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# DRIVER DISTRACTIONS AND TRAFFIC SAFETY

## STAFF REPORT PURSUANT TO 2000 SENATE RESOLUTION NO. 127, PRINTER'S NO. 1935

General Assembly of the Commonwealth of Pennsylvania
JOINT STATE GOVERNMENT COMMISSION
December 2001

# DRIVER DISTRACTIONS AND TRAFFIC SAFETY

2000 SENATE RESOLUTION NO. 127,
PRINTER'S NO. 1935

Staff Report
General Assembly of the Commonwealth of Pennsylvania
JOINT STATE GOVERNMENT COMMISSION
108 Finance Building
Harrisburg, Pennsylvania 17120
December 2001

The release of this report should not be interpreted as an endorsement by the members of the Executive Committee of the Joint State Government Commission of all the findings, recommendations and conclusions contained in this report.

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The Joint State Government Commission was created by act of July 1, 1937 (P.L.2460, No.459) as amended, as a continuing agency for the development of facts and recommendations on all phases of government for the use of the General Assembly.

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GENERAL ASSEMBLY OF THE COMMONWEALTH OF PENNSYLVANIA
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December 2001

TO THE MEMBERS OF THE GENERAL ASSEMBLY:

The Joint State Government Commission is pleased to present its staff report regarding driver distractions and traffic safety. This study was undertaken pursuant to 2000 Senate Resolution No. 127. The Commission recognizes with gratitude the assistance of the Pennsylvania Department of Transportation and the Pennsylvania State Police in gathering driver distraction data for this report.

Respectfully submitted,

Roger A. Madigan
Chair

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# EXECUTIVE SUMMARY

Concern about drivers being distracted by technology dates back to at least 1913, when windshield wipers became standard equipment on American cars leading to fears that drivers would become hypnotized by them.[1] Opportunities for driver distractions have increased in the intervening years as motoring has become more common, automobiles have become more automated, technology has continued to be developed, our nation has become more prosperous and commerce has stimulated and responded to demand.

Adaptive cruise control, which operates similarly to conventional cruise control, is being offered on some models of vehicles.[2] This radar based sensor monitors traffic ahead and has limited, automatic braking to reduce speed and prevent striking a leading vehicle.[3] "**[T]echnologies** offer drivers assistance in the form of information and, increasingly if the technology developers have their way, in the form of input into control. However, they **also offer the possibility of serious problems if drivers misuse them or become complacent because of them**."[4] These technologies include heading control systems to keep vehicles in their lanes, navigational systems to direct motorists to destinations, message channels to report traffic and emergency response to automatically call for assistance in an emergency.[5] Voice-based internet access is also expected to become available to motorists via General Motors' OnStar[6] and Wingcast.[7]

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[1] GM, GM Ability-Safety *at* http://gm.com/company/gmability/safety/senseable/milestones/milestones.html (last visited Oct. 26, 2001).

[2] Drivers.com, *High-tech Cars Cruising on Radar* (Sept. 11, 1999), *at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000226&static=1 (last visited Aug. 31, 2000).

[3] *Id.*

[4] Drivers.com, *Technology and the Driver* (Jan. 15, 1999), *at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000228&static=1 (last visited Aug. 31, 2000).

[5] *Id.*

[6] Drivers.com, *Coming to Your Car: the Internet* (Sept. 4, 1999), *at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000227&static=1 (last visited Aug. 31, 2000).

[7] The Hollywood Reporter.com, *Convergence* (July 12, 2001), *at* http://www.hollywoodreporter.com/hollywoodreporter/convergence/brief_display.jsp?vnu_content_id=955328 (last visited July 13, 2001).

Technology exists that tracks vehicles and telephonically identifies vehicles whose airbags have deployed.[8] Additional telematics systems being offered can be voice-activated. Among these are emergency and roadside assistance, operator assistance, traffic information, remote diagnosis of a vehicle's operating systems, and internet and multimedia connections.[9] "**All this technology appearing on new vehicles leads one to wonder whether drivers will be qualified to operate them efficiently and safely . . ..**"[10]

The popularity of consumer electronics products has increased for several reasons, but miniaturized wireless devices are portable making them usable in automobiles. **Driving an automobile is an overlearned skill and becoming easier thanks to advanced automotive technology; this allows a motorist to allocate spare mental capacity to secondary tasks.** These secondary tasks can be as common as listening to broadcast radio, which motorists have been doing for scores of years, and phoning, a more recent innovation. These secondary tasks can be technological or nontechnological. Numerous nontechnological distractions such as minding children and consuming food and beverage have likewise occurred in automobiles for scores of years. Just as the motor companies have designed and embedded cupholders in cars, they are designing and embedding electronic products in cars to capitalize on their popularity.

Distractions to drivers are disturbing because motorists sometimes wreck when distracted. Many of these crashes could have been averted had a driver not been distracted. U.S. Department of Transportation's National Highway Traffic Safety Administration estimates that 25-30 percent of crashes nationally are at least partially attributed to distracted motorists.[11] According to AAA Foundation for Traffic Safety's study, approximately 8.3 percent of vehicles in crashes nationally from 1995-99 involved a distracted driver.[12] **According to our Commonwealth's Department of Transportation, 3.5 percent of the crashes reported to police throughout Pennsylvania during 1999 and 2000 are at least partially attributed to distractions.**[13] The wide disparity between percentages from actual crash statistics and the estimates is commonly believed

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[8]The former could be used to recover a stolen vehicle. The latter is automatic collision notification. An operator receives an automatic transmission identifying the vehicle and its location. She then calls to determine whether emergency assistance is required. Drivers.com, *Auto Show about Vehicles or Information Technology?* (Jan. 13, 2000), *at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000255&static=1 (last visited Aug. 31, 2000).

[9]*Id.*

[10]*Id.*

[11]This estimate refers to injury and property-damage-only crashes. Nat'l Highway Traffic Safety Admin., U.S. Dep't of Transp., Research Note: Passenger Vehicle Driver Cell Phone Use Results from the Fall 2000 National Occupant Protection Use Survey (2001). This percentage likely includes fatigue and "looked but did not see."

[12]This is a weighted percentage. Jane C. Stutts et al., U. of N.C. Highway Safety Research Ctr., The Role of Driver Distractions in Traffic Crashes 9 (2001).

[13]*Infra* p. 95.

to result from distractions being underreported because they are largely self-reported.

**Part of the challenge in addressing driver distractions that adversely affect traffic safety is this lack of reliable data necessary to accurately assess the actual magnitude of this hazard.** Crash data are neither collected in Pennsylvania nor nationally to systematically and readily identify various, specific driver distractions as primary and contributory causes to crashes. **From the data that have been collected, crash statistics *per se* do not justify statutorily restricting specific driver distractions.** This does not mean that statutorily or regulatorily addressing driver distractions is inappropriate, fruitless or undesirable.

**It is evident that driver distraction is underreported, by how much is unknown.** Even if driver distraction were precisely reported, such data would be of limited value if no one knows how to effectively reduce net distractions to drivers. This leads to another big challenge in addressing driver distractions that adversely affect traffic safety: understanding driver behavior.

**The most prominent hazard on a road is typically its user.** Actions and inactions of road users contribute to nearly all crashes. A big and highly influential component of road usage is a driver's behavior. Perception, cognition and memory have been tested for scores of years, but psychology has been inadequately applied to driving. This is at least partly because driving doesn't seem to require more rigorous application and because it has been very difficult to collect actual data of what a driver does in his own vehicle during self-directed travel. At least two studies are now or will soon be collecting these data to learn how often and under what conditions drivers actually engage in distractive behavior along with the consequences.

**Traffic safety has been improving since the inception of the automobile.** The crash rate continues to decline relative to the increased exposure of travel, but better understanding the behavior of drivers may be crucial to substantially accelerate improved traffic safety. Various psychological theories proposed to explain driving all describe the same behavior. One curiously controversial theory is known as risk homeostasis; other, related theories are called risk compensation and driver adaptation, *inter alia*. They all attempt to provide a theoretical understanding of behavior by variously articulating a driver's tolerance to subjectively perceived risk and his response to feedback when driving.

Because humans efficiently allocate their psychological resources, drivers frequently assume secondary tasks when the primary task, driving, doesn't demand too much of those resources. For this reason, the simple and appealing solution of regulating a specific distraction might not improve traffic safety. **During the same or similar circumstances when a driver is willing to undertake a secondary task, he can easily substitute a potentially equally or more distractive legal task for a prohibited one.** In other words, exposure to a risk of distraction may remain unaffected or even exacerbated by a regulatory solution depending upon one's adaptive response to the regulation.

**A corrective policy has the best chance to succeed if it is based upon reliable data and reasonable assumptions and then tested for efficacy. Continued, careful study of driver distractions might best assure that any statutory or regulatory response be widely supported, actually increase safety, avoid a perverse result and allow innovative technology to continue to concurrently improve mobility and safety.**

As more and more jurisdictions collect data on driver distractions, National Association of Governors' Highway Safety Representatives is coordinating with U.S. Department of Transportation to help assure that Model Minimum Uniform Crash Criteria are consistently collected so that the database is standard nationally. These voluntary criteria are being revised in 2002 and Pennsylvania's Department of Transportation is currently revising its police crash reporting form. Adopting the revised criteria could help to provide consistently reliable crash data nationally to improve traffic safety. **The uniformity sought by these criteria should allow for more effective identification of hazards, more relevant measures of performance and better-informed monitoring of programs.**

**It is evident that the great threat posed by driver distractions is from the aggregate of those distractions.** Any policy addressing a particular distraction will likely only alleviate the risk presented by that distraction. **The finite resources dedicated to traffic safety will best be allocated if they are effectively rather than easily expended.** While we all want to travel safely, the motoring public enjoys its safest travel ever so that undue haste is unnecessary when considering regulating traffic to improve mobility and safety. A traveler desires safe mobility so that consideration of policy regulating transportation always has to balance a potential conflict between mobility and safety.

**While more study is necessary to increase safe mobility, it is obvious that not everything needs studied.** For instance, viewing television is incompatible with the attentional demands of driving. Likewise, graphical and textual displays commonly viewed via personal computer along with its typical interface, a keyboard and mouse, are certainly unsuited to contemporary driving.

**In Pennsylvania and nationally,**[14] **an outside object, person or event is most often the distraction that at least partially contributed to causing a crash and represents 20 to 30 percent of those distractions.** The next most prominently occurring distractions that at least partially contributed to causing a

[14]*Infra* p. 96. The data for Pennsylvania is from a census of all traffic accidents reported to police in 1999 and 2000 that were primarily or contributorily caused by a distracted driver. The U.S. data is from a study of data sampled nationally for the years 1995 through 1999 of thousands of crashes of passenger vehicles that were reported to police and required at least one vehicle to be towed.

crash are adjusting audio equipment and another occupant with each representing between 10 and 12 percent of those distractions. Of all traffic crashes at least partially attributed to distracted driving, 42 to 52 percent of distractions are attributed to longstanding ones, namely an outside object, person or event, adjusting audio equipment and another occupant.

Of the contemporary distractions to drivers, the one receiving the most publicity is that from wireless communications, specifically mobile phones. **Of all distractions identified as primarily or contributorily causing a crash in Pennsylvania during 1999 and 2000, cell phones represented 5.2 percent of those distractions.**[15] Of all crashes reported to police throughout Pennsylvania during those years, this represents 0.4 percent. During those years, this percentage is nearly the same as the percentage of other, commonly acceptable distractions that were also identified as primarily or contributorily causing a crash, namely consuming food and beverage and smoking.[16]

**State of New York evidently expects to increase safety by prohibiting drivers from holding a phone while moving. This might be prove to be an enforceable prophylaxis, albeit an ineffective one.** Academic studies persistently demonstrate that interactive conversation adversely affects attention shared with a concurrent task. The exposure to a risk of distraction typically endures substantially longer during a conversation than during the brief, associated tasks of dialing, retrieving and replacing a phone. The net risk of cognitive distraction on situational awareness caused by interactive conversation is probably equivalent to or greater than the net risk of structural distraction on vehicular control caused by glancing at and manipulating a phone while driving. Because of traffic flow and inadequate shoulders, many of which have disappeared as they have been converted into an additional lane, it is unrealistic and unsafe to expect motorists to routinely stand roadside while phoning.

Even so, the widespread, inexpensive availability of adaptive equipment to convert hand-held phones into hands-free devices, the introduction of a universal cellport system and the growing popularity of embedded systems will likely and relatively soon make any mandate that a motorist phone only with hands-free equipment a largely moot requirement.

The most prevalent, crash-causing distraction is an outside object, person or event. Forbidding windows would solve that problem but perversely impact safety. The suggested hands-free solution for cell phones does not solve a sizeable and extant portion of that distraction, cognitive tunneling from interactive conversation. **According to crash statistics from Pennsylvania during 1999 and 2000, other occupants caused approximately twice as many distractions leading to crashes as cell phones so that a ban of wireless conversations doesn't seem promising when personal conversations with**

[15] *Id.*
[16] *Id.*

**other occupants would presumably remain unabated.**[17] In descending order of frequency, the three most prevalent distractions from other occupants were talking to a passenger, arguing with a passenger and looking at a passenger.[18] Some contend that conversations qualitatively differ between those in person with a passenger and those remotely via cellular communications because a passenger can responsively modulate the conversation while concurrently observing traffic. This occurs in some cases, probably more often if the passenger is riding in a front seat. They fail to acknowledge that short, simple, dispassionate cellular conversations are likely no more cognitively demanding than similar conversations with a passenger. All of the dialogues used in studies have been free of emotional content. Lengthy, complex and passionate conversations place potentially distractive attentional loads on a driver whether those conversations are cellular or in person.

## SUMMARY OF RECOMMENDATIONS

1. A statutory or regulatory restriction on specific driver distractions does not yet appear to be warranted based upon available data. Should future data demonstrate the necessity of a restriction, its application and enforcement should be uniform statewide.

2. To contribute to consistent collection of reliable crash data nationally, Pennsylvania's Department of Transportation should adopt the voluntary criteria known as Model Minimum Uniform Crash Criteria, which are expected to be revised next year.

3. Pennsylvania's Department of Transportation should routinely collect and annually publish data specifying distractions that contributed to motor vehicle crashes in our Commonwealth. A corrective policy has the best chance to succeed if it is based upon reliable data to best assure that any regulatory response actually increases safety.

4. The public and private sectors should continue to increase drivers' awareness of distractions through training, educational materials and publicity designed to emphasize the importance of suitably attentive driving.

5. While the public and private sectors must encourage and require safe driving, there is no substitute for a suitably attentive and cautious driver. Ultimately, motorists are individually responsible to carefully attend to their primary task, driving.

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[17] *Id.*

[18] *Infra* p. 10.

# INTRODUCTION

Public interest in driver distractions and traffic safety has increased in recent years and continues to attract attention by those who desire to better understand how distracted driving degrades traffic safety and to reduce driving distractions. Since legislation on this topic has been introduced in many jurisdictions and approved in others, several public hearings have been held to consider this topic.

In 2000, U.S. Department of Transportation's National Highway Traffic Safety Administration hosted a public meeting and internet forum focusing on the potential safety implications associated with driver distraction while using advanced in-vehicle technologies.[19] At the public meeting, representatives of the public, industry, government, and safety groups shared viewpoints, information, and recommendations for strategies and research to help minimize the adverse safety consequences of distraction from these technologies. Due to a dearth of data, the administration does not have a policy on cell phones and driving.[20]

In 2001, National Conference of State Legislatures created a partnership forum on Driver Focus and Technology and is expected to publish its report in January 2002. Also this year, U.S. House of Representatives heard testimony on driver distractions to oversee the use of electronic devices in automobiles and how the use of current and emerging technologies may cause distractions that contribute to accidents.[21] More than a year before U.S. House of Representatives heard this testimony, Pennsylvania's Senate heard testimony to better inform itself about distracted driving and determine whether to develop responsive safety rules.[22] Following this hearing, Pennsylvania's General Assembly adopted the resolution[23] directing the present study by Joint State Government Commission. Pennsylvania's General Assembly recognizes the many opportunities for driver distractions while operating a motor vehicle and its

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[19]Nat'l Highway Traffic Safety Admin., U.S. Dep't of Transp., Safety Implications of Driver Distraction when Using In-vehicle Technologies *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/DriverDistraction.html (last visited Oct. 27, 2001).

[20]Joseph Carra, Remarks at Nat'l Conf. of State Leg's Driver Focus and Technology Forum (Sept. 11, 2001).

[21]Hearing Before the Subcomm. on Highways and Transit of the House Comm. on Transp. and Infrastructure, 107th Cong. (2001).

[22]Hearing Before the S. Comm. on Transp., Gen. Assem., 184th Reg. Sess. (Pa. 2000).

[23]S. Con. Res. 127, Gen. Assem., 184th Reg. Sess. (Pa. 2000). This appears *infra* p. 181 in appendix F.

responsibility to ensure traffic safety by enacting enforceable laws.[24] Its concurrent resolution directs the Commission to:[25]

- Study and develop recommendations concerning highway safety and driver distractions including technology, entertainment and all other forms of nontechnological distractions.

- Review and analyze studies and statistics relating to all types of driver distractions, which affect safety.

- Inquire into innovative communications technologies being used or proposed to be used in motor vehicles that may alleviate risks to safety.

- Recommend strategies and legislative or regulatory action.

## DRIVER DISTRACTIONS

The resolution identifies some driver distractions.[26] In this discussion, the term "distraction" refers to a diversion of attention from driving produced by some situation. The diversion of attention can affect a driver's cognition, perception and reaction. AAA Foundation for Traffic Safety contracted with University of North Carolina Highway Safety Research Center to identify the major sources of distraction to drivers nationally and their relative importance as potential causes of crashes.[27] This ongoing AAA Foundation for Traffic Safety project distinguishes between driver distraction and inattention, characterizing the latter as broader.[28] It considers driver distraction to be a shift of attention away from driving compelled or induced by an activity, event, object or person that delays a driver's recognition of information necessary to safely drive.[29] The Commission's staff attempted to likewise distinguish between driver distraction and inattention and adopted the taxonomy that University of North Carolina

[24] *Id.*
[25] *Id.*
[26] The first clause resolved includes "communications technology and electronic entertainment such as wireless telephones, pagers, facsimile machines, [computers], locator devices, AM/FM radios, compact disc players, audio cassette players, citizens band radios and dispatch radios, and all other forms of nontechnological distractions." The initial whereas clause identifies "opportunities for driver distractions . . . including, but not limited to, communications technology, electronic entertainment, [computer use], fatigue, reading, food and beverage consumption and passengers, including children and pets[.]"
[27] Stutts et al., *supra* note 12, at 3.
[28] *Id.*
[29] *Id.*

Highway Safety Research Center employed for AAA Foundation for Traffic Safety.[30]

Fatigue and sleep may or may not be considered a distraction. One wonders what could be more distracting to a driver than sleeping. Probably because "sleepiness is a basic physiological state,"[31] the seemingly prevailing view characterizes it and related terms having similar effects as conditions rather than distractions. In fact, our Commonwealth's current POLICE CRASH REPORTING FORM identifies fatigue and asleep as conditions *inter alia*.[32] As it is for distractions, it is difficult to obtain accurate data for the number of crashes caused by drowsy drivers. Police officers may fail to recognize, and drivers may fail or be unable to admit to drowsiness.[33] National Highway Traffic Safety Administration estimated that 1 to 3 percent of all crashes reported to police are primarily caused by drowsiness and result in 4 percent of fatalities, but estimates elsewhere range much higher.[34] The administration estimated that inattentive driving causes 10 times as many crashes as sleep-related causes.[35] Of the crashes throughout our nation during 1995-99, those involving distracted drivers are estimated to represent 8.3 percent of crashing vehicles and those attributed to fatigue or sleep represented 1.8 percent of all crashing vehicles.[36] Of all the crashes reported to police throughout Pennsylvania during 1999 and 2000, those attributed to distractions represented 3.5 percent of all crashes and those whose primary contributing factor was attributed to fatigue or sleep represented 1.7 percent of all crashes.[37]

To assist the Commission's study, Pennsylvania's Department of Transportation and State Police supplied the staff with a census of recent police accident reports whose cause is primarily or contributorily attributed to driver distraction. The census covered 1999 and 2000 and totaled 10,315. In a commonly occurring order of frequency within each category, the most prevalent, actual but incomplete examples of distractions follow and can be seen to include those that are technological, entertaining and nontechnological. Except for "other

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[30]The taxonomy can be found *infra* p. 180 in appendix E.

[31]Jane C. Stutts et al., U. of N.C. Highway Safety Research Ctr. & Sch. of Med., Why Do People Have Drowsy Driving Crashes? Input from Drivers Who Just Did 7 (1999). For this study, 1,403 drivers in North Carolina were interviewed. *Id.* at 5. When asked to rank the importance of seven different factors causing motor vehicle accidents, alcohol received the highest ranking; driver drowsiness received the second or third highest ranking by drivers involved in crashes. The ranking of importance of driver inattention including not being alert and being distracted was low and ranged from fourth to sixth among drivers involved in crashes and those not involved in crashes. *Id.* at 25, 73.

[32]The others are Apparently Normal, Had Been Drinking, Illegal Drug Use, Sick, Medication and Unknown. *Infra* p. 172

[33]Stutts et al., *supra* note 31, at 49.

[34]*Id.* at 8.

[35]*Id.*

[36]Stutts et al., supra note 12, at 9 and *see infra* p. 183 in appendix G.

[37]*Infra* p. 95 and *see infra* p. 183.

distraction," the categories themselves are also listed in descending order of frequency.

**Outside object, person or event**
- Looking at traffic
- Waved out by another
- Cut off by vehicle
- Looking at vehicle
- Deer in roadway

**Adjusting radio/cassette/CD**
- Adjusting radio
- Looking at radio
- Changing CD
- Reaching for CD
- Adjusting CD player

**Other occupant**
- Talking to passenger
- Arguing with passenger
- Looking at passenger
- Attending to child
- Passenger grabbed steering wheel

**Moving object in vehicle**
- Bee
- Dog
- Dropped something
- Reached for fallen item
- Spider

**Using other device/object brought into vehicle**
- Looking at directions
- Looking at map
- Reaching for purse
- Reaching for map
- Looking at paperwork

**Using/dialing cell phone**
- Talking on cell phone
- Answering cell phone
- Reaching for cell phone
- Using cell phone
- Dialing cell phone

**Adjusting vehicle/climate controls**
- Heater
- Air conditioner
- Defroster

**Eating and/or drinking**
- Spilled beverage
- Reaching for beverage
- Drinking beverage
- Eating

**Smoking related**
- Dropped cigarette
- Lighting a cigarette
- Reaching for cigarette
- Reaching for lighter
- Looking for cigarette

**Other distraction**
- Looking away
- Inattentive
- Daydreaming
- Lost in thought

## STUDIES AND STATISTICS

Studies relating to driver distractions affecting traffic safety that are summarized were published by academic, governmental and corporate researchers. Some studies broadly examine driver inattention, whereas other studies consider driver workload demands of specific technology. Unfortunately, the scientific literature provides little insight into hazards posed by similarly distractive behaviors while driving because objective records are unavailable and self-reporting is unreliable. Remarkably little is known, at least quantitatively, about what people do in their vehicles, how often and under what conditions they do things and what are the consequences. Reliably accurate scientific data on comparative and relative distractions may become available soon. Via video and other data recording, University of North Carolina Highway Safety Research Center is collecting actual, driving data during self-directed travel for phase II of AAA Foundation for Traffic Safety's study of driver distractions.[38] Similarly, National Highway Traffic Safety Administration contracted with Virginia Tech Transportation Institute to likewise collect actual, driving data during self-directed

[38] Jane C. Stutts, Remarks at Nat'l Conf. of State Leg's Driver Focus and Tech. Forum (Sept. 11, 2001).

travel. A significant sample of driver distraction research that is readily available and meaningfully explained is conveyed herein.

Statistics relating to all types of driver distractions affecting highway and traffic safety have been compiled by governmental sources, particularly Pennsylvania and U.S. Departments of Transportation along with Pennsylvania State Police. All data are from recent periods and include a census of police accident reports from 1999 and 2000 covering accidents in Pennsylvania primarily or contributorily caused by driver distraction. These police accident reports numbered 10,315 and disclosed 10,415 distractions.

Pennsylvania began using new police crash reporting forms this year.[39] These forms have codes for *Driver Action* to identify factors that contributed to a crash.[40] The codes thereunder include Driver Was Distracted, Driving Using Hand Held Phone and Driving Using Hands Free Phone *inter alia.* There is also space on these forms to indicate whether the coded *Driver Action* was the *prime factor* of the crash. After being in use less than a year, this form is being revised again. In 2000, police throughout our Commonwealth were asked or directed to inquire whether a cell phone was present in the occupant compartment of each involved vehicle. If so, the responding officer was instructed to attempt to determine if an involved driver was using the phone immediately prior to the impact. These results were to be included in the accident report's narrative. As the Commission staff examined a census of Pennsylvania's recent police accident reports whose cause is attributed to driver distraction, it determined how many of these coincidences were reportedly regarded to have been the driver distraction primarily or contributorily causing the crash. Since the examined police accident reports are from 1999 and 2000, coded data from the new forms as well as other information on motor vehicle crashes occurring this year are excluded.[41]

National Highway Traffic Safety Administration captures distraction data on its Fatality Analysis Reporting and National Automotive Sampling Systems. National Automotive Sampling System is divided into General Estimates and Crashworthiness Data. Crashworthiness Data is a survey sampling crashes reported to police whereafter passenger vehicles were towed. These crashes, unlimited to fatal wrecks, are investigated in detail by teams of trained crash researchers. This Crashworthiness Data was reviewed by researchers at University of North Carolina Highway Safety Research Center for AAA Foundation for Traffic Safety. The primary rationale for using this data is the

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[39]Appendix B, *infra* p. 168.

[40] *Infra* p. 175.

[41]This exclusion is primarily because a complete year of data is unavailable. Data from the limited, available number of police accident reports from earlier in the year cannot be meaningfully compared to the preceding years. The form used during 1999 and 2000 appears *infra* p. 166 in appendix A.

level of detail contained for each crash reported therein.[42] Those results[43] are comparatively presented with Pennsylvania data in the section on statistics.[44] Fatality Analysis Reporting System is a census of all crashes nationally on public roadways that result in a death within 30 days of the crash. Both of these systems as well as all of the data available to the Commission's staff suffer limitations. Because the information compiled in Fatality Analysis Reporting System is based on police accident reports and does not collect data on nontechnological distractions,[45] it remains unknown whether there are more technological than nontechnological distractions that resulted nationally in fatal accidents reported to police.

## INNOVATIVE COMMUNICATIONS TECHNOLOGY

Innovative communications technology that is being developed and that has recently been introduced into the market will be discussed. The focus will be on those communications technologies that may help alleviate risks to highway and traffic safety. An example of new communications technologies that has recently been introduced to the market is in-vehicle navigational systems.[46] Manufacturers can incorporate safeguards into new communications technologies. A feature might be inoperable while the vehicle is moving or under challenging traction conditions. A phone's ring could be silenced during a busy driving task or when travelling an excessive speed. Call-forwarding and voicemail are established technologies that can limit calls at inopportune times. Technology could suppress or delay nonessential warnings such as low fuel when a vehicle is in a maneuver involving driver effort such as a turn. New warnings can be developed to alert motorists to potential hazards such as lane departures. Another new communications technology would automatically signal a collision to a response center upon deployment of an airbag.[47] This signal could include a vehicle identification number, locale, and other relevant information. A database containing vehicle identification numbers might disclose potentially useful information such as medical conditions and allergies of primary drivers of registered vehicles. Systems can be controlled via buttons on the steering wheel and voice activation. There can, however, be lengthy delays before innovative technologies are incorporated in marketed products. Shatter-resistant glass was developed in 1905 but wasn't incorporated in U.S. manufactured automobiles until 1927. The first patent for air bags was granted in 1952, but they weren't offered as standard equipment until 1980 when a European automotive manufacturer began offering them. Automated cars and

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[42]Stutts et al., *supra* note 12, at 7.

[43]The analysis of this data is based on Crashworthiness Data from 1995-1999. *Id.*

[44]*Infra* pp. 85-108.

[45]It does, however, tally a driver related factor for inattention.

[46]Functionally, these systems are electronic maps.

[47]General Motors OnStar is already marketing a version of this Mayday system.

highways exist now.[48] These automated cars and highways are computer controlled and use laser scanners and other sensors. Many of us rely on computer controlled transport now via elevators. Many of us rely on partially automated cars now via cruise control.

## ORGANIZATION

This report is organized as follows. Numerous studies are discretely summarized in the immediately following section.[49] Next is the section uniquely revealing crash statistics from Pennsylvania along with the statistics developed for AAA Foundation for Traffic Safety by University of North Carolina Highway Safety Research Center.[50] After that, a section discusses innovative communications systems.[51] The following section attempts to provide some context for driver distractions via a short overview of traffic safety in general.[52] After that, a section discloses some relevant laws elsewhere and others' recommendations relating to driver distractions.[53]

[48]The Navlab group in Carnegie Mellon University's Robotics Institute has built and tested robotic automobiles on an automated highway.

[49]*Infra* pp. 15-83.

[50]*Infra* pp. 85-108.

[51]*Infra* pp. 109-21.

[52]*Infra* pp. 123-51.

[53]*Infra* pp. 153-60.

# STUDIES

The studies summarized herein are relatively recent and concentrate on technological distractions, especially wireless telephones. In the aggregate, one is likely to consider them to be inconclusive so that they offer no practical, legislative solution for wireless telephones, the most examined distraction. Unless done vocally, entering destinations on route guidance systems seems to be more distractive than phoning, but these systems are not yet popular enough to have obtained more, actual data. Even if they are more distractive, they may prove safer than using a paper map. A lot of research is commercially driven so that nontechnological distractions don't attract a commensurate amount of research. It is a big challenge to apply psychological research to traffic safety. It is difficult to control tests on a road in real traffic and test safely or simulate real traffic on a test track. It is difficult to faithfully simulate realistic driving in a laboratory. Even when well simulated, one cannot simulate risk. We have yet to learn how people allocate and reallocate attention over time while driving. Researchers are just starting to gather empirical data on what drivers actually do while driving. Applying basic, psychological research to driving remains a fundamental challenge.

> The position of a scientist trying to understand traffic safety has more in common with that of an astronomer than with that of a . . . physical . . . scientist. . . . The luxury of varying input variables and observing what happens, and then repeating until reliability is established is not available. Some research relating to traffic safety is done in laboratories, and on test tracks and public roads using volunteer subjects and instrumented vehicles. This provides more experimenter control, but a question arises regarding how the results relate to normal driving. Studies have also been conducted in which the behavior of drivers in actual traffic has been observed. . . . Although such studies can illuminate road-user behavior, they cannot address the matter of most interest—the crash.[54]

Some researchers whose work is summarized herein studied crash statistics, others tested drivers on a road or track or via simulation. Some researchers surveyed drivers, others tested equipment to assess whether it could be effectively used to measure performance in forthcoming studies. Many studies distinguish between male and female subjects as well as old and young subjects. Usually, any difference between the former was insignificant and is

[54] Leonard Evans, *Traffic Safety and the Driver,* ch. 1 (1991), *available at* http://www.scienceservingsociety.com/book/CH01.htm (last visited July 17, 2001).

excluded from the summaries. The difference between the latter was more often significant and is included in the summaries.

The summarized studies typify the nature of and represent a substantial number of those available that were reviewed for this effort. The increasingly rapid pace of publication of studies; the increasingly rapid development and marketing of portable, electronic consumer goods; the multiple sciences required to understand the topic; and the dearth of accurate, timely and reliably consistently collected data conspire to frustrate the possibility that this report can be comprehensive or definitive.

The first study summarizes research on driver distraction by or for National Highway Traffic Safety Administration.[55] It is followed by a summary of that administration's investigation of the safety implications of wireless communications in vehicles, which was comprehensive when it was published approximately four years ago.[56]

Four studies disclosing the effect of cellular phone use upon drivers are thereafter summarized.[57] These mostly address cognitive distraction while communicating. Four studies examining mobile phones' impact on road accidents follow those.[58] Three of these four are foreign studies including the most, albeit undeservedly, famous one on this topic. The best one of the foreign studies was finished just a few months ago.

Several surveys are summarized.[59] Three of the surveys solicited responses to queries, but two of the three are several years old. Two other surveys are much more contemporary and were observational, one of which was part of National Occupant Protection Use Survey.

Following these are summaries of studies relating to measuring eye movement while driving.[60] They deal with a technical platform and method for measuring during different tasks.

Later, two papers discuss testing route guidance systems on a test track.[61] That is followed by summaries of studies relating to divided attention ability of younger and older drivers,[62] non-driving tasks interacting with driving,[63]

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[55] *Infra* pp. 17-19.
[56] *Infra* pp. 19-38.
[57] *Infra* pp. 38-46.
[58] *Infra* pp. 46-52.
[59] *Infra* pp. 52-56.
[60] *Infra* pp. 56-62.
[61] *Infra* pp. 62-65.
[62] *Infra* pp. 65-66.
[63] *Infra* pp. 66-69.

issues in the evaluation of driver distraction associated with telematics[64] and the effect of speech-based e-mail on drivers' attention.[65]

Nearing the end of this section, cost-benefit analysis[66] of activities distracting to drivers is explained generally. This is followed by more specific discussions of the risks and benefits of cellular phone use while driving and whether one should be allowed to use a cell phone while driving.

Finally, the role of driver inattention in crashes is summarized based upon statistics from the 1995 Crashworthiness Data System.[67] It is an appropriate conclusion for this section because the immediately following section extends the examination of these, national statistics by disclosing them for the years 1995-99 and adds statistics from our Commonwealth for the years 1999 and 2000.

## NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Driver Distraction Research: Past, Present, and Future. "Driver distraction may be characterized as any activity that takes a driver's attention away from the task of driving."[68] Distraction can be distinctly categorized as visual, auditory, biomechanical and cognitive.[69] Distraction is associated with the attention demanded by or dedicated to a secondary task and a driver's willingness to perform that task.[70] Secondary tasks can be directly and indirectly related to driving or unrelated.[71] Secondary tasks themselves can require associated tasks.[72] A driver's willingness to perform a secondary task is a function of multiple factors including his own experience and the characteristics of the task.[73] While drivers can be expected to typically initiate a task at an opportune moment,

> [i]t is the coincidence of driver inattention and the occurrence of unanticipated events . . . that characterizes the random nature of distraction related crashes. It follows that the dynamic nature of the circumstances across drivers, along with the random nature of distraction related crashes, would make it difficult, if not

[64] *Infra* pp. 69-72.
[65] *Infra* pp. 73-75.
[66] *Infra* pp. 75-81.
[67] *Infra* pp. 82-83.
[68] Thomas A. Ranney et al., NHTSA Driver Distraction Research: Past, Present, and Future 1 *available at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/233.PDF (2000) (last visited Oct. 30, 2001).
[69] *Id.*
[70] *Id.* at 2.
[71] *Id.*
[72] *Id.*
[73] *Id.*

impossible, to associate specific devices with a specific degree of risk. . . . [T]he major components of inattention-related police reported crashes include "distraction" . . ., "looked but did not see" . . ., and situations where the driver was drowsy or fell asleep.[74]

Uncertain relationships among the demands that available, portable devices and installed systems and driving have prompted the research by National Highway Traffic Safety Administration and others in this area.[75] Because heavy trucks were among the first to use navigational systems and wireless phones, National Highway Traffic Safety Administration initially attempted to assess the safety implications of in-vehicle devices by studying truck driver workload beginning about 1992.[76]

> One major conclusion . . . was that . . . a quantitative model to predict crash incidence as a function of driver workload measures was not feasible. Among the difficulties are the complexity and multiplicity of factors involved in determining driver workload and crash causation and the limitations of existing crash data bases . . . identifying crashes that were caused by driver distraction associated with in-vehicle technologies. Because of these difficulties, . . . workload assessment is best considered as a relative assessment made in comparison to other tasks . . .. [77]

Safety-related measures of performance such as lane-keeping and visual allocation were and are used to assess workload and potentially consequential distraction.[78]

The administration's "An Investigation of the Safety Implications of Wireless Communications in Vehicles" was published in 1997 and found most drivers conversing rather than dialing at the time of a crash.[79] A dearth of national data left the magnitude of danger associated with wireless communications inestimable, leaving the authors to encourage improved collection of data so that decisions thereon can be informed.[80]

When National Highway Traffic Safety Administration tested commercially available route guidance systems on a test track, it found that older drivers required considerably more time than younger ones to enter a destination, that entering a destination took longer than tuning a radio station, and that dialing a wireless phone and the voice-activated system took drivers' eyes off the road the least amount of time.[81] Given the advantage of vocal entry over visual/manual

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[74] *Id.*
[75] *Id.* at 3.
[76] *Id.*
[77] *Id.* at 4.
[78] *Id.*
[79] *Id.* A summary of this investigation appears *infra* pp.19-38.
[80] Ranney et al., *supra* note 68, at 4, 5.
[81] *Id.* at 5. A summary of this test appears *infra* pp. 62-65.

entry of a destination, a lockout sensitive to speed might prevent distraction posed by the latter.[82]

The administration also found that individual differences in drivers' temporal and spatial abilities create different responses to in-vehicle technologies along safety-related dimensions.[83] It is now comparing vocal versus visual/manual interfaces of an AutoPC to assess their potential to distract and evaluating eye-tracking technology to monitor visual scanning.[84] It is also evaluating driver workload and distraction among wireless phone interfaces to learn: (1) the differences of interference between using hands-free and hand-held phones; (2) whether conversational content affects driving; and (3) if hands-free phones encourage more use while driving.[85] Its National Advanced Driving Simulator will allow assessment of "the distraction potential associated with various in-vehicle technologies . . . under identical driving conditions."[86]

"Initial NHTSA research highlighted the complexity . . . and the difficulties in establishing a direct link between distraction and crashes."[87] Through continuing research, it attempts to better learn the relationship among in-vehicle technologies, distraction and risk as well as how to technologically mitigate those risks.[88]

Approximately four years ago, National Highway Traffic Safety Administration reported "An Investigation of the Safety Implications of Wireless Communications in Vehicles." Distracted or inattentive driving is often suggested to have been a primary or contributing factor in wildly varying but always substantial percentages of crashes. Since the administration published the aforementioned report, it and others have continued to research the correlation between distracted driving and the use of in-vehicle technologies.

An Investigation of the Safety Implications of Wireless Communications in Vehicles. This report was published approximately four years ago and comprehensively reviewed scientific literature on the topic. The next several pages summarize its content. This report's stated objective is to assess current knowledge of the safety implications of using wireless communications while driving motor vehicles and to explore associated, broader safety issues.[89] It addressed four specific questions:

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[82] Ranney et al., *supra* note 68, at 5.
[83] *Id.* at 5, 6.
[84] *Id.* at 7.
[85] *Id.* at 7, 8.
[86] *Id.* at 8.
[87] *Id.* at 9.
[88] *Id.*
[89] Nat'l Highway Traffic Safety Admin., U.S. Dep't of Transp., An Investigation of the Safety Implications of Wireless Communications in Vehicles 3 (1997).

- Does use of cellular telephone[90] technology while driving increase the risk of a crash?

- What is the magnitude of the traffic safety problem related to cellular telephone use while driving?

- Will crashes likely increase with increasing numbers of users of cellular telephone technology in the fleet?

- What are the options for enhancing the safe use of cellular telephones by drivers?[91]

National Highway Traffic Safety Administration investigated this topic because the administration considered the investigation to be consistent with its statutory mission[92] and recognized that related safety concerns have increased[93] as wireless communications have recently become much more extensive.[94] The overall conclusion is that like other distractions, cellular phone usage while driving increases risks of crashes in some cases.[95] Because inadequate reporting resulted in insufficient data to determine the magnitude of the safety-related problem, the report called for enhanced collection of data.[96] The administration expressed concern that deployment of technology being developed for intelligent transportation systems might overwhelm drivers and recommended:

- Improving data collection and reporting.

- Improving consumer education.

- Initiating a broad range of research to better define and understand the problem.

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[90]Throughout the report, this phrase was used synonymously for wireless communications device. *Id.* at 1. The administration recognized that technological development could avail cellular technologies to more functions to include internet access, e-mail and so forth, but primarily focused "on the potential impact of voice communications on driving." *Id.* at 5.

[91]*Id.* at 3.

[92]Among other duties prescribed by U.S. Secretary of Transportation, it carries out a number of the secretary's duties relating to highway safety. 49 U.S.C.A. § 105 (West 1997), 23 U.S.C.A. §§ 401-411 (West 1990 & