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Understanding the Effects of Distracted Driving and Developing Strategies to Reduce Resulting Deaths and Injuries

A Report to Congress

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This report was prepared in accordance with Section 31105 of the 2012 Moving Ahead for Progress in the 21st Century (MAP-21) Act. The report summarizes a series of studies undertaken by the National Highway Traffic Safety Administration and others, to acquire the information needed to address the general problem of distracted driving. The report documents what is known about distracted driving, including distractions other than the use of personal wireless communications devices; identifies metrics to determine the nature and scope of the distracted driving problem; and discusses methods to enhance education and awareness of the problem to reduce deaths and injuries caused by all forms of distracted driving. It highlights the need for further research and concludes with recommendations to better address the problem of distracted driving.

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Understanding the Effects of Distracted Driving and Developing Strategies to Reduce Resulting Deaths and Injuries

A Report to Congress

INTRODUCTION

Section 31105 of the Moving Ahead for Progress in the 21st Century Act (MAP-21), enacted on July 6, 2012, amends Section 405 of title 23, United States Code to authorize State grant programs known collectively as the National Priority Safety Programs. In connection with new distracted driving grants, MAP-21 directs the Secretary of Transportation to conduct a study of all forms of distracted driving, and submit a report to the Committee on Commerce, Science and Transportation of the Senate and the Committee on Transportation and Infrastructure of the House of Representatives.

Section 405 NATIONAL PRIORITY SAFETY PROGRAMS

. . .

(8) DISTRACTED DRIVING STUDY.—

(A) IN GENERAL.—The Secretary shall conduct a study of all forms of distracted driving.

(B) COMPONENTS.—The study conducted under subparagraph (A) shall—

(i) examine the effect of distractions other than the use of personal wireless communications on motor vehicle safety;

(ii) identify metrics to determine the nature and scope of the distracted driving problem;

(iii) identify the most effective methods to enhance education and awareness; and

(iv) identify the most effective method of reducing deaths and injuries caused by all forms of distracted driving.

(C) REPORT.—Not later than 1 year after the date of enactment of the Motor Vehicle and Highway Safety Improvement Act of 2012, the Secretary shall submit a report containing the results of the study conducted under this paragraph to—

(i) the Committee on Commerce, Science, and Transportation of the Senate; and

(ii) the Committee on Transportation and Infrastructure of the House of Representatives.

This report documents what is known about distracted driving, including distractions other than the use of personal communications devices, discusses metrics to better determine the nature and scope of the problem, and discusses countermeasure approaches and strategies for enhancing awareness and reducing deaths and injuries.

BACKGROUND

Although the meaning may seem obvious, the term distracted driving is often used to represent different driver conditions. While drowsiness and daydreaming can be categorized as inattention, the term distraction as used in this report is specific to the inattention that occurs when drivers divert their attention away from the driving task to focus on another activity.

These distractions can be from electronic devices, such as navigation systems and cell phones, or more conventional sources such as interacting with passengers or eating. These distracting tasks affect drivers in different ways, and can be categorized into the following major types:

> Visual distraction: Tasks that require the driver to look away from the roadway to visually obtain information;
>
> Manual distraction: Tasks that require the driver to take a hand or hands off the steering wheel and manipulate an object or device;
>
> Cognitive distraction: Tasks that are defined as the mental workload associated with a task that involves thinking about something other than the driving task (National Highway Traffic Safety Administration, 2010).

The U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) estimates that there are more than 3,000 deaths and approximately 400,000 injuries annually from distraction-affected motor vehicle crashes—crashes in which a driver lost focus on the safe control of his/her vehicle due to a manual, visual, or cognitive distraction (National Highway Traffic Safety Administration, 2013a).

NHTSA uses information available from police crash reports to try to quantify which motor vehicle crashes are distraction affected, meaning that at least one driver involved in the crash was identified in NHTSA's data collection systems as "distracted." Based on crashes that occurred in 2010, the economic cost of distraction-affected crashes was approximately $22 billion (in 2010 dollars). NHTSA is currently evaluating its cost estimation methodology and plans to release an update in 2013, which means this estimate may change.

With more than 320 million cell phone subscriptions in America today (CTIA, 2012) and a growing number of devices and services designed to keep individuals constantly connected, technology is playing an increasing role in enhancing our quality of life. Yet using these technologies while behind the wheel can have serious consequences on our roadways.

Studies show that texting which, simultaneously involves manual, visual, and cognitive distraction, is among the worst of all driver distractions. In a recently published study, Ranney, Baldwin, Parmer, Martin, and Mazzae (2012) concluded that"… text messaging was associated with the highest levels of driving performance degradation..." (p.i).

Recent results from the National Occupant Protection Use Survey indicated that the percentage of drivers who were text messaging or manipulating hand held devices increased significantly for a

second year in a row from 0.9 percent in 2010 to 1.3 percent in 2011, while driver hand held cell phone use stood at five percent in 2011 (National Highway Traffic Safety Administration, 2013b). The results of this observational survey translate into 660,000 drivers holding hand held phones to their ears while driving at any typical daylight moment.

The impact of distraction on driving is determined not just by the type of distraction, but also the frequency and duration of the task. Even if a task is less distracting, a driver who engages in it frequently or for long durations may increase his/her crash risk to a level comparable to that of a much more difficult task performed less often. Because drivers often have a choice regarding when and how often to multitask when driving, their exposure to risk is typically within their control; and drivers typically underestimate the overall risk of various tasks.

While distracted driving can take on many forms and affects all road users, young drivers are at particular risk. A nationally representative telephone survey of distracted driving attitudes and behavior published in 2011 (Tison, Chaudhary, & Cosgrove, 2011) shows that, of those drivers who report having been involved in a crash or near-crash, young drivers (18-20 years old) report the highest incidence of crash or near-crash experience—and to have been using a cell phone at the time of the incident. Drivers under 25 years of age are 2-3 times more likely than older drivers to send text messages or emails while driving. While almost all drivers believe that sending text messages while driving is very unsafe, young passengers are much less likely than older passengers to say something to their driver if he or she is texting.

The problem of distracted driving reached the attention of the highest levels of government: on September 30, 2009, President Obama issued an Executive Order prohibiting Federal employees from texting while driving government vehicles or while using a government supplied cell phone while driving any vehicle. U.S. Department of Transportation agencies have issued similar directives. For example, the Federal Motor Carrier Safety Administration (FMCSA) banned commercial truck and bus drivers from texting while driving in September 2010, and in November 2011, banned all hand-held cell phone use by commercial drivers. The Pipeline and Hazardous Materials Safety Administration (PHMSA) followed by banning texting on electronic devices by drivers operating a motor vehicle containing hazardous materials and the Federal Railroad Administration (FRA) banned rail employees from using cell phones or other electronic devices when performing safety-related duties on the job. Finally, the Federal Aviation Administration (FAA) advised air carriers to create and enforce policies that limit distractions in the cockpit and keep pilots focused on transporting passengers safely.

