coach responses were very similar to those for motor carriers, there was slightly more diversity in the responses. Again, there was wide agreement that driver distraction from all sources is a significant safety issue for fleet operations, with only one respondent disagreeing with this statement. As to a driver's personal electronic devices causing distraction, nine agreed with this statement and two disagreed. Eight respondents agreed that job-related devices contribute to distraction, with three disagreeing.

In the comments, several mentioned the unique aspects of passenger transportation, specifically the role of passenger interactions in distraction. One noted that his tour drivers "by definition . . . are distracted drivers" and dispatch communication and operation of on-board systems such as audio entertainment just adds to the issue. One believed that motorcoach operators needed to refrain from all device distractions and "concentrate totally on their job of transporting passengers in a total safe environment." He called for enforcement to be increased against both drivers and companies, as well as for an educational process to ensure that all motor coach operators are aware of the distraction problem.

Distracted Driving Behaviors

Motor Carriers

More than 30 of the respondents identified the following as distracted driving behaviors:

- Eating, drinking, and smoking;
- Reading a map or directions;
- Talking on a hand-held mobile phone;
- Texting and dialing a hand-held mobile phone; and
- Searching or reaching for objects in the cab.

There were 25 respondents who believed that talking on a hands-free phone was distracting, as well as partaking in grooming and hygiene tasks. Just fewer than 20 reported that attending to passengers and adjusting in-vehicle controls (entertainment and climate control) were distracting. Reading billboards was cited by 14 respondents, and one noted that writing down state line crossings was an additional distraction.

Motor Coaches

Ten or more respondents identified the following as distracted driving behaviors:

- Passenger interactions;
- Eating, drinking, and smoking;
- Grooming and hygiene;
- Reading a map or directions;
- Talking on a hand-held mobile phone;
- Texting and dialing a hand-held mobile phone; and
- Searching or reaching for objects in the cab.

There were eight respondents who believed that talking on a hands-free phone was distracting. Reading billboards was cited as distracting by six respondents, about half of the group.

Devices Contributing to Distracted Driving

Motor Carriers

More than 30 respondents believed that driver's personal electronic devices contributed to distracted driving. The next most prevalent were job-related devices contributing to distracted driving, with responses ranging from 20 to 25, specifically onboard entertainment and GPS navigation systems. Eight respondents said aftermarket active safety systems were a distraction concern, about the same number as those who indicated weigh-in-motion.

One respondent noted that although ". . . anything taking your eyes off the road is technically a distraction, every safety professional has seen consequences for something as simple as changing the radio station. But we obviously don't want everything regulated. There's no way to enforce looking at a billboard."

To reduce some in-cab distractions, a respondent noted that "we have programmed our satellite communication systems to 'blank out' their screens when tractors are in motion.

We have also employed a text-to-voice system to read aloud directions to customer facilities, preventing drivers from having to read directions from paper while driving."

Others believed that phone conversations can hold a driver's attention and distract from driving, that audio devices are more distracting than visual devices, and that adjusting controls or reading billboards are things that are done by choice when the time is right. As one individual noted, "The behavior is difficult to change, thus it takes a strong commitment from management. We need to lead by example. I would appreciate a system that would disable all personal device electronics while the vehicle is in motion [so as to] take away the temptation on the front end to effect behavior change."

Motor Coaches

Ten or more respondents believed that a driver's personal electronic devices and on-board entertainment systems contribute to distracted driving. The next most prevalent sources were job-related devices and GPS navigation systems. Four respondents reported that aftermarket active safety systems were a distraction concern.

One comment noted that commercial drivers do "an outstanding job given all of the distractions required" in addition to maintaining safe driving. Another mentioned that there have been "way too many" motor coach accidents that could have been avoided if proper rules and laws had been followed. This respondent also noted that driver fatigue remains an important safety issue.

Effective Distracted Driving Countermeasures

Motor Carriers

The group responded as to distracted driving countermeasures they see as effective, in terms of measures external to the company, internal to the company, and internal to the vehicle.

External to the company, insurance penalties only received seven responses, whereas there was a strong affirmative response (20–25) to cell phone prohibition laws and education campaigns (on the risks of driving with cell phones and distracted driving in general). Approximately half of the respondents believed that increased fines for driving while using cell phones would be effective.

Internal to the company, the strongest response was in supporting a strong safety culture and clear employee policies and consequences for violations. Approximately 25 respondents noted that good recruiting and post-incident coaching are effective countermeasures. Emphasizing the importance of company culture, one noted that

> Safety culture as a whole is key, and both policies and training/coaching practices play a part. If drivers see how serious you are regarding on-road distraction, then they will be just as serious. If it's never mentioned, and they're still pushed from an operational standpoint to answer their phone or use their job-related electronic device no matter where they are (driving or not), then they may consider the distraction 'supported' by the carrier. Reinforcing this point was this comment: 'Complacency is our greatest enemy. We have to keep drivers focused on the task at hand. Whether they are driving, loading or unloading we have to train them to stay focused on what they are doing.'

Nevertheless, respondents noted their frustration with enforcement of policies, in that "policies do work sometimes, but to have a policy for everything that can happen is ridiculous. How do you enforce them? You are not in the cab with them. You can say that you are going to terminate them, but it is usually after something has happened." Another view emphasized the value of awarding drivers who demonstrate and develop a safe employment record, and the importance of communicating driver safety deficiencies immediately with the driver.

Internal to the vehicle, the highest response (25 responses) was to implement lock-out functions on company devices when the vehicle is being driven. Responses ranging in the low 20s advocated:

- Banning the use of personal communications,
- Taking care in placing aftermarket devices within the cab,
- Using active safety systems,
- Conducting ride-along observations, and
- Implementing automatic video monitoring (the "most effective tool" for one carrier).

About half of the responses supported the effectiveness of dispatcher messages sent with different levels of urgency, so that the driver can defer reading nonurgent messages until safely parked. As one noted, "We need to ensure that the dispatch/operations department provides the driver the highest quality data available to minimize any distractions from that end of the operation."

Fourteen believed that monitoring systems that provide retrospective feedback on the driver's distraction statistics were useful. As to cell phone use, 10 each said they supported a company policy only banning cell phone use while driving, and a company policy only allowing hands-free or voice-operated communication devices while driving. Combined, this indicates that 20 advocate prohibiting use of a hand-held cell phone. The difficulty of enforcement of such policies was again mentioned, as was the desire for a device to deactivate personal communication devices or at least report their use while the vehicle is in motion. One noted that, when possible, one-on-one contact is still the best trainer. Finally, nine respondents believed that physiological monitoring would be effective.

One comment noted frustration with the interaction of external versus internal factors; that is,

> Much of the countermeasures that anyone initiates is nullified by the government reports that state to the effect that there is no proof that there has been an increase in the number of accidents because of cell phone usage or texting while driving. I strongly believe that there is very little investigative data gathered (at the crash scene) about the cell phone, texting, Qualcomm, etc., usage in the 10 seconds before the crash. The crash data must be properly gathered in order to make a statement like that.

Motor Coaches

The group responded as to distracted driving countermeasures they see as effective, in terms of measures external to the company, internal to the company, and internal to the vehicle.

External to the company, broad education campaigns on the risks of distracted driving were most frequently reported, with 10 responses. Cell phone driving prohibitions, increased fines for violations, and better education as to the risks of driving while phoning each received 9 responses. The concept of incorporating insurance penalties only received 5 responses.

Internal to the company, the strongest response was in supporting a strong safety culture and recruiting drivers with a demonstrated safety record (12 and 13 responses, respectively). Having clear employee policies and consequences for violations received 11 responses. The use of post-incident coaching tools and targeted training received 10 responses each.

Internal to the vehicle, the highest number of responses (12) was for the use of automatic video monitoring, with 11 respondents noting the importance of carefully placing aftermarket devices in the driver area. Ten responses supported banning the use of all personal communications devices, which somewhat contradicts the nine responses supporting company policy allowing only hands-free communications devices. About half responded that cell phone use in particular should be prohibited. Monitoring systems providing retrospective driver feedback, as well as ride-along observations, each received 9 responses. Use of active safety systems and physiological monitoring each received 8 responses. Functional lock-outs for company devices only received 7 responses of support, somewhat less than that indicated by motor carriers.

Assessment of Human–Machine Interface Techniques

Motor Carriers

Opinions were provided as to the relative effectiveness of audible, visual, and haptic means of communicating information to the driver by means of devices not integrated into the vehicle, as well as graded warnings (warnings that progress from less urgent to more urgent if the driver does not respond). Audible alerts were clearly seen as effective (with a mean of 3.8 on a 5-point scale, with 5 indicating "highly effective"); one response saw audibles as ineffective. Support for visual alerts was somewhat less (with a mean of 3.5), with responses split about evenly between "effective" and "neutral." There was one response for "ineffective." Opinions on haptic alerts were mixed. Although the mean was 3.4, only slightly fewer supported this than visual; three respondents saw this mode as "highly effective" and three others saw it as "ineffective." Graded warnings received the strongest support with a mean of 3.9; 24 responses were "highly effective," and there were no negative opinions expressed for this mode.

Several respondents were concerned about false alarms and desensitization from too many alarms. One noted that, "overall, if drivers are provided accurate feedback they will then adjust their habits. Provided with feedback that is only marginally correct they will only become frustrated and more distracted. I also believe that an integrated all-in-one system would be better than the one-off systems that exist today (such as one system for speeding, one for lane departure, one for following distance, etc.)." Another reinforced this point, saying that "what makes any alert ineffective is the occurrence of false alerts. If a driver sees regular false alerts, the technology becomes meaningless. Also, if too many warning signals are present, a driver can easily get confused which warning signal belongs to which hazard."

Motor Coaches

For motor coach professionals, audible alerts were also seen as effective (a mean of 3.9 on a 5-point scale, with 5 indicating "highly effective"). Support for visual alerts was somewhat less (with a mean of 3.5), with several "effective" responses and one response for "ineffective." Opinions on haptic alerts were largely positive; although several responded as "neutral," there were enough supporters such that the mean was 3.6. Graded warnings received strong support with a mean of 3.8. Overall, the motor coach response on this topic was very similar to that of motor carriers.

Discussion

For both industry sectors, there was wide agreement that driver distraction from all sources is a significant safety issue. In terms of behaviors, although passenger interactions were the top source of distraction for motor coaches, both sectors view personal activities (eating, grooming, etc.) as major distraction sources, as well as reaching for objects and map reading. Talking, texting, and dialing on a hand-held phone were clearly seen as distracting by both groups. In terms of distracting devices, personal electronic devices received the strongest response. Job-related devices and GPS navigation systems received many responses as well. Approximately one-quarter of each group believed that aftermarket active safety systems were a distraction source.

There was more divergence on distracted driving countermeasures. The motor carrier industry respondents strongly supported laws prohibiting cell phone use while driving, whereas broad education campaigns on the risks of distracted driving represented the top priority for motor coach respondents, closely followed by support for cell phone prohibitions while driving. Insurance penalties were not strongly supported by either group.

Internal to the company, both groups believed that having a strong safety culture was the most important countermeasure. Careful hiring, plus clear employee policies and consequences for violations were also seen as very important. Post-incident coaching was also strongly supported by both groups.

Internal to the vehicle, for motor carriers the strongest response was to implement lock-out functions on company devices when the vehicle is being driven, reflecting the high degree of interaction with dispatching in many freight operations. For motor coaches the strongest response was for the use of automatic video monitoring, which was supported by more than half of the motor carrier responses. From both groups, there was strong support for banning the use of all personal communications devices, using active safety systems, and carefully placing aftermarket devices in the driver area. There was strong opposition to the use of hand-held cell phones by drivers, and opinions were mixed as to allowing the use of hands-free cell phones.

As to the relative effectiveness of audible, visual, and haptic means of communicating information to the driver by means of devices not integrated into the vehicle, there was strong alignment between both groups. All three modes were seen as effective, with audible alerts viewed as most effective. The use of graded warnings was strongly supported.

CHAPTER FOUR

STRUCTURED INTERVIEWS

BACKGROUND

This chapter presents findings from structured interviews with carrier owners and managers. The structured interviews are based on phone interviews, which followed the completion of the survey by each respondent. The last question the survey asked respondents was if they would be interested in participating in a brief follow-up interview to discuss safety practices relating to driver distraction. The question included the assurance, "Responses will be confidential; none of your comments are for attribution." Interviewees were selected based on their willingness to participate and on indications in the survey that they were actively engaged in carrier safety. The phone interviews lasted approximately 30 min each and followed a structured but flexible sequence of questions.

As seen in the interview summary tables in Appendix D, the interviews addressed the following general topics:

- Carrier description
- Degree to which distracted driving is a safety problem
- Primary sources of driver distraction (behaviors as well as devices)
- Countermeasures put in place by fleet and motivation to implement these particular countermeasures
- How measures were communicated to drivers, and their responses
- Measures of success and benchmarks
- Additional comments.

The responses shown in the right column of each structured interview table include some respondent answers transcribed from the survey questionnaire in addition to comments in the phone interview.

Companies are identified here only as "Carrier A," "Carrier B," etc. No interviewee names or company contact information is provided.

All of the interviewees projected themselves as conscientious individuals and well-intended managers of their companies' safety operations. Many good safety insights and examples of effective management practices are provided in the structured interviews. Nevertheless, project resources did not permit formal evaluation of any carrier or its practices. No carrier or public records on safety or compliance were examined. Doing so would have required a far greater contract effort and would likely have sharply reduced participation. Practices described should be taken as suggestions for consideration by readers, not necessarily as scientifically proven methods. Industry readers may judge for themselves the applicability of methods and ideas presented to their operations.

As with the project survey, the structured interviews and structured interview write-ups are intended to capture both objective information (e.g., carrier characteristics and practices used) and subjective information (e.g., opinions on safety risks, effective practices, and outside factors affecting their companies). Some of the interview questions addressed controversial topics, such as potentially prohibiting cell phone use in commercial trucking. Varied views on these topics were stated and are conveyed here to fully and accurately capture interviewee opinions. These opinions may be paraphrased in the write-ups or provided as direct quotations. Importantly, within each structured interview, qualitative statements made and provided here reflect the opinions of the interviewee. Statements from the structured interviews do not necessarily reflect those of the report authors or TRB.

Only motor carriers are represented in the structured interviews. Motor coach surveys did yield some responses in terms of follow-up interviews; however, efforts to arrange these interviews were not successful.

MOTOR CARRIER COMPANIES

Eleven trucking company owners and managers were interviewed. Their structured interviews are presented in the tables in Appendix D and summarized here.

Structured Interviews Summary

Nature of the Problem

As to the degree to which distracted driving is a safety problem, one safety manager recalled the "old days" when operating the tractor took a significant amount of attention and the in-cab distractions were as simple as operating an eight-track tape player. Now the tractor is easier to operate; there are driver assist systems for collision avoidance, the dashboard includes many indicators, and cell phones are ringing: so in-cab distractions have "exponentially grown."

Although all of those interviewed agreed distraction is a problem, several cautioned about overreacting to it. One safety manager who was a former driver noted "You don't want a cab with nothing at all going on, but you need to eliminate distractions that remove the driver's concentration from his driving duties." Another former driver agreed and was of the opinion that CB radios are not a problem because their operation is different from using mobile phones.

Prime sources of driver distraction noted by these safety managers were personal tasks, cell phone use, reaching for objects, and interacting with audio entertainment. About half considered reading maps and passenger interactions key sources of distraction, and a few reported that active safety systems could also be distracting. One manager relayed a story of a driver who dropped an important document and crashed while trying to pick it up.

In general, this group believes in using systems such as FCW, LDW, and roll stability systems to address unsafe driving overall. However, whereas "every new piece you add is a shiny light and can be a distraction," even adjusting a seat can be a distraction. Another made the point that driver mindset is key; many factors are under the driver's control, such as use of the CB radio, use of the cell phone, reaching into the cooler, and attending to cigarettes, climate control, and audio entertainment.

Company culture plays a role. One interviewee noted that monitoring drivers for distractions is certainly possible; however, it becomes an issue with "big brother" watching over a driver. The interviewee works for a private fleet with a low turnover, and he noted that the company culture will suffer if the right balance between monitoring, safety, and trust is not achieved. Another manager contrasted his operation with bigger fleets—they can have hard policies because they do not know their drivers, but how can they really enforce them? For him, "I can put my arms around all my drivers—I know them." The personal touch makes for a culture where they rely on their driver's good judgment. At the same time, as another put it, his drivers "understand Big Brother is here."

Regarding driver distraction, he is trying to slowly ease them into a changed mindset that focuses on what they personally control:

- Choosing when and how to communicate while driving,
- Using a CB radio,
- Tuning a radio,
- Using a GPS, and
- Wellness habits (including smoking).

With regard to smoking in particular, several see it as a distraction risk as well as a wellness issue; therefore, workplace wellness programs can positively impact the distraction arena as well.

Addressing the Problem

Participation in national programs such as a Responsible Care program was reported as part of establishing a strong safety culture, from which a distracted driving policy can be derived. The FMCSA Compliance, Safety, Accountability initiative was also noted by some as being helpful.

These discussions indicated that larger fleets are more likely to have clear cell phone use policies. For instance, one of the these fleets had a stringent policy that was characterized informally as "you can't play with anything" while operating the vehicle, including anytime the driver is at the controls of a truck, even if stopped at a traffic light. In the group interviewed, some smaller fleets prohibited cell phone use, whereas others discouraged it or had no policy. These smaller fleets were more likely to emphasize the importance of trust relationships with their drivers, expecting professionalism and for them to exercise good judgment. One manager noted that his company had considered the possibility of allowing drivers to talk in a hands-free mode and decided against it—they do not want them talking at all. More than one noted that, even while they currently do not have a cell phone ban in place, they are working toward a total ban and are developing the driver buy-in and ownership to go there. Several noted that, regardless of the policy, it is very difficult to ensure compliance.

Addressing in-vehicle devices and screens is a high priority. Several companies in the interview group use vehicle messaging and tracking systems or electronic on-board recorders that have display screens with various levels of lock-out capability. Some prevent outgoing messages only, whereas others blank the screen entirely while the vehicle is moving. However, for some fleets blanking the screen would interfere with the navigation function. Other features enable the driver to have messages relayed by computer voice through the vehicle speakers or a single button to push to tell dispatch "I'm driving, don't call my phone right now." For a fleet in which drivers use a personal digital assistant for messages, the protocol is that the device sounds to indicate a message is waiting and the driver must stop the vehicle to access and read the message.

Team driving represents a special case. One fleet blanks the in-cab screen when tractors are rolling, with an exception for teams. He believes drivers comply with this policy and that team driving provides checks and balances; the nondriving member of a team can recognize how the driver may be distracted.

Automatic video monitoring is of high interest, with one fleet recently starting a pilot program advocated by its insurance company. Several managers noted that these systems help to enforce compliance and augment their ride-along observations; some barriers reported were shipper prohibitions to having any cameras enter their facilities, as well as cost.

Fleet managers relayed their concerns about driver-installed electronics, such as satellite radio or navigation systems, noting that a company installation approach was viewed as being safer.

Cell phone lock-out devices now being offered by some vendors were of interest for some, but none of the interviewees are currently using such devices. Concerns were expressed as to cost and modifying a personal item of the employee (the cell phone could be damaged).

Two managers use performance bonuses to encourage compliance with distraction policies. For one fleet, infractions relating to hard braking, traffic tickets, etc., affect the driver's safety bonus; if there is a safety incident in the areas of safe driving, safe loading, or unloading, the quarterly bonus is decremented. In another fleet, every driver takes a battery of tests each month and a performance bonus is paid if they complete all testing correctly.

Effective hiring is a priority and was addressed in the interviews by several managers. One noted that they screen thoroughly, and go a step farther to identify any traffic ticket or crash problems, and will not hire people if this is the case.

Driver Acceptance

As to driver acceptance, one opinion voiced was that generally there is always resistance to putting new things in place, but over time drivers will accept them. The most significant issues have arisen regarding automatic video monitoring. Although these systems only record based on trigger events, the perception can persist among drivers that they are being constantly watched. One manager views these driver misconceptions as "a fact of life."

From a broader perspective, one manager noted that public awareness plays an important role: "the more public opinion is involved and in favor of what we are saying, the easier it is to get drivers in line." For example, his fleet has not had driver resistance to seat belt policies owing to broad public compliance, but finds support for sleep apnea programs challenging because there is not as much public visibility. When it comes to cell phones, he believes public information and attitudes also help. Another helpful technique mentioned was to teach a driver's family members about distraction and other safety issues by sending the company newsletter to the driver's home.

Benchmarks

Vehicle electronics provide for information on hard braking events and, for some fleets, roll stability and lane departure events. Although these data are useful when assessing safety performance (one company has documented a 75% reduction in hard braking events), it is generally not seen by the group as directly addressing distracted driving; video monitoring is viewed as the better tool for this.

The overall fleet crash rate was frequently cited as their key measure of effectiveness. Carriers examine accident type to assess the potential for a distraction component in a crash—striking vehicle ahead, run-off-road, and intersection crashes are seen as relevant to distraction.

When asked, interviewees did not observe an increase in crashes based on cell phone use; instead, crashes are down. One safety manager noted that, generally, he cannot tie any increase in crash involvement to the cell phone.

Additional Comments

Some respondents commented on the government role, with some believing that the government could do more, others less. The view of those seeking less government was expressed as "tell us what the rules are and then let us do our job." Those advocating a strong government role sought greater clarity in defining the driver distraction situation, greater and more consistent enforcement of existing laws, making cell phone use a primary (rather than secondary) offense where it is illegal, and a federal ban on cell phone use for commercial drivers.

To this latter point, a useful story was relayed by one safety manager. He had a long discussion with their operations department when they were working with a customer who wanted to use push-to-talk units to change destinations in real time. This conversation delved into whether it was legal to use cell phones in certain areas, and whether this would be a distraction for the driver. In a such a case, it would have been easier to respond to the customer by saying, "no, this is illegal due to federal law." Without these absolutes, they can lose a customer, he said. In this particular case, they agreed to carry the push-to-talk units, with the caveat that the driver would not respond immediately to "pings" and instead pull off the road to respond.

As a final point, it was noted that it is difficult to place strong prohibitions on CMV drivers alone and not the general public—if distraction is dangerous for any driver it is dangerous for every driver.

CHAPTER FIVE

CONCLUSIONS

This synthesis study has been successful in addressing small and large carrier experiences with, and response to, driver distraction for both motor carriers and motor coaches. A broad view of best practices was gained, as well as views on driver acceptance and the effectiveness of various types of human–machine interfaces.

A summary of results is provided here, followed by the team's perception of research priorities going forward.

- Driver distraction is an extremely complex issue. Much of the historical research presents conflicting findings. More research is needed to fully understand the physical, cognitive, and emotional attributes of technology- and nontechnology-based driver distraction.
- There is a fine line between removing unnecessary distractions from the truck cab and leaving drivers with enough resources to remain alert and stimulated (e.g., radios may present a minimal increase in the potential for distraction; however, they prevent the driver from getting bored and losing focus).
- There is little empirical research on the operational role and safety benefits associated with onboard technologies, including onboard safety technologies that can generate audio and visual distractions, and the indirect safety benefits associated with onboard communication devices including cell phones and navigation devices.
- Accurate feedback is critical in changing driver behavior; however, inaccurate feedback (especially false positives from safety technologies) can be detrimental.
- Currently, the research does appear to be clear that texting is very dangerous, hand-held cell phone calls range from potentially dangerous to very dangerous, with respect to hands free phones, research findings are inconclusive and hands-free calls may not be much of a safety concern.
- Many common driver distractions identified in the research are not technology-based and would be difficult to manage or regulate (eating, manipulating dials and buttons, adjusting mirrors, etc).
- Large and small fleets fundamentally differ in their approaches for managing distraction—large carriers are quick to form policies, whereas small carriers know their drivers better and rely on communication and trust.

Based on this report, it was concluded that there is a need to better understand how the different types of distractions (visual, manual, or cognitive) affect driving performance. For example, does a driver who is visually distracted drive at slower speeds or brake more readily (i.e., *knowingly compensating through cautiousness*) because of the reduced visual input for lane and headway keeping? To improve the efficacy of countermeasures in triggering monitoring devices, it is important to understand how the distraction types affect driving performance.

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APPENDIX A

Survey Forms

Driver Distraction Screening Survey

for Motor Carrier and Motor Coach Managers

August 4, 2011

This survey is being distributed as part of the Transportation Research Board Commercial Truck & Bus Safety Synthesis Program project MC-24: Distracted Driving Countermeasures for Commercial Vehicles. The project examines distracted driving, with emphasis on commercial drivers, and the effectiveness of counter-distraction devices. The approach consists of both literature review and surveys of industry professionals to assess the current state of practice.

For purposes of this survey, distracted driving for commercial drivers is defined as attending to tasks not directly related to operating the vehicle. (Driver interaction with integrated displays and controls implemented by the vehicle manufacturer is considered to be part of vehicle operation, as well as reading and comprehending roadside signage.)

As a trucking industry professional your knowledge and opinions are important to this study. This survey seeks your input on various driver distraction issues. The survey will take about 10 minutes to complete. There is also a space for your comments and suggestions. Final research results will be provided to interested parties and stakeholders, but **all information provided by you will be kept strictly confidential! The information collected from this survey will not be used for any other purposes.**

This screening survey will be followed by a small number of structured interviews with fleet managers as to current and potential tactics and training methodologies to aid motor carriers / drivers in avoiding a crash through awareness of dangerous actions and possible countermeasures.

Thank you for your participation and support!

If you would like us to send you a copy of the project's final report, please complete information below:
Name:_____ Phone:_____
Company:_____ Email:_____
Job Title: _____

Background Information

1. Number of years you have been a manager for commercial vehicle operations:_____ years

2. Your approximate number of years experience in commercial vehicle operations: _____ years

3. Please estimate the percent of your work time focused primarily on safety concerns (as opposed to other, non-safety management areas such as operational management, administration, and sales): _____ %

4. Number of power units in your company's fleet: _____ power units

5. How would you characterize your fleet's primary operation (select one)
   - ☐ For hire: local/short-haul (less than 100 miles from home base)
   - ☐ For hire: long-haul (over 500 miles from home base)
   - ☐ Private Fleet: long-haul
   - ☐ Private Fleet: local/short-haul
   - ☐ Passenger carrier: long-haul
   - ☐ Passenger carrier: local transit
   - ☐ Other (please specify): _____

6. What is your primary type of business? (check all that apply)
   - ☐ Truckload
   - ☐ Less-than-Truckload
   - ☐ Bulk/Tankers
   - ☐ Hazmat
   - ☐ Specialized
   - ☐ Private Fleet
   - ☐ Other (please specify): _____

7. What type of truck drivers do you primarily employ? (check all that apply)
   - ☐ Employee Drivers
   - ☐ Owner-Operators with own authority
   - ☐ Leased Owner-Operators/Independent Contractors

Role of Driver Distraction in the Overall Safety Picture

1. Driver distraction, from all sources (internal and external), is a significant safety issue for my fleet operations.
   - ☐ Strongly Agree
   - ☐ Agree
   - ☐ Neutral
   - ☐ Disagree
   - ☐ Strongly Disagree

2. Driver distraction from drivers' personal electronic devices brought into the vehicle is, in particular, a significant safety issue for my fleet operations. (Personal electronic devices are defined here as cell phones, smart phones, electronic tablets (such as iPads), and portable music players (such as iPods).)
   - ☐ Strongly Agree
   - ☐ Agree
   - ☐ Neutral
   - ☐ Disagree
   - ☐ Strongly Disagree

3. Driver distraction from job-related electronic devices (i.e., dispatch and/or customer interface) is, in particular, a significant safety issue for my fleet operations.
   - ☐ Strongly Agree
   - ☐ Agree
   - ☐ Neutral
   - ☐ Disagree
   - ☐ Strongly Disagree

Please provide any further comments on your view of safety management issues relating to driver distraction.

_____

_____

_____

Assessment of Distracted Driving

1. Please indicate which of the following <u>behaviors</u> while driving you believe constitute distracted driving (select all that apply):
   - ☐ passenger interactions
   - ☐ personal: eating, drinking, smoking

- ☐ personal: grooming/hygiene
- ☐ reading a map or directions
- ☐ reading billboards
- ☐ talking on mobile phone (hand-held)
- ☐ talking on mobile phone (hands-free)
- ☐ texting/dialing on mobile phone
- ☐ searching for objects in the cab
- ☐ reaching for objects in the cab
- ☐ adjusting on-board entertainment or climate control systems
- ☐ other (please specify)_____

2. Please indicate which of the following devices you believe contribute to distracted driving (select as many as applicable):
   - ☐ personal electronic devices
   - ☐ job-related electronic and/or dispatching devices
   - ☐ aftermarket active safety systems (lane departure warning, forward collision warning, etc.)
   - ☐ onboard entertainment systems
   - ☐ GPS navigation systems
   - ☐ Weigh-in-motion or vehicle-in-motion inspections
   - ☐ other (please specify) _____

Please provide any further comments on your view of behavioral- and device-related driver distraction.

_____

_____

_____

Identification of Effective Distracted Driving Countermeasures

Please indicate which of the following distracted driving countermeasures you believe to be effective (whether present or not in your current operations)

External to Company

- ☐ insurance penalties for phone-linked crashes
- ☐ increased fines for crashes with cell phone use
- ☐ cell phone prohibition laws
- ☐ broad education campaigns on risk of driving while using cell phones in particular
- ☐ broad education campaigns on risks of distracted driving in general

Internal to Company

- ☐ maintaining a strong safety culture
- ☐ strong focus on recruiting drivers with a demonstrated safety record
- ☐ clear employee policies and consequences for policy violation
- ☐ specific training techniques
  Please elaborate:_____
- ☐ having a post-incident coaching tool (or metric) that addresses potential distraction issues that could have played a role in a safety critical event

Internal to Vehicle

- ☐ company policy banning use of all personal communication devices while driving
- ☐ company policy only banning cell phone use while driving
- ☐ company policy only allowing hands-free or voice-operated communication devices while driving
- ☐ fleet managers locking out certain functions on employer-provided communication devices
- ☐ use of in-vehicle placards to remind drivers to “stay alert”
- ☐ paying careful attention to placement of aftermarket devices within vehicle to minimize distraction
- ☐ providing messaging from dispatcher with different levels of urgency so that driver can defer reading non-emergency messages
- ☐ using active safety systems to augment driver’s situational awareness and improve reaction time
- ☐ physiological monitoring of driver attention placement (typically head- or eye-trackers) and warning driver when needed
- ☐ monitoring systems that provide retrospective feedback on the driver’s distraction state

☐ conducting observations / ride-alongs to assess driver's behavior and provide feedback
☐ use of on-board safety monitoring systems which capture video of the driver and traffic environment when extreme maneuvers occur to identify training needs

Other

☐ other (please specify) _____

Please provide any further comments on effective driver distraction countermeasures.

_____
_____
_____

Assessment of Driver-Machine Interface Techniques

A series of questions assessing opinions on the relative effectiveness of (a) audible, (b) visual, and (c) haptic means of communicating information to the driver via devices not integrated into the vehicle

1. Please indicate your view of the effectiveness of driver warnings based on audible alerts.
   ☐ Highly Effective
   ☐ Effective
   ☐ Neutral
   ☐ Ineffective
   ☐ Highly Ineffective

2. Please indicate your view of the effectiveness of driver warnings based on visual alerts.
   ☐ Highly Effective
   ☐ Effective
   ☐ Neutral
   ☐ Ineffective
   ☐ Highly Ineffective

3. Please indicate your view of the effectiveness of driver warnings based on haptic alerts (such as a vibrating seat or steering wheel).
   ☐ Highly Effective
   ☐ Effective
   ☐ Neutral
   ☐ Ineffective
   ☐ Highly Ineffective

4. Please indicate your view of the effectiveness of graded warnings (early indication of potential issue with warning escalating as situation becomes more risky) versus single stage warnings.
   ☐ Highly Effective
   ☐ Effective
   ☐ Neutral
   ☐ Ineffective
   ☐ Highly Ineffective

Please provide any further comments on your view of effective driver-vehicle interfaces.

_____
_____
_____

Follow-Up

Please indicate here if you would be willing to participate in a follow-up interview of approximately ½ hour, focusing on your fleet's experience with distracted driving issues.

☐ Yes
☐ No

Thank you for your time. Please submit your survey in one of the following ways.

Email: richardbishop@mindspring.com
Fax: Richard Bishop, Bishop Consulting, 443 200 1225

APPENDIX B

Survey Results from Motor Carriers

There were 34 total responses from Motor Carriers. In this summary, the number of responses to a particular item is listed immediately to the left of the checkbox and underlined. Text comments are provided verbatim from the respondents. The response mean is calculated where appropriate (for the mean, a higher number indicates a more positive response).

Background Information

1. Number of years you have been a manager for commercial vehicle: operations: Mean (M) = 20.5

2. Your approximate number of years experience in commercial: vehicle operations: M = 23.8

3. Please estimate the percent of your work time focused primarily on safety concerns (as opposed to other, non-safety management areas such as operational management, administration, and sales): M = 74.2%

4. Number of power units in your company's fleet: M = 1665.9

5. How would you characterize your fleet's primary operation (select one)
   - 13 ☐ For hire: local/short-haul (less than 100 miles from home base)
   - 16 ☐ For hire: long-haul (over 500 miles from home base)
   - 0 ☐ Private fleet: long-haul
   - 6 ☐ Private fleet: local/short-haul
   - 1 ☐ Passenger carrier: long-haul
   - 0 ☐ Passenger carrier: local transit
   - 4 ☐ Other (please specify): Between 100–500 miles

6. What is your primary type of business? (check all that apply)
   - 12 ☐ Truckload
   - 5 ☐ Less-than-Truckload
   - 23 ☐ Bulk/Tankers
   - 19 ☐ Hazmat
   - 2 ☐ Specialized
   - 7 ☐ Private Fleet
   - 2 ☐ Other (please specify): Time-sensitive overnight

7. What type of truck drivers do you primarily employ? (check all that apply)
   - 32 ☐ Employee Drivers
   - 2 ☐ Owner-Operators with own authority
   - 11 ☐ Leased Owner-Operators/Independent Contractors

Role of Driver Distraction in the Overall Safety Picture

1. Driver distraction, from all sources (internal and external), is a significant safety issue for my fleet operations. (Mean = 4.3)
   - 17 ☐ Strongly Agree
   - 14 ☐ Agree

4 ☐ Neutral
1 ☐ Disagree
0 ☐ Strongly Disagree

2. Driver distraction from drivers' personal electronic devices brought into the vehicle is, in particular, a significant safety issue for my fleet operations. (Personal electronic devices are defined here as cell phones, smart phones, electronic tablets (such as iPads), and portable music players (such as iPods).) (Mean = 4.1)
   11 ☐ Strongly Agree
   20 ☐ Agree
   3 ☐ Neutral
   2 ☐ Disagree
   0 ☐ Strongly Disagree

3. Driver distraction from job-related electronic devices (i.e., dispatch and/or customer interface) is, in particular, a significant safety issue for my fleet operations. (Mean = 3.4)
   5 ☐ Strongly Agree
   13 ☐ Agree
   10 ☐ Neutral
   5 ☐ Disagree
   2 ☐ Strongly Disagree

Please provide any further comments on your view of safety management issues relating to driver distraction:

I believe that this is the number one concern for all safety professionals. But where do you draw the line? Before there were cell phones and GPS (Tom-Toms) there were still driver distractions in the cab. Things like where is the driver's mind at? Drinking coffee or cokes? Smoking, etc.
A significant percentage of crashes can be directly related to driver distraction issues. More awareness and driver training should be set as goals within carriers' Safety Programs to eliminate and teach drivers of the importance of not permitting themselves to become distracted while driving.
Anything that requires or encourages a driver to take his eyes off the road or the driver's mind away from his driving for more than ½ second should be discouraged by the industry.
1. Driver distraction from job-related road construction/repair detours, lane restrictions, reduced speeds, and congestion. 2. Driver distraction from job-related road issues such as accidents and roadside hazards
Using Qualcomm that does not allow interaction while unit is moving.
In Question #2, please add GPS direction systems, especially of the sort that are limited in their ability to differentiate truck routes or routes that are restricted to full sized equipment. It might also be a good idea to mention hands-free cell phones, which we also believe distract from the job of driving.
There are other significant distractions in today's environment including but not limited to eating and drinking soft drinks, etc., while driving. This has increased with the advent of the 14 hour limit.

There needs to be an understanding that there is a line that can be crossed. You don't want a cab with nothing at all going on, but you need to eliminate distractions that remove the driver's concentration from his driving duties. Removing CB radios, other radios and sources of entertainment would tend to lull the driver into boredom and sleep. This opinion comes from my experience as a driver. While I don't advocate the use of cell phones, there are sleep experts that will tell you a phone call can raise the alertness of a dozing driver. I am only using this to illustrate the need to keep the driver's mind stimulated.
Technology has created the issue and truly needs to assist in solving this problem. Cell phones are of particular interest for safe driving. Monitoring drivers for these distractions is certainly possible; however, it becomes an issue with big brother watching over a driver. As a private fleet with low turnover, the company culture will suffer if the right balance between monitoring, safety and trust is not achieved.
I feel our drivers deal with "car"distraction. They are keeping their eyes on the cars, which is very distracting. Entering and exiting ramps, lane changes, speed, slower cars, objects on the highway and the list goes on and on. We cannot blame just the electronics.
Eating and drinking
We have training and policy in place to address Distracted Driving practices. This has significantly reduced our distractive driving exposure.
Driver personal cell phones are the biggest distraction.
Electronic devices, both personal and company-provided, only add to the problems of driver distractions

Assessment of Distracted Driving

1. Please indicate which of the following behaviors while driving you believe constitute distracted driving (select all that apply):
   - 18 ☐ passenger interactions
   - 32 ☐ personal: eating, drinking, smoking
   - 25 ☐ personal: grooming/hygiene
   - 30 ☐ reading a map or directions
   - 14 ☐ reading billboards
   - 34 ☐ talking on mobile phone (hand-held)
   - 25 ☐ talking on mobile phone (hands-free)
   - 34 ☐ texting/dialing on mobile phone
   - 31 ☐ searching for objects in the cab
   - 32 ☐ reaching for objects in the cab
   - 19 ☐ adjusting on-board entertainment or climate control systems
   - 3 ☐ other (see below): _____

Adjusting and listening to audio entertainment devices
All items are distracting that take your attention away from driving defensively
Writing down state line crossings

2. Please indicate which of the following devices you believe contribute to distracted driving (select as many as applicable):
   - 34 ☐ personal electronic devices
   - 23 ☐ job-related electronic and/or dispatching devices
   - 8 ☐ aftermarket active safety systems (lane departure warning, forward collision warning, etc.)
   - 22 ☐ onboard entertainment systems
   - 20 ☐ GPS navigation systems
   - 7 ☐ weigh-in-motion or vehicle-in-motion inspections
   - 0 ☐ other (please specify): _____

Please provide any further comments on your view of behavioral- and device-related driver distraction:

I feel that anything taking your eyes off the road is technically a distraction, every safety professional has seen consequences for something as simple as changing the radio station. But we obviously don't want everything regulated. There's no way to enforce looking at a billboard.
Audio device distractions are more of a distraction than visual distractions.
To reduce some in-cab distractions, we have programmed our satellite communication systems to "blank out" their screens when tractors are in motion. We have also employed a text-to-voice system to read aloud directions to customer facilities, preventing drivers from having to read directions from paper while driving.
Phone conversations can hold your attention and distract you from your driving. Adjusting controls or reading billboards are things that are done by choice when the time is right.
The behavior is difficult to change; thus, it takes a strong commitment from management. We need to lead by example. I would appreciate a system that would disable all personal device electronics while the vehicle is in motion. Take away the temptation on the front end to effect behavior change.

Identification of Effective Distracted Driving Countermeasures

Please indicate which of the following distracted driving countermeasures you believe to be effective (whether present or not in your current operations)

External to Company

- 7 ☐ insurance penalties for phone-linked crashes
- 18 ☐ increased fines for crashes with cell phone use
- 24 ☐ cell phone prohibition laws
- 23 ☐ broad education campaigns on risk of driving while using cell phones in particular
- 23 ☐ broad education campaigns on risks of distracted driving in general

Internal to Company

- 31 ☐ maintaining a strong safety culture
- 25 ☐ strong focus on recruiting drivers with a demonstrated safety record
- 30 ☐ clear employee policies and consequences for policy violation
- 24 ☐ having a post-incident coaching tool (or metric) that addresses potential distraction issues that could have played a role in a safety critical event
- 10 ☐ specific training techniques

→***Please elaborate:***

Policies do work sometimes, but to have a policy for everything that can happen is ridiculous. How do you enforce them? You are not in the cab with them. You can say that you are going to terminate them, but it is usually after something has happened.
Safety culture as a whole is key, and both policies and training/coaching practices play a part. If drivers see how serious you are regarding on-road distraction, then they will be just as serious. If it's never mentioned, and they're still pushed from an operational standpoint to answer their phone or use their job-related electronic device no matter where they are (driving or not), then they may consider the distraction "supported" by the carrier.
Award drivers who demonstrate and develop a safe employment record. Communicate driver safety deficiencies immediately with the driver.
Use of distracted driving training: Video–Test–Discussion
Complacency is our greatest enemy. We have to keep drivers focused on the task at hand. Whether they are driving, loading, or unloading we have to train them to stay focused on what they are doing.

Internal to Vehicle

- 21 ☐ company policy banning use of all personal communication devices while driving
- 10 ☐ company policy only banning cell phone use while driving
- 10 ☐ company policy only allowing hands-free or voice-operated communication devices while driving
- 25 ☐ fleet managers locking out certain functions on employer-provided communication devices
- 3 ☐ use of in-vehicle placards to remind drivers to "stay alert"
- 20 ☐ paying careful attention to placement of aftermarket devices within vehicle to minimize distraction
- 15 ☐ providing messaging from dispatcher with different levels of urgency so that driver can defer reading non-emergency messages
- 20 ☐ using active safety systems to augment driver's situational awareness and improve reaction time
- 9 ☐ physiological monitoring of driver attention placement (typically head- or eye-trackers) and warning driver when needed
- 14 ☐ monitoring systems that provide retrospective feedback on the driver's distraction stat
- 22 ☐ conducting observations / ride-alongs to assess driver's behavior and provide feedback
- 21 ☐ use of on-board safety monitoring systems which capture video of the driver and traffic environment when extreme maneuvers occur to identify training needs
- 3 ☐ other (please specify):

All dispatch messages should be deferred until unit is not moving
Prohibitions are great but not enforceable as preemptive measures
A device to deactivate personal communication devices or one that at least reports their usage while the vehicle is in motion.

Please provide any further comments on effective driver distraction countermeasures.

Much of the countermeasures that anyone initiates are nullified by the government reports that state to the effect that there is no proof that there has been an increase in the number of accidents because of cell phone usage or texting while driving. I strongly believe that there is very little investigative data gathered (at the crash scene) about the cell phone, texting, Qualcomm, etc., usage in the 10 seconds before the crash. The crash data must be properly gathered in order to make a statement like that. Anyone commuting to and from work cannot help but notice the number of vehicle drivers with a cell phone in one hand, sipping the coffee, smoking a cigarette, and somehow managing to steer the vehicle.
The sole effective distraction countermeasure is focusing drivers' attention to the task of driving.
We use many of the systems above to help us train, remind, and monitor drivers of distracting behaviors.
Company policies are fine but if they are hard to enforce or not enforced at all they are not effective. When possible, one on one contact is still the best trainer.
Cameras have been the most effective tool.
Internally we need to ensure that the dispatch/operations department provides the driver the highest quality data available to minimize any distractions from that end of the operation.

Assessment of Driver-Machine Interface Techniques

A series of questions assessing opinions on the relative effectiveness of (a) audible, (b) visual, and (c) haptic means of communicating information to the driver via devices not integrated into the vehicle.

1. Please indicate your view of the effectiveness of driver warnings based on audible alerts. (Mean = 3.8 on a 5-point scale)

   0 ☐ Highly Effective
   26 ☐ Effective
   6 ☐ Neutral
   1 ☐ Ineffective
   0 ☐ Highly Ineffective

2. Please indicate your view of the effectiveness of driver warnings based on visual alerts. (Mean = 3.5 on a 5-point scale)

   0 ☐ Highly Effective
   17 ☐ Effective
   14 ☐ Neutral
   1 ☐ Ineffective
   0 ☐ Highly Ineffective

3. Please indicate your view of the effectiveness of driver warnings based on haptic alerts (such as a vibrating seat or steering wheel). (Mean = 3.4 on a 5-point scale)

   3 ☐ Highly Effective
   11 ☐ Effective
   17 ☐ Neutral
   3 ☐ Ineffective
   0 ☐ Highly Ineffective

4. Please indicate your view of the effectiveness of graded warnings (early indication of potential issue with warning escalating as situation becomes more risky) versus single stage warnings. (Mean = 3.9 on a 5-point scale)
   - 5 ☐ Highly Effective
   - 19 ☐ Effective
   - 9 ☐ Neutral
   - 0 ☐ Ineffective
   - 0 ☐ Highly Ineffective

Please provide any further comments on your view of effective driver–vehicle interfaces.

I'm not familiar with haptic alerts or graded warnings, so it would be hard to form an opinion without doing some further research. What makes any alert ineffective is the occurrence of false alerts. If a driver sees regular false alerts, the technology becomes meaningless. As an example, I live in a small town which uses the tornado siren to alert their volunteer fire fighters to emergency situations (car crashes, fires, etc.). The amount of times they sound the horn is different for emergency notification or severe weather; however, I hear these "false alarms" all the time. This is the same for any safety technology. If the technology is constantly inaccurate, it's ineffective. Also, if too many warning signals are present, a driver can easily get confused which warning signal belongs to which hazard.
The problem with any alarm be it audio, visual, or felt is that people become desensitized if the alarm is initiated often, in opposition to intermittently.
Pilot programs have illustrated that too many audible or visual warnings in a cab will soon be "tuned out" by drivers. They will start to marginalize the warnings, or even consider them "phantom" in nature.
Overall, if drivers are provided accurate feedback they will then adjust their habits. Provided with feedback that is only marginally correct they will only become frustrated and more distracted. I also believe that an integrated all-in-one system would be better than the one-off systems that exist today (such as one system for speeding, one for lane departure, one for following distance, etc.).
Countermeasures are only effective as part of an overall program to monitor, report, and review as part of a continuing monitoring and improvement program.

Follow-Up

Please indicate here if you would be willing to participate in a follow-up interview of approximately ½ hour, focusing on your fleet's experience with distracted driving issues.

Yes	21
No	5
No Response	1

APPENDIX C

Survey Results from Motor Coaches

There were 13 total responses from motor coaches. In this summary, the number of responses to a particular item is listed immediately to the left of the checkbox and underlined. Text comments are provided verbatim from the respondents. The response mean is calculated where appropriate (for the mean, a higher number indicates a more positive response).

Background Information

1. Number of years you have been a manager for commercial vehicle: operations: Mean (M) = 15.9

2. Your approximate number of years experience in commercial: vehicle operations: M = 19.0

3. Please estimate the percent of your work time focused primarily on safety concerns (as opposed to other, non-safety management areas such as operational management, administration, and sales): M = 49.2%

4. Number of power units in your company's fleet:_____

5. How would you characterize your fleets primary operation (select one)
   - 0 ☐ For hire: local/short-haul (less than 100 miles from home base)
   - 0 ☐ For hire: long-haul (over 500 miles from home base)
   - 0 ☐ Private Fleet: long-haul
   - 0 ☐ Private Fleet: local/short-haul
   - 5 ☐ Passenger carrier: long-haul
   - 4 ☐ Passenger carrier: local transit
   - 0 ☐ Other (please specify):

6. What is your primary type of business? (check all that apply)
   - 0 ☐ Truckload
   - 0 ☐ Less-than-Truckload
   - 0 ☐ Bulk/Tankers
   - 0 ☐ Hazmat
   - 1 ☐ Specialized
   - 3 ☐ Private Fleet
   - 10 ☐ Other (please specify): _____

7. What type of truck drivers do you primarily employ? (check all that apply)
   - 12 ☐ Employee Drivers
   - 1 ☐ Owner-Operators with own authority
   - 0 ☐ Leased Owner-Operators/Independent Contractors

Role of Driver Distraction in the Overall Safety Picture

1. Driver distraction, from all sources (internal and external), is a significant safety issue for my fleet operations. (Mean = 4.5)
   - 8 ☐ Strongly Agree
   - 4 ☐ Agree
   - 0 ☐ Neutral
   - 1 ☐ Disagree
   - 0 ☐ Strongly Disagree

2. Driver distraction from drivers' personal electronic devices brought into the vehicle is, in particular, a significant safety issue for my fleet operations. (Personal electronic devices are defined here as cell phones, smart phones, electronic tablets (such as iPads), and portable music players (such as iPods).) (Mean = 4.1)
   - 8 ☐ Strongly Agree
   - 1 ☐ Agree
   - 2 ☐ Neutral
   - 1 ☐ Disagree
   - 1 ☐ Strongly Disagree

3. Driver distraction from job-related electronic devices (i.e., dispatch and/or customer interface) is, in particular, a significant safety issue for my fleet operations. (Mean = 3.6)
   - 4 ☐ Strongly Agree
   - 4 ☐ Agree
   - 2 ☐ Neutral
   - 2 ☐ Disagree
   - 1 ☐ Strongly Disagree

Please provide any further comments on your view of safety management issues relating to driver distraction:

As a passenger transportation company, we have passenger distractions to contend with as well.
My drivers are tour drivers, by definition they are distracted drivers without adding dispatch communication and operation of items such as DVDs, etc.
School and passenger buses have a different type of risk to individual's safety because they carry a large amount of passengers on highways.
As a safety expert in this business, companies and operators need to refrain from all distractions (no cell phones, pagers, iPods or any other devices) and concentrate totally on their job of transporting passengers in a total safe environment. Enforcement needs to be increased against both drivers individually who violate these restrictions as well as fines against the companies who permit the drivers to violate. A dedicated education forum needs to be done on both the internet as well as within companies also to ensure that all motorcoach operators are aware of the distraction problem.
Passenger behavior.
You have covered most issues of driver distraction.

Assessment of Distracted Driving

1. Please indicate which of the following behaviors while driving you believe constitute distracted driving (select all that apply):
   - 11 ☐ passenger interactions
   - 11 ☐ personal: eating, drinking, smoking
   - 10 ☐ personal: grooming/hygiene
   - 11 ☐ reading a map or directions
   - 6 ☐ reading billboards
   - 12 ☐ talking on mobile phone (hand-held)
   - 8 ☐ talking on mobile phone (hands-free)
   - 12 ☐ texting/dialing on mobile phone
   - 9 ☐ searching for objects in the cab
   - 10 ☐ reaching for objects in the cab
   - 9 ☐ adjusting on-board entertainment or climate control systems
   - 3 ☐ other (see below): _____

Anything but two hands on the wheel and two eyes on the road.
Using iPods, etc.
The items not checked above could be distractions depending on the particular situation.

2. Please indicate which of the following devices you believe contribute to distracted driving (select as many as applicable):
   - 12 ☐ personal electronic devices
   - 9 ☐ job-related electronic and/or dispatching devices
   - 4 ☐ aftermarket active safety systems (lane departure warning, forward collision warning, etc.)
   - 10 ☐ onboard entertainment systems
   - 7 ☐ GPS navigation systems
   - 1 ☐ weigh-in-motion or vehicle-in-motion inspections
   - 0 ☐ other (please specify): _____

Please provide any further comments on your view of behavioral- and device-related driver distraction:

I believe the Commercial Driver does an outstanding job given all of the distractions required of him besides safe driving.
The industry needs to take distracted driving seriously. There have been way too many motorcoach accidents that could have been avoided if proper rules and laws had been followed. Along with distractions, driver fatigue still continues to affect many accident problems as you are well aware of.

Identification of Effective Distracted Driving Countermeasures
Please indicate which of the following distracted driving countermeasures you believe to be effective (whether present or not in your current operations)

External to Company
- 5 ☐ insurance penalties for phone-linked crashes
- 9 ☐ increased fines for crashes with cell phone use
- 9 ☐ cell phone prohibition laws
- 9 ☐ broad education campaigns on risk of driving while using cell phones in particular
- 10 ☐ broad education campaigns on risks of distracted driving in general

Internal to Company
- 12 ☐ maintaining a strong safety culture
- 13 ☐ strong focus on recruiting drivers with a demonstrated safety record
- 11 ☐ clear employee policies and consequences for policy violation
- 10 ☐ having a post-incident coaching tool (or metric) that addresses potential distraction issues that could have played a role in a safety critical event
- 10 ☐ specific training techniques

Internal to Vehicle
- 10 ☐ company policy banning use of all personal communication devices while driving
- 7 ☐ company policy only banning cell phone use while driving
- 9 ☐ company policy only allowing hands-free or voice-operated communication devices while driving
- 7 ☐ fleet managers locking out certain functions on employer-provided communication devices
- 6 ☐ use of in-vehicle placards to remind drivers to “stay alert”
- 11 ☐ paying careful attention to placement of aftermarket devices within vehicle to minimize distraction

6 ☐ providing messaging from dispatcher with different levels of urgency so that driver can defer reading non-emergency messages
8 ☐ using active safety systems to augment driver's situational awareness and improve reaction time
8 ☐ physiological monitoring of driver attention placement (typically head- or eye-trackers) and warning driver when needed
9 ☐ monitoring systems that provide retrospective feedback on the driver's distraction stat
9 ☐ conducting observations / ride-alongs to assess driver's behavior and provide feedback
12 ☐ use of on-board safety monitoring systems which capture video of the driver and traffic environment when extreme maneuvers occur to identify training needs
1 ☐ other (please specify):

Actually all of these could be checked but then again we have the enforcement issue of what happens when someone does get distracted through their own violation of policies or laws.

Assessment of Driver–Machine Interface Techniques

A series of questions assessing opinions on the relative effectiveness of (a) audible, (b) visual, and (c) haptic means of communicating information to the driver via devices not integrated into the vehicle.

1. Please indicate your view of the effectiveness of driver warnings based on audible alerts. (Mean = 3.9 on a 5-point scale)
   3 ☐ Highly Effective
   6 ☐ Effective
   4 ☐ Neutral
   0 ☐ Ineffective
   0 ☐ Highly Ineffective

2. Please indicate your view of the effectiveness of driver warnings based on visual alerts. (Mean = 3.5 on a 5-point scale)
   0 ☐ Highly Effective
   7 ☐ Effective
   5 ☐ Neutral
   1 ☐ Ineffective
   0 ☐ Highly Ineffective

3. Please indicate your view of the effectiveness of driver warnings based on haptic alerts (such as a vibrating seat or steering wheel). (Mean = 3.6 on a 5-point scale)
   3 ☐ Highly Effective
   2 ☐ Effective
   8 ☐ Neutral
   0 ☐ Ineffective
   0 ☐ Highly Ineffective

4. Please indicate your view of the effectiveness of graded warnings (early indication of potential issue with warning escalating as situation becomes more risky) versus single stage warnings. (Mean = 3.8 on a 5-point scale)
   3 ☐ Highly Effective
   4 ☐ Effective
   6 ☐ Neutral
   0 ☐ Ineffective
   0 ☐ Highly Ineffective

Follow-Up

Please indicate here if you would be willing to participate in a follow-up interview of approximately ½ hour, focusing on your fleet's experience with distracted driving issues.

Yes	3
No	9
No Response	1

APPENDIX D

Motor Carriers Company Interviews

TABLE D1
CARRIER A, LONG- AND SHORT-HAUL TL PNEUMATIC BULK

Carrier A Description	This fleet consists of 270 power units, which are applied to both local and long-haul services as a for-hire operation. The freight focus is pneumatic bulk truckload (i.e., flour, dry cement, etc., including hazardous materials).
Interviewee and Job Description	The interviewee is a former driver with 40 years in commercial vehicle operations. He was formerly on the safety committee of a major national trucking association.
Degree to which distracted driving is a safety problem	Sees distracted driving as a significant safety problem. However, there needs to be an understanding that there is a line that can be crossed. You don't want a cab with nothing at all going on, but you need to eliminate distractions that remove the driver's concentration from his driving duties. Removing CB radios, other radios, and sources of entertainment would tend to lull the driver into boredom and sleep. This opinion comes from experience as a driver. Does not advocate the use of cell phones, but notes there are sleep experts that say a phone call can raise the alertness of a dozing driver. He sees the need to keep the driver's mind stimulated.
Primary sources of driver distraction (behaviors as well as devices)	Personal tasks (e.g., eating and grooming) Cell phone use including texting Reading maps Searching/reaching for objects in the cab He reported an instance where the driver dropped an important document and crashed while trying to pick it up. In another case, a driver almost crashed while seeking to retrieve a dropped cell phone.
Countermeasures put in place by fleet/motivation	<u>Company Culture</u> Company culture must be kept in mind. He had previously worked for a large national chemical carrier and noted that his current small company culture was very different. What worked at the large carrier, including prohibiting cell phone use, would not work at his current carrier. His company has banned use of all personal communications, but not cell phones. However, he has been working to reduce the number of calls with dispatchers by better preparing the drivers ahead of the trip with items such as turn-by-turn directions. He believes that eventually cell phones must be totally banned for his drivers. <u>Training</u> He instructs his drivers, before getting underway, to look around the cab and ensure that all items are secure, which includes identifying any items that could hit the driver in a crash, and securing them. <u>In-Vehicle Company Device</u> His company uses the Qualcomm system, which has a "Can't use while running" feature, but the only function locked is sending messages. Drivers still attempt to pull up history, check hours of service, and other things. So a substantial number of text pages can be read on the screen. <u>Monitoring</u> Working with their insurance carrier, they are just starting a 90-day pilot of automatic video monitoring using the SmartDrive system. It will be installed on 75 trucks at two terminals. The intent is to use it as a coaching tool.

TABLE D1
(*continued*)

	Driver Observations Company policy is that every terminal manager must observe 20% of his drivers every month; however, there's not enough staff for driving observations. SmartDrive provides a measurement system to address the staff shortfall. Driver Coaching When crashes occur, the policy calls for an investigation that includes hard braking events recorded by Qualcomm. A discussion is held as to what happened in the event. If a third instance occurs, the driver must meet with the manager and describe what happened in a signed written statement. On a fourth instance, they look closely at data, such as following distances, for the purpose of re-training. If further instances occur, there can be suspension or firing. This policy has been in place for two years.
How measures were communicated to drivers, and their responses	Generally, there is always resistance to put new things in place; however, over time drivers come to accept them. He has been very thorough introducing the drivers to video monitoring, but "drivers don't like change." He tells them that the system only records incidents and still some say "I don't like being watched all the time." He sees such misconceptions as a fact of life. Monitoring is a "bad word" in his company.
Measures of success and benchmarks	Quantified measures are important. They rely on Qualcomm data to identify hard braking events. Video monitoring data are more related to distraction. Using Qualcomm data, they have documented a 75% reduction in hard braking events. The Qualcomm unit records two levels of braking events; drivers are allowed four per month for the lesser events. He believes these data have made his drivers better drivers.
Additional comments	Policymakers should first define the driver distraction situation to give the industry greater clarity. He also cautions against FMCSA overreacting (i.e., "don't make the cab so quiet that you put the driver to sleep"). For instance, CB radios may be an easy target for prohibition, but in his mind there is a big difference between a cell phone and a CB radio. The CB radio is relevant to the road situation. He would hate to see radios or light entertainment forbidden in trucks. The survey was very good, covering the issues well.

TABLE D2
CARRIER B, LONG- AND SHORT-HAUL PACKAGE DELIVERY

Carrier B Description	Large carrier with more than 30,000 trucks operating on a for-hire basis for short- and long-haul service. This includes 2,700 tractors and the rest are pickup and delivery vehicles. The freight includes hazardous materials.
Interviewee and Job Description	The interviewee has 26 years in commercial vehicle operations and is focused 100% on safety management.
Degree to which distracted driving is a safety problem	He called distraction "a bigger problem than we know." He sees a cell phone in every vehicle, not just trucks. A cell phone is one thing, but a smart phone is worse, as it is "too tempting" to read those new e-mails.
Primary sources of driver distraction (behaviors as well as devices)	Passenger interactions Personal tasks (e.g., eating and grooming) Cell phone use including texting Reading maps Searching/reaching for objects in the cab Personal electronic devices Onboard entertainment systems Job-related devices Radios can be a distraction as well; these are in their tractors but not pickup vehicles.

(*continued on next page*)

TABLE D2
(*continued*)

Countermeasures put in place by fleet/motivation	Electronic Devices They use Automatic On-Board Recorders (AOBRs) in their tractors, which communicate by voice and are voice-activated. There is a "big button" to push to tell dispatch "I'm driving, don't call my phone right now." Their policy is "you can't play with anything" while operating the vehicle. The policy refers to electronic devices and does not spell out specific device names or types. He notes that this policy extends to anytime the driver is at the controls of a truck, even if they are stopped at a traffic light, for instance. For their smaller pickup and delivery trucks they use a pad computer that "gives us fits." In earlier times, when the dispatch computer was hardwired in the cab, they could implement a blanking system activated by engine or speedometer data, shutting off the screen with movement. With the pad computer, because it is not hardwired, they can't control when the driver uses it. They would like to disable it when it senses motion but they aren't there yet. They don't even want the driver using the device when walking due to the injury potential. Training Training methods include presentations on the danger of distraction, as well as safety posters on distraction placed in company facilities. Safety observations Field safety staff does a set number of observations per month, as do operations managers. Both good and bad practices can be observed, and in particular this process allows them to recognize drivers for good practices. For instance, an experienced manager can tell if a driver routinely uses the seat belt just from observation of them putting it on during a check ride. Any employee can observe and report on a driver anywhere. In cities where his company has a large corporate presence this can be effective; the drivers know they're watching. Video Monitoring He would like to implement a video monitoring service such as DriveCam, but their legal department has concerns. He believes that with video monitoring, the crash rate would "drop like a rock." Related Health Policies Since the early 1990s they have had a "no smoking in vehicle" rule, which started as a health initiative and is now seen as relevant to distraction.
How measures were communicated to drivers, and their responses	From a driver standpoint, if video monitoring were implemented he would remind them that almost all companies have cameras in their buildings, so "what's the difference?"
Measures of success and benchmarks	The overall fleet crash rate is their key measure of effectiveness. They examine accident type—striking vehicle ahead, run off road, and intersection crashes are seen as relevant to distraction. When crashes happen, they use EOBR data to identify hard braking/acceleration. They also look at these data every quarter for every driver. Coaching discussions are held based on what the data reveals.
Additional comments	Regarding insurance, they are self-insured, so insurance is not a direct influence; it is all about loss prevention. Government has started in the right direction. Should they hold company responsible for breaking a driver distraction law? Yes—but they should also hold the driver responsible. The $2,750 texting fine is a good start. Enforcement matters.

TABLE D2
(*continued*)

	But how far should government go? All trucking companies have dispatching—should they be policed as well with regard to calling drivers? It is difficult to place strong prohibitions on CMV drivers alone and not the general public—if distraction is dangerous for any driver it is dangerous for every driver. He noted that law enforcement vehicles set particularly bad examples regarding distraction, with all the equipment that the driver interacts with in their vehicles.

TABLE D3
CARRIER C, LONG-HAUL TL BULK

Carrier C Description	This is a for-hire long-haul carrier with 145 power units. The freight carried is primarily bulk/tankers, including hazmat.
Interviewee and Job Description	The interviewee has been a manager in commercial vehicle operations for 15 years, with 50% of his time spent on safety issues.
Degree to which distracted driving is a safety problem	There have always been distractions when driving and there are more of them now; we are adding to the problem by trying to address it. It is an ongoing issue that requires continued attention. It is incumbent on every fleet to find the equipment and practices to address their own specifics. It is a continually changing issue and "it ain't going away."
Primary sources of driver distraction (behaviors as well as devices)	"Electronic devices, both personal and company-provided, only add to the problems of driver distractions." Personal tasks (e.g., eating) Cell phone use including texting Reading maps Searching/reaching for objects in the cab Personal electronic devices (e.g., mobile phone, hand-held or hands-free) Onboard entertainment systems Job-related devices Aftermarket active safety systems They use forward collision warning, lane departure warning, and roll stability systems to address unsafe driving overall. However, "every new piece you add is a shiny light and can be a distraction." Even adjusting a seat can be a distraction.
Countermeasures put in place by fleet/motivation	Countermeasures are only effective as part of a continuing overall program to monitor, report, and review. They have no specific policy about distracted driving. They discourage the use of cell phones while driving but do not prohibit them. They don't have that much authority. They ask drivers to be professional, adult, and responsible and have to rely on them. There is no way to ensure compliance through edicts. <u>Electronic Monitoring</u> They have electronic systems on their vehicles and are trialing others. They monitor, record, and tabulate all information from trucks to "read" a driver's habits. They review ECM data; the most critical are hard braking events plus speed. They have data to prove these are good measures. What the driver says is important too. They do not have systems in place to directly measure driver distraction. The most related system is lane departure warning; second, hard braking. Following distance is also telling. On a quarterly basis, they review findings with drivers individually, and the drivers adjust their habits. Terminations are not specific to distracted driving.

(*continued on next page*)

TABLE D3
(*continued*)

	Hiring and Training Discussions about cell phone policy are a starting point to discuss other distraction factors. They are a member of DriverSmart Virginia whose focus includes driver distraction. Hiring the right people is the number one factor and training can make them better. In hiring, they examine their driving record, work history, and online driver profile. The ultimate decision is with the person doing the hiring.
How measures were communicated to drivers, and their responses	He contrasted his operation with bigger fleets—they can have hard policies since they don't know their drivers, but how can they really enforce them? For him, "I can put my arms around all my drivers—I know them." The personal touch makes for a culture where they rely on their driver's good judgment. He identifies trends and discusses with drivers as needed. He has seen one or two of those types of information exchange focus on distracted driving.
Measures of success and benchmarks	They are convinced that data on hard braking, speed, and lane departures are good measures.
Additional comments	They are insured by an outside carrier and recently received a safety award from them. They set premiums based on empirical data rather than the presence of particular types of safety equipment. The less government, the happier he is: "put the rules in play, get out of the way." Fleet operations vary significantly depending on size, type of freight, and vehicle configurations; it is difficult to set broad policies.

TABLE D4
CARRIER D, SHORT-HAUL GASOLINE DELIVERY

Carrier D Description	This carrier is a private fleet with 200 power units, which specializes in local gasoline delivery.
Interviewee and Job Description	The interviewee has 23 years experience in commercial vehicle operations, including 16 years as a manager; 75% of his time is spent on safety matters.
Degree to which distracted driving is a safety problem	Technology has created the issue and truly needs to assist in solving this problem. Cell phones are of particular interest for safe driving. Monitoring drivers for these distractions is certainly possible; however, it becomes an issue with big brother watching over a driver. As a private fleet with low turnover, the company culture will suffer if the right balance between monitoring, safety, and trust is not achieved.
Primary sources of driver distraction (behaviors as well as devices)	Personal tasks (e.g., eating and grooming) Cell phone use including texting Reading maps GPS navigation systems Searching/reaching for objects in the cab Personal electronic devices (e.g., mobile phone, hand-held or hands-free) Onboard entertainment systems Job-related devices Aftermarket active safety systems Writing down state line crossings Disagreed driver distraction comes from job-related electronics, because in his fleet with onboard computer they have no function when truck is in motion; so not an issue.
Countermeasures put in place by fleet/motivation	Internally we need to ensure that the dispatch/operations department provides the driver with the highest quality data available to minimize any distractions from that end of the operation. Devices Company policy is that no additional electronics are allowed in the vehicle without approval. They do allow cell phones.

TABLE D4
(*continued*)

	Regarding satellite radio, they chose to not allow drivers to install units; instead the fleet assessed it and defined their own installation approach. They didn't trust driver installations. Drivers are not allowed to install or use navigation systems. He notes monitoring of drivers is difficult and he would "love" to use cameras, but they are somewhat of a "big brother" measure. He would also like to have some device to disable electronic devices. He has examined such "cell phone disablers;" they don't jam the signal, they "sniff it" and if the vehicle is moving, any cell phone or texting signal is detected and logged. This function in principal is great—he would use it. There would be a real benefit to jam the signal, in a limited area within the cab. <u>Training</u> Upon hiring they review policies with drivers and explain the basis of the policies. For the driver pool, in an ongoing manner they maintain awareness with posters, monthly driver meetings, and videos. They also keep them up-to-date on state laws. <u>Coaching</u> In event of an incident or infraction, there is a discussion with a manager and counseling. A plan for improvement is discussed, as well as why to do this. Drivers are "close" to termination with two infractions and on the third time probably terminated.
How measures were communicated to drivers, and their responses	Infractions affect the driver's safety bonus, which he sees as an important element of gaining compliance with company policies. Drivers are paid the bonus quarterly, anywhere from $600/quarter to $1,350/quarter, depending on tenure. If there is a safety incident in the areas of safe driving, safe loading, or unloading, the bonus is decremented. Their earnings are directly affected by safety incidents. As to the company safety culture, they have low driver turnover and seek to maintain a feeling of trust. In this context, "checking on drivers" is a challenge. He noted that in (another) smaller fleet within their company group SmartDrive video monitoring was implemented. Within that fleet, misconceptions abounded as to "always being watched." Within his fleet, despite thorough explanations and regular updates, his drivers objected to the concept. His view is that misconceptions are a given—it doesn't matter how much you explain. On the other hand, drivers are acclimated to information coming from onboard systems (i.e., hard braking events, speeding); they have no objections here. As to a cell phone disabler device, he has no hesitation to put something in the cab that prevents drivers from doing something they shouldn't be doing anyway.
Measures of success and benchmarks	They examine the crash rate, the driving complaint rate, and the incidents referred to above. He notes these are all lagging indicators but "that's just the way it is." Also, managers observe their drivers while they are driving to check for policy violations.
Additional comments	Overall, if drivers are provided accurate feedback they will then adjust their habits. Provided with feedback that is only marginally correct they will only become frustrated and more distracted. I also believe that an integrated all-in-one system would be better than the one-off systems that exist today (such as one system for speeding, one for lane departure, one for following distance, etc.). Government could do more to increase public awareness campaigns about distracted driving. Messages need to hit home—it can happen to you. These campaigns should show what simple distractions can lead to and include the emotional aspects of crashes. Communication with driver's families is also important. He is not opposed to any enforcement elements: "the more people out there looking for it, the better." There are no anti-cell phone laws on the books in states where they run.

TABLE D5
CARRIER E, LONG-HAUL TL BULK TANKER

Carrier E Description	This fleet consists of 220 power units hauling bulk tankers in a for-hire long-haul operation; 40% of the material is petroleum and the rest is chemicals in a fully hazmat operation. The vehicles are speed governed.
Interviewee and Job Description	A former driver, the interviewee has 36 years experience in commercial vehicle operations, including 29 years as a manager; 80% of his time is spent on safety matters.
Degree to which distracted driving is a safety problem	Driver distraction is a serious problem. From his office window, he watches his drivers on the phone as they leave the pipeline loading area. When he was a driver, it was CB radio. But CB radio was not a problem; drivers could drop the microphone when needed. It didn't distract; however, phones are distracting, because you have to look at the phone to make a connection. Also, talking on the CB radio is a "looser" conversation and thus has less impact on driving.
Primary sources of driver distraction (behaviors as well as devices)	Cell phone use including texting GPS navigation systems Searching/reaching for objects in the cab Personal electronic devices (mobile phone, hand-held or hands-free) Onboard entertainment systems Job-related devices
Countermeasures put in place by fleet/motivation	His fleet uses the Qualcomm in all trucks. Earlier configurations were a distraction but the current systems are configured so that they cannot be activated while the vehicle is in motion. In fact the parking brake has to be set to use the system or even bring up the display. If a message comes through while the vehicle is in motion, the driver has the option for it to be relayed by voice through the vehicle speakers. This way the driver doesn't have to stop to hear job-related messages. He is very satisfied with this approach. Cell phone use is forbidden; however, drivers are not complying. He is "on" his drivers frequently in this regard. When drivers call him, he asks if they are driving; they may say they are talking via Bluetooth; he says he will not talk to them until they pull over. The dispatch office is instructed to do this as well. However, this policy is virtually impossible to enforce. In responding to a question about cell phone lockout devices offered by some vendors, he noted that he hasn't looked at this and cost would be an issue. Also, there would be concerns about the company taking steps to modify the personal device of an employee, as it might be damaged. Vehicle data are monitored in terms of hard braking and stability control events. To get five hard braking events within 2 weeks is out of the norm. He finds most of these are low speed events (10–15 mph) as the vehicle approaches a stop sign; they are very rarely high speed. He also noted that the tanker is so light when empty that it is easy to lock up the brakes. Is this vehicle data useful to assessing distracted driving? No, it is more of a speed issue. He does not see a link between the vehicle data available to him and driver distraction. He also noted the role of the company safety culture, including recruiting.
How measures were communicated to drivers, and their response	He sees the issue as "manageable" right now. If it gets to be a problem, he would take some action with employees. For instance, if a driver was ticketed for cell use by state police, he would make an example in the employee newsletter (without identifying the individual). Since the newsletter goes to the driver's home addresses, family members will see it as well. He feels this is helpful to motivate family members to help reinforce his message on company policy in the newsletter. His fleet uses both employee drivers and owner–operators. He doesn't see a significant difference between them regarding company policy; they generally comply.
Measures of success and benchmarks	As noted, he sees the issue as manageable at this time. Has he seen any increase in crashes based on cell phone use? No, crashes are down and from his perspective crashes come from being too used to the roadway; i.e., complacency.

TABLE D5
(*continued*)

Additional comments	His fleet is self-insured to a certain limit, and they have worked with the same insurer for 40 years, which is a "good relationship." He drafted language re cell phone usage and sent it to them, which the insurer received positively. In this case the fleet took the initiative, not the insurer. As to state laws prohibiting cell phone use, these are not a deterrent. States need to start enforcing the laws in place, whether for trucks, cars, or bicycles. They should be aggressive as has been done with DUI, where progress has been made. In the Midwest where his office is located, they are not very aggressive about driver distraction. Nationally, he notes there is more signage in the East, especially New England. Here, enforcement is aggressive and he thinks this is great. He believes his drivers comply with the laws there. Also, cell phone prohibitions should be a primary offense, not secondary, as is the case in his area. As a hazmat carrier, they see themselves as a target for new regulations. He is "fine with that." As to government actions in general, he is always seeing articles about distracted driving and feels people are starting to get saturated and ignore it.

TABLE D6
CARRIER F, LONG- AND SHORT-HAUL HAZMAT

Carrier F Description	This fleet consists of 328 power units hauling hazardous materials for both short and long haul.
Interviewee and Job Description	A former driver, the interviewee has 43 years experience in commercial vehicle operations, including 32 years as a manager; 75% of his time is spent on safety matters.
Degree to which distracted driving is a safety problem	Sees driver distraction from all sources (internal and external) as a significant safety issue for his fleet operations.
Primary sources of driver distraction (behaviors as well as devices)	Passenger interactions Personal (e.g., eating and grooming) Map reading Billboards Cell phone use including texting GPS navigation systems Searching/reaching for objects in the cab Personal electronic devices (mobile phone hand-held or hands-free) Onboard entertainment systems
Countermeasures put in place by fleet/motivation	Job-Related Electronics They use a PeopleNet system for electronic logs and can receive messages through that system; i.e., the document comes across on screen. The driver cannot send a message while driving, but can't block messages from coming in. This system also logs hard braking events. They also use a GPS location system for navigation. A feature that would blank the screen while the vehicle is in motion would interfere with the navigation function. He feels that "anything on the screen could be a distraction" if the driver chooses to look at it for 4–5 seconds. When this occurs, the driver "loses all peripheral vision and awareness of whatever else" in the driving scene. These are great tools, but also distractions.

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TABLE D6
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	Company Policy Regarding Mobile Phones Drivers are told to concentrate fully on driving; however, they have CB radios and cell phones. Company policy is to not allow use of the computer while the truck in motion, nor to allow cell phone use. However, the latter is unenforceable unless you happen to see it. If a driver is caught using a phone, a reprimand is issued. In one case a driver was terminated in the yard. In his view, some people can talk on the phone and drive a truck safely, and some cannot. They considered the possibility of allowing drivers to talk in hands-free mode and decided against it—they don't want them talking at all. Training Drivers participate in a classroom program, in which they learn on tabletop PeopleNet units. They also place drivers in vehicle with a driver trainer. The only remedial training relates to hours of service. Active Safety Systems Major roadways are not a problem. In addition to having 100% of his power units detecting hard braking, a 50 truck subset in his fleet consists of 2,011 vehicles, which are capable of automatic braking if an imminent forward collision is detected. That's great, he says, but driver's need to be doing that. Is he satisfied with this automatic braking system? He noted that on these 2,011 vehicles there have been no rear-end collisions, but there are few rear-ends anyway. A system like this is great if you're in the open spaces like New Mexico, but not for downtown or in heavy traffic. However, having such a system "makes you look good in court." Hiring Effective hiring is a priority. They screen thoroughly, and go a step further to identify any traffic ticket or crash problems and will not hire people if this is the case.
How measures were communicated to drivers, and their responses	When a driver has a series of hard braking incidents a discussion ensues in which the driver is shown the data and asked what happened. Sometimes the drivers are surprised the information on their driving exists. This safety manager believes they are likely to describe a situation not involving a cell phone, even if a cell phone was involved. At the same time, he says his drivers "understand Big Brother is here."
Measures of success and benchmarks	They monitor their crash rate as a key measure. Their current crash rate is 0.35 per million miles. He has not seen an uptick in their crash rate over recent years as cell phones have become more pervasive; however, he has seen a slight increase in their vehicles being hit by other drivers using cell phones. Generally, he can't tie any increase in crash involvement to the phone.
Additional comments	They are both self-insured and have an insurance carrier for major events. Regarding distracted driving, the insurer sends memos occasionally. Their "big kick" is cameras in tractors, but his chemical plant customers don't want cameras entering their facilities. In fact, if his driver has a camera in his phone, he must turn it in to the chemical plant guard gate when entering. It is not sufficient for a camera system to simply be switched off. The government needs to educate the public. Generally, the commercial vehicle industry has proven itself as safe and good stewards. However, some laws let 16 year olds drive and don't educate them. Prohibitions on electronics usage are a great idea but not enforceable. Whatever technical features might be prohibited or required on a commercial vehicle should apply to everyone.

TABLE D7
CARRIER G, LONG- AND SHORT-HAUL TL PNEUMATIC BULK

Carrier G Description	This is a private, for-hire short-haul fleet, which consists of 85 power units (20 bobtail units) in a bulk/tanker hazardous materials operation. They deliver propane between Houston and Louisiana, with annual fleet mileage of 4.5 million miles.
Interviewee and Job Description	The interviewee, a former state policeman, has 27 years experience as a manager in commercial vehicle operations; 80% of his time is spent on safety matters.
Degree to which distracted driving is a safety problem	A significant percentage of crashes can be directly related to driver distraction issues. More awareness and driver training should be set as goals within carriers' safety programs to eliminate and teach drivers the importance of not permitting themselves to become distracted while driving. We as an industry are tasking their drivers with so many issues, pushing multi-tasking. We make too many demands in addition to other distractions. With distraction, there are certain things a driver can control: no CB, no text, no TV monitor, not lighting the cigarette, not adjusting air conditioning , not changing a CD, not reaching to the cooler while driving—it will take a lot of training and education to change that mindset.
Primary sources of driver distraction (behaviors as well as devices)	Passenger interactions Personal (e.g., eating and grooming) Map reading Cell phone use including texting Personal electronic devices (mobile phone hand-held or hands-free) Onboard entertainment systems Job-related electronics
Countermeasures put in place by fleet/motivation	Participation in National Programs His company is a member of the Responsible Care program, a certification program through the American Chemistry Council. This is part of their Total Quality Management system. The go through a certification audit, both internal and external. This includes building a safety consciousness. Their distracted driving policy is derived from that program. He is also a supporter of the FMCSA Compliance, Safety, Accountability (CSA) initiative. This involves more roadside inspections along with more education, such that violations have decreased. He attributes this to the knowledge of his drivers. Electronic Devices Their vehicles have GPS locaters and electronic logs. The drivers use a PDA for messages. When the device sounds, the driver must activate it to read the message; the policy is that they have to stop the vehicle to do this. More broadly, the company policy is to prohibit the manipulation of electronics while in motion. Hands-free phones are not allowed either. “Both hands on wheel and eyes on road are what they want.” Their drivers are professionals and they expect this. He noted that devices that disable cell phones could be useful and “we’ll look at it eventually.” Performance Bonus Every driver takes a battery of tests each month. A performance bonus is paid if they complete all testing correctly, Hiring During the hiring process, they check for general history plus all citations and accidents. The “greying of the fleet” is an issue as people retire; new drivers are not coming in. Further, someone new coming into this industry knows they’ll get drug/alcohol tests and this chases away applicants.

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TABLE D7
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How measures were communicated to drivers, and their responses	Employee Communications They publish a company newsletter every two weeks, which concentrates on safety, regulations, and reminders. There are also quarterly safety meetings. On each truck are decals in the cab, saying "no texting while driving." He seeks to have more interactions with his drivers, so that they see him as more than "the guy who fires drivers or checks fire extinguishers." He invites them to lunch anytime they are at corporate headquarters. Regarding driver distraction, he is trying to slowly ease them into a changed mindset that focuses on what they personally control: • Choosing when/how to communicate while driving • Use of CB radio • Tuning radio • Use of GPS • Wellness habits – Poor health, including smoking cigarettes, can lead to sleep apnea, which contributes to driver fatigue—and this is *the* contributor to crashes. These issues must be addressed by education, particularly in the areas of wellness and health care.
Measures of success and benchmarks	He noted that his fleet is 40% compliant based on their measures; they have a long way to go and education and training is the way to get there. Their quantified measures derive from vehicle data, including hard braking and idling time. Their main measure is cost per mile to operate on a per terminal basis. As to the crash rate, his reference point is his experience as a state policeman in the 1970s; since then there has been a tremendous improvement in the crash rate. He does not see cell phones as having a tremendous impact on total fatalities. He is very pleased with his fleet's crash rate; the statistics have gone down over time, and he credits the improvement to education and training of drivers.
Additional comments	Insurance companies initially took a "hands off" approach to CSA but are now taking a big interest. Outside insurance carriers will ask "did you check CSA?" As to driver distraction, they haven't made it an issue yet. Underwriters have asked him to educate them on the topic. He notes shippers are now looking at CSA more than price. Their fleet philosophy is to focus on dependability rather than giving the cheapest price. He considers himself to not be a "big-brother type" and thus his focus is on education. "We the industry fall short, not the regulatory agencies." For instance, people in the industry don't know what CSA is, even though there is plenty of educational material out there. "We as the industry need to do more promotion," such as through state ATA chapters. In particular, a small trucking company doesn't have luxury of a dedicated safety person and needs assistance from the broader industry.

TABLE D8
CARRIER H, LONG-HAUL TL BULK/TANKER

Carrier H Description	This is a for-hire long-haul fleet, which consists of 900 power units in a bulk/tanker operation for specialty chemical hauling.
Interviewee and Job Description	The interviewee has 21 years experience as a manager in commercial vehicle operations. Ninety percent of his time is spent on safety matters.
Degree to which distracted driving is a safety problem	He believes that driver distraction from both internal and external sources is a significant safety issue for his fleet operations. He remembers when in-cab entertainment was an eight-track tape player, which the driver could turn off/on. Then, operating the tractor took more attention. Now the tractor is easier to operate, and there are systems for collision avoidance, roll stability, dash indicators, and cell phones. The in-cab distractions have grown exponentially.
Primary sources of driver distraction (behaviors as well as devices)	Personal (e.g., eating and grooming) Map reading Cell phone use including texting Personal electronic devices (mobile phone hand-held or hands-free) Reaching for objects in cab GPS devices
Countermeasures put in place by fleet/motivation	<u>Company Policy</u> Cell phone use while driving is prohibited. Also, drivers are trained to go 10 mph below the posted speed limit. They do not allow the use of off-the-shelf GPS navigators, as they are "all over board on accuracy and truck routes." Instead, they rely on good, old-fashioned phone calls and atlases, when not driving. <u>Device-Based Countermeasures</u> There is a blank in-cab screen when tractors are rolling, with an exception for teams. He believes drivers comply with this policy and "can't imagine a teammate would allow the driver to look at the screen." Team driving provides checks and balances. The nondriving member of a team may recognize how the driver may be distracted. When asked if this has created more tension between team members, he said he has no feedback along those lines. The teammates know each other well, are frequently husband/wife, and are not afraid to check each other. As to other devices, they have upgraded their satellite communications systems for text-to-voice to give the driver directions. <u>Driving Performance</u> Over-speed and RPMs are monitored via the Qualcomm TRACS system and hard braking and roll stability events are monitored as well. The notification of an event goes to the driver team leader who has a discussion with the driver. The system sometimes has glitches and may not be accurate on the hard braking, so the discussion is important. Can the vehicle data be related to distraction? He noted that someone not familiar with an area may be looking for exit and end up making a quick turn—these situations can happen. <u>Training</u> They train new drivers to be careful about getting lost and needing to use a cell phone to find their way. They "never want to be part of crash with a cell phone." Drivers participate in quarterly sustainment training. <u>Compliance</u> Compliance is "pretty darn good." Eyewitness reports observing drivers on cell phones are extremely minimal. If a driver is witnessed using a cell phone, especially if repeated, this could lead to termination. <u>Statistics</u> They believe that a driver involved in vehicle incidents leads to crashes later, according to statistical data they have reviewed.

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TABLE D8
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How measures were communicated to drivers, and their response	Communications Campaign to Drivers This includes a driver reference guide, driver handbook, newsletter, and monthly business reviews. Driver Acceptance The more public opinion is involved and in favor of what we are saying, the easier it is to get drivers in line. For example, with seat belts, the public push has been out for a while, so this is easy. On the other extreme, they have a strong sleep apnea program in the company, but this is harder to push to drivers, as there is not as much public visibility. When it comes to cell phones, public information helps. "Acceptance hasn't been real tough, but there are those who don't believe, especially on a long open highway."
Measures of success and benchmarks	He views their measurement system as robust. High-level metrics (DOT reportable crashes) and vehicle incidents all go into an analysis process and they look for trends/ outliers. For particular events, they ask, "is it possible/probable this person was on a cell phone?" They reserve the right to research their cell phone billing records if needed, but they haven't done this in the ten years he has been with the company.
Additional comments	He would love to have a federal ban on cell phone use by commercial drivers—this is "a no brainer." This would make it extremely easy for carriers to have consistent rules. Even something consistent across the states would help. He has had long discussions with their operations department when they were working with a customer who wanted to use Nextel push-to-talk units to change destinations in real time. This conversation got into whether it was legal to use cell phones in certain areas, and would this be a distraction for the driver. In a case such as this, it would be must easer to respond to the customer by saying, "no, this is illegal due to federal law." Without these absolutes, they can lose a customer, he said. In this particular case, they agreed to carry Nextels, but that the driver would not respond immediately to "pings" and instead pull off the road to respond.

TABLE D9
CARRIER I, LOCAL TL TANKER HAZARDOUS MATERIALS

Carrier I Description	This is a for-hire local fleet which consists of 34 power units in a liquid bulk truckload operation for hazardous materials hauling. This includes waste hauling and servicing refineries.
Interviewee and Job Description	The interviewee has 16 years experience as a manager in commercial vehicle operations. Seventy (70) percent of his time is spent on safety matters.
Degree to which distracted driving is a safety problem	He believes that driver distraction from both internal and external sources is a significant safety issue for his fleet operations. To him, driver distraction includes job-related road construction/repair detours, lane restrictions, reduced speeds and congestion. Driver distraction also comes from job-related road issues such as accidents, and roadside hazards. He believes audio information is more distracting than visual information, because auditory information is sequential – it disappears quickly like human speech. With visual communications you always have the ability to retrace/ review what you missed. Drivers do not recognize behind the wheel their vulnerability to these distractions.
Primary sources of driver distraction (behaviors as well as devices)	Passenger interactions Personal (e.g., eating and grooming) Map reading Reading billboards

TABLE D9
(*continued*)

	Cell phone use including texting Personal electronic devices (mobile phone hand-held or hands-free) Reaching for objects in cab Adjusting entertainment and climate control systems GPS devices Job-related devices Aftermarket active safety systems Weigh-in-motion inspections
Countermeasures put in place by fleet/motivation	Company Policy The company has zero tolerance for cell phone use, neither hands-free nor hand-held phones are allowed. This in particular because of state law locally. They participate in the American Chemistry Council Responsible Care program. Electronic Devices and Monitoring They are using a Qualcomm system to measure metrics such as speed, hard braking, and location. When incidents occur, they communicate with the driver on safety deficiencies. They can mitigate distraction via Qualcomm through canned messages, preprinted across the computer screen, such as "shipper destination arrived." The screens are darkened when wheels are turning; drivers cannot view or hear messages. They do not have electronic on-board recorders. As to the use of video camera monitoring, they are aware of this and have seen information from the National Tank Truck Carriers Association; they have no cameras in their trucks, as "we aren't up to that yet." He noted that his sector of the industry is so regulated that compliance issues take up our resources; onboard cameras are not part of Federal compliance. As safety manager, he is keenly aware of the advantage of on-board cameras, but they are cost prohibitive. Furthermore, facilities do not want cameras entering the grounds; some facilities confiscate the driver's personal cell phone if it has a camera on it.
How measures were communicated to drivers, and their response	Communication to drivers occurs through regularly scheduled safety meetings to communicate policy; policies are also posted in the driver's room. Third party training services are used. His fleet did not encounter any driver resistance to zero tolerance of cell phones. As part of the communications process, this safety manager did a presentation to his drivers, noting that they "are a small, controlled group, a captive audience, paid for their attendance." He also noted that States do a good job of checking credentials (to see a history of their training). They can also convey messages on Qualcomm, even though there is a cost for use. He is skeptical that his drivers are actually adhering to the policy; he assumes that at minimum their family members are calling. The fleet awards drivers who demonstrate a good safety record.
Measures of success and benchmarks	None

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TABLE D9
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Additional comments	He adds that he has a full plate each day; the job doesn't turn off at the end of the day. In the chemical industry, security is right up there with other responsibilities. The topic of distraction is highly relevant and appropriate. The industry is going through a transformation with stabilization systems on liquid trailers and other enhancements. These come at a tremendous cost to industry and this is especially tough on small fleets. Nevertheless, "we have the commitment to continual improvement." He supports the aims of this project; for the government to shoulder cost of this kind of study is good. He also advocates helping small companies who are understaffed. All compliance areas are understaffed and it is important to reach out to contact and assist companies.

TABLE D10
CARRIER J, LONG- AND SHORT-HAUL TL PNEUMATIC BULK

Carrier J Description	This private fleet operates 66 tractor-trailers in the New England area in a local operation.
Interviewee and Job Description	The interviewee has 20 years experience in commercial vehicle operations, with 16 years as a safety manager; 70% of his time is spent on safety matters.
Degree to which distracted driving is a safety problem	He believes that driver distraction from both internal and external sources is a significant safety issue for his fleet operations. He is not aware of incidents in his fleet where cell phones were involved.
Primary sources of driver distraction (behaviors as well as devices)	Personal (e.g., eating and grooming) Cell phone use Reaching for objects in cab Personal electronic devices
Countermeasures put in place by fleet/motivation	<u>Company Policy</u> Beginning in 2008, the fleet had a policy about cell phone use, and he since enhanced the policy to limit it to hands free only. They also have a mandate against texting, including e-mails. The policy must be companywide, and includes sales force. What was the motivation for only allowing hands free? He is working toward a total ban and thinks he has the driver buy-in and ownership to go there. The current policy is a step in that direction. Driver buy-in and ownership is key; he is leery about a policy that can't be enforced. They do not supply cell phones to their drivers. <u>Electronic Devices</u> They currently have NavTrak, a basic GPS system. They will go with PeopleNet for an Electronic On-Board Recorder. With this system they will use the lockout function: drivers will get message alerts, but have no ability to use the system while the vehicle is in motion. He was not aware of monitoring electronics. He recently saw a webinar about distracted driving sponsored by "Comply." This focused on increasing monitoring through the PeopleNet device, linking the Central Office to vehicles on the road, with at least e-mails. They are in the preliminary stages of looking at lane departure warning systems, which may be tied into the PeopleNet system. <u>Monitoring</u> Working with their insurer, there is a proposal to have driver supervisors in cab to monitor drivers. There is also an 800 call-in number for monitoring. They are considering third-party observations with objective and trained monitors.

TABLE D10
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How measures were communicated to drivers, and their responses	They have two meetings a year with drivers. They must stress and reinforce their policy on distraction in every safety meeting. As noted above, he thinks he has the driver buy-in and ownership for a total ban on cell phone use.
Measures of success and benchmarks	None
Additional comments	None

TABLE D11
CARRIER K, LONG- AND SHORT-HAUL BULK TANKER HAZMAT

Carrier K Description	This is a for-hire, short- and long-haul fleet, which consists of 99 power units in a bulk/tanker hazmat operation.
Interviewee and Job Description	The interviewee has 35 years experience in commercial vehicle operations, with 12 years as a manager. All of his time is spent on safety matters. He was formerly an owner–operator driver. He is a regional safety chairman for NTTC, and now national chairman. He has been involved with the driver distraction issue for about 12 years, doing lots of networking in the industry. He developed his own training videos, using past accidents to show the effects of distracted driving. He used his situations for examples rather than other training.
Degree to which distracted driving is a safety problem	He believes that driver distraction from both internal and external sources is a significant safety issue for his fleet operations.
Primary sources of driver distraction (behaviors as well as devices)	Passenger interactions Personal (e.g., eating and grooming) Map reading Reading billboards Cell phone use including texting Personal electronic devices (mobile phone, hand-held or hands-free) Reaching for objects in cab Adjusting entertainment and climate control systems GPS devices Job-related devices Regarding CB radios, older guys use them. Younger drivers don't. They may or may not be distracting. Try to heighten sensitivity while doing other things. Be aware you are taking your eyes off the road. Therefore, it is a training and heightened awareness matter. Keep drivers aware, and let them know the consequences. Also, personal matters are distracting; i.e., mind not on the task
Countermeasures put in place by fleet/motivation	<u>Company Policy</u> No current policy, but they are in the process of switching to Qualcomm just in the training direction. They will use emergency alerts, but can't use while driving. Policy is only as good as it can be enforced; they don't have company cell phones. He doesn't know how you can really enforce policies in the real world. The key is to instill the concern with the driver, through the dispatcher. <u>Training</u> They use driver trainers, observe units, and report on results. They can pull up hard braking on current Qualcomm systems (on one-third of current fleet). This enables them to monitor in real time in the office.

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TABLE D11
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How measures were communicated to drivers, and their responses	Diligent training to keep drivers aware is the bottom line. Drivers are the last safety valve on the truck. It has to come down to personal responsibility. What has been the response of drivers to training? He can't attribute any accident to the use of a cell phone or other personal communications device.
Measures of success and benchmarks	None
Additional comments	Re driver machine interface techniques, they have roll over sensors on trailers. It still comes down to driver training and sensitivity to potential consequences. The more of this type of stuff you put on the truck, the more you take away the driver responsibility. It will never get to the point where the truck stops on its own. Re the policy of government; it is illegal in Illinois to use cell phones in a construction zone. He wants FMCSA to ban them. He noted NTSB's concern and recent recommendation. He wondered whether, under CSA, violations would count against you. The challenge is to keep information accurate; there are lots of subjective situations. This applies to hands free use, too.

Abbreviations used without definitions in TRB publications:

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