In 2010, NHTSA released its Driver Distraction Program plan (National Highway Traffic Safety Administration, 2010), providing a roadmap for the Agency's long-term goal of eliminating crashes attributable to distraction. The program involves four (4) initiatives, as shown in Figure 1. The first initiative aims to improve the understanding of the extent and nature of the distraction problem by enhancing data quality and analytic methods. The next two initiatives involve vehicle approaches for reducing distracted driving. In one, the focus is to minimize workload demands for use of in-vehicle and portable technologies, while the other focuses on evaluating crash avoidance technologies to keep distracted drivers and passengers safe (e.g., use of crash warning systems and distraction monitoring systems). The fourth program initiative is a behavioral approach that seeks to educate drivers on the risks and consequences of distracted driving. This program plan has guided

NHTSA's approach to addressing distracted driving, as well as the initiatives discussed in this report.

Figure 1. Distraction Plan (from National Highway Traffic Safety Administration, 2010; p. 13)

NHTSA provided funding for several demonstration projects designed to determine if the proven high visibility enforcement (HVE) protocols utilized to address other behavioral traffic safety problems are effective in reducing distracted driving. Early indications show that these projects, outlined in greater detail later in this document, do have a positive impact on limiting the use of cell phones while driving.

To assist States in addressing distracted driving, NHTSA led a consensus effort to develop a sample law to prohibit texting while driving. The sample law helps State legislators enact effective distracted driving laws and create uniform legal policies and procedures across the country. States can use the sample law as a starting point to craft laws prohibiting texting while driving.

According to the Governors Highway Safety Association, as of March 2013, 39 States, Guam and the District of Columbia have enacted laws to ban text messaging by drivers, with some limited exceptions. Thirty-five of these States require primary enforcement of their law. Driving while talking on a hand held cell phone is banned in 10 states, the District of Columbia, Puerto Rico, Guam and the U.S. Virgin Islands (Governors Highway Safety Association, 2013).

To address the issues of distraction occurring within the vehicle, NHTSA finalized on April 26, 2013 voluntary guidelines for vehicle manufacturers to discourage the introduction of excessively distracting devices that are integrated into vehicles. (See the Notice Of Federal Guidelines, Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices, 78 FR 24818, at www.federalregister.gov.)

NHTSA is now developing a second phase of guidelines that would address portable and aftermarket devices, including electronic devices such as navigation systems, smart phones, electronic tablets and pads, and other mobile communications devices. Finally, a third phase of guidelines are planned to address voice-based user interfaces for both integrated and portable and aftermarket devices.

As indicated in the above description of the Driver Distraction Plan, NHTSA will also examine the potential of advanced crash warning and driver monitoring technologies to help avoid crashes caused by distraction.

OBJECTIVE

The objective of this report is to examine the effects of all forms of distraction; identify metrics to determine the nature and scope of the distracted driving issue; and identify the methods to enhance awareness of distracted driving and strategies for reducing deaths and injuries caused by all forms of distracted driving.

SCOPE

The information in this report is based largely on a review of existing research and limited archival data. There is little information on the effects of distraction other than the use of personal electronic communication devices. As distracted driving, particularly as it relates to the use of personal electronic communication devices, is an emerging traffic safety issue, the depth and quality of literature is more limited than in other traffic safety areas.

DRIVER DISTRACTION RESEARCH

Ranney (2008) indicated one of the challenges in driver distraction research was the lack of a common definition of distraction. However, for the purposes of his review, Ranney indicated that "distraction occurs when a driver's attention is diverted away from driving by a secondary task that requires focusing on an object, event, or person not related to the driving task." This definition is consistent with that used by NHTSA and cited earlier. Ranney's review found that while the most common distraction was conversing with another passenger, most of the research addressed electronic devices.

The majority of driver distraction research has focused on high-profile technology-based distraction sources like cell phones most recently, and navigation systems before that. Older distraction research was primarily concerned with built-in equipment such as GPS navigation systems, audio systems, and even climate controls. With the advent of portable devices becoming so popular and functionally powerful, the research focus has largely shifted to smart phones, portable navigation devices, and even portable mp3 music players. Much of the research on technology-based distraction sources has used experimental methods in driving simulators and test tracks. However, the increasing number of naturalistic driving studies has produced stronger connections between crash risk and how and when drivers engage in technology- and non- technology-based distractions. Drews and Strayer (2009) reviewed the research on the effects of personal wireless communication devices on driver performance, and organized their review based on the type of distraction and the methodology used. In addition, Bayly, Young, and Regan (2009) reviewed the research on various sources of distraction found inside the vehicle, including technology-based distractions and non-technology-based distractions. They concluded that few sources of distraction have been extensively studied to determine their effects on driving performance.

Non-technology-based sources of distractions include activities such as smoking, eating and drinking, reaching for objects, grooming activities, reacting to an insect inside the vehicle, reading and writing, and interacting with passengers. A driver may also lose focus on driving due to engaging in internal sources of inattention or distraction, such as being lost in thought or thinking about personal or financial problems. In addition, some crash-associated factors such as driver age and gender, roadway traffic, and environmental conditions may influence a driver's likelihood of engaging in non-driving activities. Most of the data on these sources of distraction come from observational and naturalistic data collections such as from Stutts, Feaganes, Rodgman, Hamlett, Meadows, Reinfurt and Staplin (2003); Glaze and Ellis (2003); and Klauer, Dingus, Neale, Sudweeks and Ramsey (2006). As can be seen in Table 2 (p. 9), several of the distractions with the highest risk odds ratios are non-technology-based. For example, reaching for a moving object resulted in a risk odds ratio of 8.82, which is not surprising because reaching typically involves all three forms of distraction: manual, visual, and cognitive.

Audio systems have been in vehicles since the 1930s and have typically represented minor sources of distraction. Most recent studies have shown radio tuning, CD manipulation and use, and other audio system controls to have little effect on driving performance (Strayer & Johnston, 2001) or crash risk (Stutts, et al., 2003). The 100-car study (discussed later in this section) data support these findings in that neither adjusting the radio nor inserting/retrieving a CD from the audio system resulted in a significant increase in crash risk (Klauer, et al., 2006). Because audio systems have been in vehicles for a long time and the crash risk is low, NHTSA selected radio tuning as the reference task for its Visual-Manual Driver Distraction Guidelines. For more discussion of the selection of radio tuning as the reference task, please see the Notice Of Federal Guidelines, Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices, 78 FR 24818, at www.federalregister.gov.

Two studies (Chisholm, Caird, & Lockhart, 2008; Salvucci, Markley, Zuber, & Brumby, 2007) specifically examined the effects of mp3 players on performance in a driving simulator. Both studies found that more complex tasks with the mp3 player (e.g., searching for a song requiring several menus and submenus) resulted in delayed response times, more eyes-off-road time, and

inferior lane-keeping performance. However, both of these studies were conducted with earlier generation mp3 players that did not have touchscreen user interfaces that dominate the current portable device market.

Multiple studies on navigation devices have shown that visual-manual destination entry results in decrements in driving performance in both simulator and on-road studies. These decrements include deterioration in lane keeping, more frequent glances at the device, and greater periods of driving with eyes off the road. A study by Chiang, Brooks and Weir (2004) showed that drivers looked at the navigation device 50% more of their driving time while completing destination entry tasks. It is important to note that whereas the aspects of navigation systems draw significant, and risky, proportions of driver attention, at least one study (Srinivasan & Jovanis, 1997) has shown that these performance decrements are less severe than those associated with paper-based maps.

One of the first naturalistic driving studies sponsored by NHTSA, commonly known as the 100-Car Study (Klauer, et al., 2006), was conducted by Virginia Tech Transportation Institute, in which 100 cars in Northern Virginia were instrumented with a variety of sensor systems including a navigation system. Analyses of recorded video data allowed researchers to determine whether the drivers were distracted in the moments leading up to the crashes or near-crashes. The researchers also analyzed video clips when the drivers were engaging in secondary tasks. By comparing distractions during normal driving to distractions during crashes and near-crashes, estimates were made of the relative risk of crashes/near-crashes when drivers are distracted.

The 100-Car Study suggested that distraction is a common occurrence while driving. Many distractions appear to increase the relative risk of crashes and near-crashes, and distractions that require drivers to take their eyes off the road are potentially more of a safety problem than distractions that do not require drivers to take their eyes off the road. The researchers used the data to estimate the odds ratio or increased risk of engaging in various secondary tasks over "just driving." Table 2 below shows some of the results (statistically significant results are in bold). A significant odds ratio indicates the likelihood of an increase in risk associated with that activity. For example, Table 2 shows a driver is 3.38 times more likely to be in a crash or near-crash while reading and driving than if she/he were just driving normally.

Odds Ratio for Secondary Tasks in the 100-Car Study

Type of Secondary Task	Odds Ratio
Reaching for a moving object	**8.82**
Insect in Vehicle	6.37
Looking at External Object	**3.70**
Reading	**3.38**
Applying Makeup	**3.13**
Dialing a Hand Held Device	**2.79**
Inserting/retrieving CD	2.25
Eating	1.57
Reaching for a Non-Moving Object	1.38
Talking/Listening to a Hand-Held Device	1.29
Drinking from an Open Container	1.03
Other Personal Hygiene	0.70
Adjusting the Radio	0.50
Passenger in the Adjacent Seat	**0.39**
Child in Rear Seat	0.33

Table 2. Odds Ratio for Secondary Tasks in the 100-Car Study (see Klauer, et al., 2006; p. 30)

Between 2005 and 2007, NHTSA conducted the National Motor Vehicle Crash Causation Survey (NMVCCS) to collect on-scene information on the events and factors leading up to crashes that involved light vehicles. Only crashes in which EMS was dispatched to the crash scene were examined. Information on the driver-, vehicle-, environment-, and roadway-related factors was collected immediately after the crash occurrence. The information was collected from driver and witness interviews, as well as vehicle and scene assessments by the researchers. Over 5,400 crashes comprise a nationally representative sample for analysis (National Highway Traffic Safety Administration, 2008a, 2008b).

In cases where the NMVCCS researchers attributed the critical reason for the critical event that precipitated the crash to the driver, about 41 percent of the critical reasons were recognition errors (e.g., inattention, internal and external distractions, inadequate surveillance). The most frequent recognition error was inadequate surveillance which was assigned to drivers in approximately 20 percent of the crashes. Internal distraction was assigned to drivers in approximately 11 percent of the crashes (National Highway Traffic Safety Administration, 2008a, p.24).

NHTSA published a subsequent report on distracted driving utilizing NMVCCS data (Singh, 2010). The NMVCCS weighted data were analyzed with a focus on distracted driving and the influence that other associated factors such as driver age and gender, roadway traffic flow, speed limit, and environmental conditions may exert on drivers' engagement in non-driving activities. NHTSA examined two categories of inattention: internal sources of distraction (e.g., conversing with a passenger, dialing or hanging up a phone, talking on the phone, adjusting radio/CD player)

and non-driving cognitive activities (e.g., thinking about personal, financial or family problems). The analysis was based on an estimated 2,188,970 NMVCCS crashes and an estimated 3,889,775 drivers involved in these crashes (Singh, 2010, p. 3).

Among 14 internal sources of distraction, conversing with a passenger was the most frequently recorded source. Seventeen percent of the crash-involved drivers were distracted from at least one internal source, and of these, 57 percent were conversing with passengers and 11 percent were engaged in phone use (talking on phone, dialing/hanging up, texting). Another seven percent of crash involved drivers were engaged in retrieving objects from the floor or seat and another seven percent were looking at the actions of other occupants (Singh, 2010, pp. 6-7).

Though available data to date indicate that other activities are more frequently associated with driving-related distractions, use of electronic devices is an increasing concern. The Transportation Research Board, under its Strategic Highway Research Program 2 (SHRP2), has initiated a more comprehensive naturalistic driving study with a larger sample of drivers, which is expected to be more representative of the general driving public. When it is completed in 2015, it will provide more comprehensive data on the incidence of distracting activities among drivers and better information on the contribution of distracting activities to crash causation in passenger vehicles.

NHTSA recently completed a naturalistic driving study with users of hand-held phones, portable hands-free phones, and integrated hands-free cell phone systems built-in to the vehicle. The study estimated the frequency of use and the distraction potential associated with each interface type. Over 200 drivers (who reported talking on a cell phone while driving at least once per day) were continuously recorded for an average of 31 days. Data acquisition systems in the participants' own vehicles recorded video and kinematic data. Drivers provided their cell phone records (calls and text messages) for analysis. The study investigated cell phone use, driver performance, and safety critical event risk. NHTSA is working towards publishing the findings of this study in 2013.

METRICS TO DETERMINE THE NATURE AND SCOPE OF THE DISTRACTED DRIVING ISSUE

Broadly speaking, there are three general types of studies that have been used to study distraction: crash-based, observational (including naturalistic) and experimental. Each has its advantages and disadvantages (see World Health Organization, 2011, p. 19), but each approach also produces useful information and collectively provides insight into the problem of driver distraction.

Crash risk alone is insufficient to properly characterize the driver distraction problem because how much a driver engages in distracting activities also has a significant role in determining the overall relative risk of a given distraction source. Observational studies, including naturalistic driving studies and surveys, have been used to estimate both the frequency and duration of distracting activities performed by drivers. Experimental methods, including test tracks and simulators, have been used to explore how distraction sources affect driving performance, such as in slower reactions to critical events, speed and vehicle position maintenance, and eyes-off-road time. Each of these method categories is discussed below.

Crash Risk Assessment Methods

Currently, NHTSA has three primary sources of data from which to assess the involvement of distraction in a crash. The Fatality Analysis Reporting System (FARS) is a census of all fatal motor vehicle crashes on public roads in which a person died within 30 days of the crash. Data for the National Automotive Sampling Systems (NASS) General Estimates System (GES) come from a nationally representative sample of police-reported motor vehicle crashes of varying severity – from property damage only to fatal. NASS/GES provides estimates of the number of injured persons, as well as the severity of the injuries. Both these systems rely on the police accident report (PAR) as their primary data sources for recording whether distraction was a contributing factor in the crash. Estimating the role of distraction from these crash databases is challenging because of difficulties in making post-crash determinations of the role of distraction in crash causation and because police crash reports vary across jurisdictions, thus creating potential inconsistencies in reporting. The third source of distraction data is an in-depth, on-scene investigation based crash data source, such as the National Motor Vehicle Crash Causation Survey (NMVCCS), which was addressed under an earlier section.

Prior to 2010, FARS and NASS/GES collected distracted driving information in different formats. FARS was more general and included generally inattentive behavior, while NASS/GES specified specific distracted driving behaviors. Beginning in 2010, the two systems' coding was unified, so that FARS data collected prior to 2010 cannot be compared to FARS data from subsequent years. Because of these changes, any crash in which the driver is identified as distracted at the time of the crash is termed a "distracted-affected" crash (see National Highway Traffic Safety Administration, 2012).

Many data items on the Police Accident Report (PAR) are common across States, but distraction is not one of them. Some PARs identify distraction as a distinct reporting field, while others do not. When there is no distinct reporting field, identification of distraction is based upon the narrative portion of the PAR. The variation in reporting forms contributes to variation in the reported number of distraction-affected crashes. Any national or State count of distraction-affected crashes should be interpreted with this limitation in mind due to potential under-reporting in some States and primary sampling units and over-reporting in others.

As part of the data improvement efforts set forth in the Distraction Plan (National Highway Traffic Safety Administration, 2010), NHTSA has leveraged the Model Minimum Uniform Crash Criteria Guideline (MMUCC) as a minimum, standardized data set for describing motor vehicle crashes and the vehicles, persons and environment involved. While voluntary, the Guideline is designed to generate the information necessary to improve highway safety within each state and nationally. This data set was revised in 2012 in response to emerging highway safety issues, such as distracted driving. The new distracted driving data elements in the Guideline are more descriptive and include attributes such as manually operating an electronic communications device; talking on hands-free electronic device; talking on hand-held electronic device; other activity; electronic device; passenger; other inside the vehicle (eating, personal hygiene, etc.) and outside the vehicle (see Department of Transportation, 2012b). States will be able to use federal funding authorized under MAP-21 to make improvements in their crash and other related data systems and comply with the new MMUCC Guideline (Fourth Edition).

In 2011, there were a total of 29,757 fatal crashes in the United States, of which 3,020 (or 10% of all crashes) involved distraction. Distraction was reported for 7 percent (3,085) of the drivers involved in fatal crashes. In these distraction-affected crashes, 3,331 fatalities (10% of overall fatalities) occurred. Of those drivers distracted during a fatal crash, cell phones are often a leading distraction (of those distractions that were identified). Cell phones were reported as a distraction for 12 percent of the distracted drivers in fatal crashes (National Highway Traffic Safety Administration, 2013a).

In 2011, an estimated 2,217,000 people were injured in motor vehicle traffic crashes. The number of people injured in distraction-affected crashes was estimated at 387,000 (17% of all injured people). An estimated 21,000 people injured in distraction-affected crashes in 2011 involved cell phones (i.e., 5 percent of persons injured in distraction-affected crashes) (see National Highway Traffic Safety Administration, 2013a).

Observational Methods

Observational surveys, as conducted under the National Occupant Protection Use Survey (NOPUS), use stationary observers to record electronic device use by drivers as they pass selected locations. Observational surveys allow the recording and tracking of electronic device use, but it is limited to a single point in time. Unlike observation of seat belt use, in which one may conclude that if the seat belt is worn, it was worn for the duration of the trip; cell phone use is sporadic in that the phone may not be in use for the duration of the trip.

In 2011, observational surveys indicated that the percentage of drivers holding cell phones to their ears while driving was five percent, which translates to 660,000 vehicles driven by people using hand-held cell phones during a typical daylight moment (National Highway Traffic Safety Administration, 2013b). In addition, the percentage of drivers who were text-messaging or visibly manipulating hand-held devices while driving increased significantly for a second year in a row from 0.9 percent in 2010 to 1.3 percent in 2011. The 2011 NOPUS also found that hand-held cell phone use was higher among female drivers than male drivers. Both hand-held cell phone use and visibly manipulating hand-held devices while driving was higher among drivers age 16-24 than drivers in other age groups.

Survey Methodologies

Another method for quantifying the scope of distracted driving is through the use of phone or other self-reported surveys. These surveys provide insight into who may be engaging in secondary tasks and how frequently, but the data are limited by self-reported behavior, low response rates, and response social desirability. In 2010, NHTSA conducted a national phone survey (cell phone and landlines) (Tison, et al., 2011) on distracted driving attitudes and behaviors. The survey involved a national sample of 6,002 drivers 18 and older, and the findings were consistent with other research findings indicating that despite the well-publicized dangers of distracted driving, many Americans choose to use cell phones while driving.

Among the behaviors that drivers reported doing on at least some trips:

- 80% talked to other passengers;

- 66% adjusted the car radio;
- 51% used a navigation system;
- 46% ate or drank;
- 41% made or accepted phone calls;
- 30% used a portable music player with speakers;
- 27% interacted with children in the back seat;
- 26% used a smartphone for driving directions;
- 22% changed CDs, DVDs, or tapes;
- 10% read e-mail or text messages;
- 6% did personal grooming;
- 6% sent text messages or email.

None of the distractions listed above is easily addressed. While some of these findings mirror those reported by Ranney (2008), it is important to note that many of the studies on distracted driving and its consequences were conducted prior to the proliferation of text messaging, GPS navigation systems, and other newly developed technologies. Consequently, it is possible that distraction-affected crashes will escalate as the use of new technologies continues to increase.

This survey also found that young drivers were more likely to report they have sent text messages or e-mails while driving; about half (49 percent) of those 21 to 24 years old reported ever doing so. More than half of all respondents believed that using a cell phone makes no difference on their driving performance, while one-quarter indicated that sending a text message/e-mail makes no difference on their driving performance. Yet as passengers, 90 percent said they would feel very unsafe if their driver was texting/e-mailing while traveling with them, and about one-third felt very unsafe if a driver was talking on a cell phone.

Males and younger respondents tend to underestimate the risks cell phone use had on their driving abilities. Moreover, those who were members of families in the upper income tier (above $100K) reported higher incidence of cell phone use while driving and they too tended to underestimate the risk. Additionally, one-third of drivers 18 to 24 years old indicated they can take their eyes off the road for 3 to 10 seconds or more before driving becomes significantly more dangerous.

These findings are consistent with other research findings indicating that despite the well-publicized dangers of distracted driving, many drivers choose to use cell phones while driving. Drivers may feel the risk and consequences of doing so don't apply to them. Survey data suggest that drivers who use cell phones and/or text while driving believe that other users pose a greater danger than they do.

A subsequent nationally representative telephone survey (landline and cell phone) was conducted in 2012 (Schroeder, Meyers & Kostyniuk, 2013) and found little change in reported behaviors such as talking to passengers, eating or drinking while driving or reading while driving compared to the 2010 survey. For example, approximately half of respondents (52 percent in 2010 and 49 percent in 2012) reported they always or almost always talked to passengers while driving. While the proportion of respondents who always or almost always reported answering the phone while driving decreased between 2010 and 2012 (33 percent and 28 percent, respectively), the percentage of drivers who reported ever sending text messages while driving increased slightly from 12 percent in 2010 to 14 percent in 2012. Support for laws banning hand-held cell phone use increased from

68 percent of all respondents in 2010 to 74 percent in 2012, while support for laws banning texting or e-mailing remained about the same (93 percent of respondents in 2010 and 94 percent of respondents in 2012).

Experimental Methods

Experimental studies have served a more diagnostic role in describing the effects of distraction on driving performance. Whereas crash data and observational methods determine crash risk and exposure, experimental studies help to define the specific performance decrements that may result in greater crash risk. Experimental studies take place in controlled environments such as simulators or test tracks. While driver behavior can be closely monitored in a controlled experiment, it is difficult to assess the crash consequences of reduced driving performance as the situation is often not realistic. The history of experimental studies exploring driver distraction research is too vast to cover comprehensively here. The reader is referred to Regan, Lee and Victor (2013) and Regan, Lee and Young (2009) for comprehensive reviews on driver distraction and associated methodologies. However, recent emphasis in the empirical literature has been on identifying discriminatory tasks and measures to determine the relative distraction potential of different sources.

Visual attention, generally, and eyes-off-road time, specifically, are important measures that have direct association to crash risk. These metrics measure where the driver is looking when performing a distracting task while driving (or performing a simulated driving task), and have been used in both naturalistic driving studies and experimental studies (see Victor, Engstrom, & Harbluk, 2009, for a review). Two methodologies are generally used to measure where drivers are fixing their gaze: (1) eye-tracking technology and (2) cameras mounted in the vehicle that capture the driver's face. Eye trackers provide a more direct measure of where drivers are looking, but they have several limitations. Eye trackers have accuracy problems, are difficult to use, and are expensive (tens of thousands of dollars) to include in naturalistic driving studies where dozens of drivers typically participate with their own vehicles. The camera-based approach is more adaptable to larger data collections, but the precision of determining where drivers are looking typically is much cruder. Regardless of the approach, visual attention measures have emerged as the dominant distraction measure, and for good reasons. Risk data clearly show the greatest concern is visual-manual distractions. Indeed, that is why NHTSA's first set of Distraction Guidelines focused on visual-manual distractions.

Recognizing the high resource requirements for measuring visual attention with eye trackers or in-vehicle cameras, there was renewed interest in an older measure of visual attention developed by Senders and colleagues in the 1960s. The visual occlusion technique (see Gelau & Krems, 2004, and Foley, 2009) is a surrogate approach for measuring visual attention that uses special goggles to alternatively allow the driver to see the distraction device and to occlude, or obscure, the driver’s vision. This cycle of making vision unavailable and available is intended to simulate drivers’ visual attention to the road while interacting with an in-vehicle device. The occluded, or "blind," periods represent the times when the driver would be looking at the roadway. If a task can be completed efficiently with intermittent brief glances, then it is considered to be relatively easy to resume after visual interruptions. The assumption is that a highly resumable task represents one of low visual demand and therefore is acceptable for use while driving. The visual occlusion technique has been introduced by the International Standards Organization (ISO) as a standard for assessing visual

demand from in-vehicle systems (ISO, 2007). NHTSA included an occlusion method protocol in its Visual-Manual Driver Distraction Guidelines.

In addition to visual attention measures, there are several measures of driving performance that have been used in distraction research. These measures focus on identifying changes in the way drivers control the vehicle and react to events rather than on where they look. Measures of vehicle control such as speed, headway, lane keeping, steering wheel angle, and event reaction times have been used in experimental studies conducted on the topic of driver distraction, across a range of experimental settings (see Young, Regan, & Lee, 2009, for an overview). Whereas these measures offer direct connection between drivers engaging in distracting activities and effects on driving performance, the connection between the various driving performance measures and crash risk is much less well understood. For example, several studies have shown that engaging in distracting visual-manual tasks results in inferior lane keeping performance, but there is no strong evidence that links poor lane keeping performance and crashes. These surrogate measures are helpful for understanding how driving performance is affected by distractions, but connecting those performance decrements with crash risk has been a limitation.

STRATEGIES FOR REDUCING DEATHS AND INJURIES

The most effective means to combat almost any traffic safety issue are those that address the issue on several different fronts. Education, engineering (both within the vehicle and on the roadway), and enforcement (including legislation) approaches, in combination, can be effective in changing driver behavior. Several different countermeasures are currently being implemented to address distracted driving, many modeled after those shown to be successful in other areas of traffic safety.

Methods to Enhance Education and Awareness of Distracted Driving

There are various methods to enhance education and awareness of traffic safety issues, including driver distraction. The following strategies are addressed in this section: Communications and Outreach Programs, Employer Programs, Graduated Driver Licensing for Beginning Drivers, and Legislation.

Communications and Outreach Programs

It is well known that education campaigns by themselves are unlikely to change behavior, especially if the intervention is an isolated event rather than a sustained program over time (NCHRP, 2005). As pointed out in *Countermeasures That Work* (University of North Carolina, 2013) there are no studies that have documented the effects of public information campaigns on driver knowledge, attitudes and behaviors regarding distracted driving. That said, communication campaigns remain a means to alert a large population about a problem.

Many organizations have developed or conducted distracted driving communications and outreach campaigns directed to the general public. Some carry a general “pay attention” message, while others are directed at specific behaviors such as cell phone use. Recently, the U.S. Department of Transportation launched a national campaign titled “Put It Down” to discourage the public from driving distracted (www.distraction.gov). Other campaigns include Oprah Winfrey’s “No Phone

Zone" (www.oprah.com/packages/no-phone-zone.html), the National Safety Council's "On the Road, Off the Phone" (www.focusdriven.org), the American Academy of Orthopedics Surgeons' "Decide to Drive" (www.decidetodrive.org), and AT&T's "It Can Wait" (http://itcanwait.com).

Driving while distracted is a particular concern with teenage drivers (Goodwin, Foss, Harrell, & O'Brien, 2012; National Highway Traffic Safety Administration, 2012). A growing number of states are including distracted driving as a required component of driver education, the driver license test, or information provided in the driver license manual (Governors Highway Safety Association, 2010). Some States have also developed their own education materials and programs aimed at teen drivers.

A recent survey by the Governors Highways Safety Association (GHSA) found that 37 States and the District of Columbia have implemented public information/education campaigns to address distracted driving. In addition, a number of States have developed distracted driving public service announcements (PSAs).

Fifteen States as well as NHTSA now use social networking sites to educate motorists about distracted driving (Governors Highway Safety Association, 2010). Sites such as Facebook, Twitter, and YouTube can reach large numbers of people inexpensively. Social networking sites are especially popular among young people, who are often a primary target of distracted driving campaigns.

NHTSA also maintains Distraction.gov and TrafficSafetyMarketing.gov; both of which have a significant amount of information, available for free, for use by traffic safety advocates to educate and inform their local population about the dangers of distracted driving. These sites also provide materials to support increasing the knowledge and awareness of this dangerous behavior.

Employer Programs

Legally, employers can be held accountable for employees who are using a cell phone (or otherwise distracted) and who are involved in a crash while working (National Safety Council, 2012). Employers can protect themselves by implementing policies that prohibit distracted driving and by monitoring compliance. In fact, Regan, Young and Lee (2009) point out that employers are in a particularly strong position to mitigate the effects of distracted driving and outline a range of initiatives that employers may undertake to prevent distracted driving crashes. These include company policies regarding data collection and analysis, exposure reduction, enforcement, education, training and technology design. New Jersey has developed a sample cell phone use policy for businesses, and the National Safety Council (NSC) has developed a policy kit to assist employers with implementing or strengthening a cell phone ban.

States can also assist employers in addressing distracted driving. Sixteen States and the District of Columbia are working with employers in their States to develop distracted driving policies (Governors Highway Safety Association, 2010). Some States, such as Delaware and Kentucky, have established corporate outreach programs related to distracted driving (Governors Highway Safety Association, 2010). The programs usually involve dissemination of traffic safety materials to employers, or sometimes directly to the employees themselves. States can also assist employers in promoting and enforcing policies to reduce distracted driving.

The Network of Employers for Traffic Safety (NETS) developed an employer tool kit in conjunction with the 2011 Drive Safely Work Week (DSWW) in partnership with the U.S. Department of Transportation. NETS provided this comprehensive tool kit for free, and employers can download it to help plan their campaign activities. The DSWW materials, also available in Spanish, are designed to support employer efforts to initiate or sustain a corporate mobile device policy and to increase awareness of behaviors that contribute to distracted driving-related incidents.

Graduated Driver Licenses for Beginning Drivers

Graduated driver licensing (GDL) is designed to provide novice drivers with substantial driving experience in low-risk settings. It consists of three-phases: a learner permit, provisional license, and full license. The learner permit phase typically lasts 6 months or more, and allows driving only while supervised by a fully licensed driver. The provisional license allows unsupervised driving with certain restrictions. Some of these restrictions include nighttime driving, passengers, and cell phone use.

All 50 States and the District of Columbia have some GDL components in place. According to a recent analysis by the Governors Highway Safety Association, laws in 45 States and the District of Columbia limit the number of passengers allowed with a driver with a provisional license for some period of time (Governors Highway Safety Association, 2013). As of March 2013, thirty-three States and the District of Columbia ban all cell phone use by novice drivers (Governors Highway Safety Association, 2013).

Several studies document that nighttime and passenger GDL restrictions reduce teenage driver crashes and injuries (Hedlund & Compton, 2005; Williams, 2007). The only evaluation of a GDL cell phone restriction suggests these laws may have little effect on teenage drivers' cell phone use (Foss, Goodwin, McCartt, & Hellinga, 2009; Goodwin, O'Brien, & Foss, 2012).

Under the recent surface transportation authorization, Moving Ahead for Progress in the 21st Century (MAP-21) one of the requirements for a State to receive a GDL grant is that it must enact a statute that "…requires distracted driving issues to be tested as part of the State driver's license examination." This provision may lead States to re-examine their existing statutes with respect to driver licensing.

Cell Phone and Text Messaging Laws

According to the Governors Highway Safety Association's March 2013 analysis, talking on a hand-held cell phone while driving is prohibited in ten States (California, Connecticut, Delaware, Maryland, Nevada, New Jersey, New York, Oregon, Washington, and West Virginia), the District of Columbia, Puerto Rico, Guam and the U.S. Virgin Islands (Governors Highway Safety Association, 2013). With the exception of Maryland and West Virginia, the cell phone bans in each of these States are primary laws. However, West Virginia's law will become primary in July 2013. In addition, several local jurisdictions such as Chapel Hill, North Carolina; Chicago, Illinois; and Cheyenne, Wyoming, have enacted their own restrictions on cell phones. Currently, no State restricts hands-free phone use for all drivers. In addition, as of March 2013, 39 States, the District of Columbia, Puerto Rico, Guam and the U.S. Virgin Islands prohibit text messaging for all drivers. All but four have primary enforcement (Governors Highway Safety Association, 2013).

There is strong public support for laws to reduce distracted driving. For example, over 90 percent of respondents in a 2012 phone survey conducted by NHTSA support laws that ban texting while driving while 74 percent support laws banning talking on a hand-held cell phone while driving (Schroeder, Meyers & Kostyniuk, 2013).

MAP-21 created a new distracted driving grant program, authorizing incentive grants to States that enact and enforce laws prohibiting distracted driving. To qualify for FY 2014 grants, States had to enact and enforce primary laws that prohibit texting while driving and also prohibit drivers who are younger than 18 years of age from using cell phones while driving. To qualify for FY 2013 grants, States could either meet the comprehensive FY 2014 requirements, or enact and enforce primary laws that prohibit drivers from texting while driving. In FY 2013, eight (8) States qualified by passing conforming legislation under the prohibition on texting while driving requirements. Those States and their award amounts are as follows:

State	FY 13 Award
Arkansas	$755,643
Georgia	$1,630,133
Maine	$459,082
Minnesota	$1,224,866
North Dakota	$459,082
Rhode Island	$459,082
West Virginia	$459,082
Guam	$153,027

In FY 2014, the State of Connecticut qualified under the comprehensive requirement and received an award in the amount of $2,312,000.

In a review of the research on cell phones and driving, McCartt, Hellinga and Braitman (2006) noted that observation studies conducted in New York, Washington, DC and the United Kingdom found that cell phone laws reduce hand-held phone use by about 50 percent shortly after the laws take effect. These reductions do not necessarily persist. In a subsequent study of the long-term

effects laws on hand-held phone use, McCartt, Hellinga, Strouse, and Farmer (2010) argue that the reductions in hand-held cell phone use in three jurisdictions were maintained three to seven years later because the cell phone use rate while driving would have been much higher had no law been in effect. However, examination of the data indicated that while the observed hand-held cell phone use was lower than the predicted rate, the long-term post-law observations were higher in one jurisdiction than the baseline observations. It may be that exposure to cell phones while driving was greater five to seven years later, thus leading to higher observed usage.

The effectiveness of hand-held cell phone bans in reducing crashes is unclear. Nikolaev, Robbins, and Jacobson (2010) examined driving injuries and fatalities in 62 counties in New York State both before and after a hand-held cell phone ban took effect. Forty-six counties showed a significant decrease in injury crashes following the ban, and 10 counties showed a decrease in fatal crashes. While encouraging, the study did not include a control group to account for other factors that may have decreased crashes.

As reported in *Countermeasures That Work* (University of North Carolina, 2013), the Highway Loss Data Institute investigated State-level automobile insurance collision claims in California, Connecticut, New York and the District of Columbia. When compared to neighboring States, there was no change in collision claim frequency after these jurisdictions implemented hand-held cell phone bans. However, the data from the Highway Loss Data Institute is proprietary and an independent analysis of the data has not been conducted. Moreover, not all crashes result in a collision claim, and many collision claims result from very minor damage, so collision claim rates may differ from injury crash rates.

Countermeasures That Work reported only one study that examined the effectiveness of laws prohibiting texting while driving. The Highway Loss Data Institute found States that enacted a texting ban showed a small increase in collision claim frequency compared to neighboring States without such bans. The authors propose that a possible explanation for this finding may be that texting drivers attempt to avoid detection by hiding their phones from view, resulting in more time with drivers' eyes off the roadway.

As with any law, costs are associated with publicizing and enforcing it. A hand-held cell phone law can be enforced during regular traffic patrol as drivers who are using a hand-held phone can be easily observed. However, some States with cell phone bans allow drivers to use a phone for specific purposes while driving (e.g., navigation), which can make enforcement more challenging. Enforcing texting bans is more problematic as it is often difficult to detect drivers who are manipulating their phones.

High Visibility Cell Phone and Text Messaging Enforcement Campaigns

High visibility law enforcement programs increase a driver's perception of the likelihood of being ticketed for violating a particular traffic safety law. High visibility enforcement programs combine active law enforcement with paid and earned media that emphasizes the heightened enforcement. This approach has been shown to be effective in increasing seat belt use and reducing alcohol-impaired driving. NHTSA recently examined whether the HVE model could be effective in reducing hand-held cell phone use and texting among drivers.

To test this approach with distracted driving, in April, 2010 NHTSA launched two pilot high visibility enforcement programs in Hartford, Connecticut and Syracuse, New York to assess whether increased law enforcement efforts combined with paid media and news announcements can get distracted drivers to put down their cell phones and focus on the road. The pilot programs, "Phone in One Hand. Ticket in the Other" were the first efforts in the country to specifically focus on the effects of increased enforcement and paid advertising on reducing distracted driving. Law enforcement officers conducted four waves of enforcement from April 2010 to April 2011. Paid media (TV, radio, and online advertisements and billboards) and earned media (e.g., press events and news releases) supported the enforcement activity. Enforcement officers actively sought out cell phone users through special roving patrols, or through spotter techniques where a stationary officer will radio ahead to another officer when a driver using a cell phone is detected. Officers reported that higher vantage points, SUVs, and unmarked vehicles assisted in identifying violators (Cosgrove, Chaudhary, & Reagan, 2011).

Results from this program showed hand-held cell phone use among drivers dropped 57 percent (from 6.8% to 2.9%) in Hartford and 32 percent (from 3.7% to 2.5%) in Syracuse (Cosgrove, Chaudhary, & Reagan, 2011). The percentage of drivers observed manipulating a phone (e.g., texting or dialing) also declined. Public awareness of distracted driving was already high before the program, but surveys suggest awareness of the program and enforcement activity increased in both Hartford and Syracuse. Surveys also showed most motorists supported the enforcement activity.

In summer 2012, California and Delaware were selected to receive federal support for pilot programs that will examine whether increased police enforcement coupled with paid media and news media coverage can significantly reduce distracted driving over a larger, more populated area. Both projects are under way. The multi-market efforts in these states mirror the approach used in smaller-scale demonstration projects. The California program is taking place in the Sacramento valley region comprising nine counties and 3.9 million residents, while the Delaware program is being conducted statewide.

In addition to the State distracted driving projects, in October 2012, NHTSA announced grant awards to Connecticut and Massachusetts to help plan and conduct high-visibility anti-texting enforcement programs. Each State will develop and train police officers on methods for spotting drivers who are texting (versus drivers using a hand-held cell phone, which was the focus of the previous demonstrations), and develop media techniques that alert the public to the dangers of texting and driving. This two year project is patterned on the experience in Hartford and Syracuse; however, as less than 5 percent of the overall citations were issued for texting while driving, NHTSA decided to undertake a project to develop and test strategies to effectively enforce anti-texting laws. In addition, given the high cost of paid media, this project will utilize earned media to alert drivers about the enforcement effort.

Vehicle Technologies

As noted earlier, the second and third initiatives in the NHTSA Distraction Program Plan (National Highway Traffic Safety Administration, 2010) involve vehicle approaches for reducing distracted driving. The second initiative focuses on how to minimize workload demands for the use of in-vehicle and portable technologies, while the third initiative focuses on evaluating crash avoidance technologies to keep distracted drivers and passengers safe (e.g., use of crash warning systems and distraction monitoring systems).

Minimizing workload demands on the driver from in-vehicle and portable technologies is directly related to the degree to which drivers' attention is diverted away from the primary driving task by the user interfaces of those devices. How the driver must attend to and interact with the device affects the degree to which drivers are able to perform primary driving tasks, such as event or object detection, and maintain vehicle control. In addition, some user interfaces require many button presses to operate them. Consequently, one way to minimize the risk is to establish device-related distraction assessment metrics (e.g., total eyes off road time, maximum glance duration) that can provide information to help identify which design features are the least disruptive to the driving task. NHTSA has chosen to issue voluntary distraction guidelines in an effort to provide system designers and developers appropriate assessment tests and performance criteria to help ensure new technologies are not too demanding of the driver's attention. NHTSA proposed the first set of voluntary guidelines that target the visual-manual interaction between the driver and integrated in-vehicle devices in 2012 and finalized them on April 26, 2013. NHTSA is planning development of a second phase of guidelines that would address portable and aftermarket devices, including electronic devices such as smart phones, electronic tablets and pads, and other mobile communications devices. A third phase of guidelines is planned to address voice-based user interfaces for both integrated and portable and aftermarket devices.

As part of its comprehensive approach to the distraction issue, NHTSA is also evaluating crash avoidance technologies that will help warn distracted drivers in an effort to mitigate potential crashes due to distraction. The manner in which crash avoidance systems warn drivers (e.g., auditory alarms, vibrating seats) is a critical component to successfully getting drivers to respond sooner to critical crash events without creating adverse effects, such as driver confusion, inappropriate responses, distraction, and automation complacency. The warning-user interface should be tailored to the capabilities of the crash prevention system as well as to the capabilities and limitations of the driving population. To help ensure that the crash warning systems provide distracted drivers an overall benefit, NHTSA is pursuing the Crash Warning Interface Metrics (CWIM) project, which will develop a set of test protocols to compare how they affect the drivers' crash avoidance responses. The CWIM project is due to be completed in late 2013.

In addition to crash avoidance technologies, NHTSA has investigated the effectiveness of cell phone blocker technologies as a means for reducing distraction. In recent years, several manufacturers have created systems that can block a cell phone from making (or receiving) calls while a person is driving. These systems detect when the phone is in motion. During that time, incoming calls are automatically diverted to voicemail and incoming text messages are not shown until the driver reaches his or her destination. Typically, these systems allow exceptions for phone calls from pre-specified numbers, and all allow emergency calls to 911. Although these systems are

potentially applicable to all drivers, they have largely been targeted to parents of teen drivers. NHTSA completed a field investigation of two cell phone blocker approaches, one software based and the other both hardware and software based. The results of this study should be published in 2013.

Another key area of research that has potential to significantly reduce crashes is DOT's Connected Vehicle program. NHTSA is partnering with the Research and Innovative Technology Administration's (RITA) Intelligent Transportation Systems Joint Program Office and the Federal Highway Administration to develop and test technology designed to help vehicles communicate with one another. NHTSA believes that vehicle-to-vehicle (V2V) safety technologies could help drivers avoid or reduce the severity of four out of five unimpaired vehicle crash scenarios. As part of the Connected Vehicle program, RITA initiated a year-long field test program called Safety Pilot Model Deployment, which was initiated in August 2012, in Ann Arbor, Michigan. Nearly 3,000 cars, trucks and buses equipped with "connected" Wi-Fi technology to enable vehicles and infrastructure to "talk" to each other in real time to help avoid crashes and improve traffic flow began traversing the streets.

Conducted by University of Michigan's Transportation Research Institute (UMTRI), the model deployment is a first-of-its-kind test of connected vehicle technology in the real world. The test cars, trucks and buses, most of which have been supplied by volunteer participants, are equipped with V2V and vehicle-to-infrastructure (V2I) communication devices that will gather extensive data about system operability and its effectiveness at reducing crashes. The model deployment vehicles will send electronic data messages, receive messages from other equipped vehicles, and translate the data into a warning to the driver during specific hazardous traffic scenarios. Such hazards include an impending collision at a blind intersection, a vehicle changing lanes in another vehicle's blind spot, or a rear collision with a vehicle stopped ahead, among others.

A key aspect of the Connected Vehicles program is the Human Factors for Connected Vehicles program, which is dedicated to ensuring the new V2V and V2I technologies do not impose additional workload or distraction on the driver. The ability to establish the basic principles of attention and distraction within the context of Connected Vehicle technologies is a challenging effort whose outcomes will form the parameters for and guide consistent development of safer systems and interfaces for countless new applications across a wide and diverse set of manufacturers. Consistency and adherence to basic countermeasures for distraction, when developing new applications, is paramount to ensuring ultimate safety for the driver. NHTSA is leading this human factors research effort that will develop more robust algorithms for prioritizing safety and for prioritizing messages that assist the driver as opposed to providing greater distraction or workload.

Roadway Engineering

There are no roadway countermeasures directed specifically at distracted drivers. Many effective roadway design and operation practices that improve traffic safety in general, such as edge line and centerline rumble strips, can warn distracted drivers or mitigate the consequences if they leave their travel lane; however, the effects of these have not been researched.

RECOMMENDATIONS

Distracted driving is a complex issue. Technologies continue to evolve at a rapid and unparalleled pace. NHTSA has made strides toward understanding the distracted driving problem but there is more to be done. It is important to continue research from a variety of angles and methodologies, identify sources of distraction and evaluate the effectiveness of behavioral and technological countermeasures. In addition, it is important to continue to work to improve data collection to characterize better the consequences of distracted driving. For States and communities to achieve significant reductions in distracted driving-related crash injuries and fatalities, a combination of components needs to be in place that addresses legislation and policy, enforcement, communication, education and evaluation. Both the *Driver Distraction Plan* (National Highway Traffic Safety Administration, 2010) and the *Blueprint for Ending Distracted Driving* (Department of Transportation, 2012a) offer approaches for moving forward.

1. Improve data collection and analysis.
    - Develop consistent methods to identify the role of distraction in crashes.
    - Provide new techniques to assist crash investigators in identifying when distractions are present at the time of a crash.
    - Utilize SHRP2 data (as it becomes available) to understand better which types and circumstances of distraction create the greatest risk of a crash.

2. Address technology.
    - Develop guidelines for portable and aftermarket devices, as well as voice-based user interfaces.
    - Continue to evaluate advanced crash warning systems and driver monitoring technologies.

3. Enact and enforce strong laws.
    - While it will be several years before there is conclusive evidence of the effect of cell phone laws, NHTSA believes it is prudent to address the problem with methods that have proven effective time and again with other high-risk driver behaviors. Strong laws and appropriate law enforcement have been effective in reducing drunk driving and increasing seat belt use. Experience in Syracuse and Hartford suggests that this combination of laws and enforcement can work for cell phone use as well.
    - Develop and test strategies and tools to assist law enforcement in enforcing bans on texting while driving.
    - Currently, 39 States have enacted anti-texting laws and 10 States have passed laws banning all hand-held cell phone use. Encourage the remaining 11 States to pass anti-texting laws.

4. Educate drivers.

- Encourage all drivers to understand the risks of distracted driving and recognize their own limitations to engage in these behaviors while driving.
- Continue to encourage the implementation of state laws, local ordinances, workplace policies and organizational resolutions that address the dangers of distracted driving.
- Continue to work with local, state and national partners to update driver education curricula to include the latest information on distracted driving.

NHTSA will continue to focus its efforts on these recommendations and actions, while examining ongoing research to ensure that any future programmatic efforts are driven by the best available and relevant data. Together these efforts can save lives and prevent injuries by reducing the frequency of distraction-related crashes.

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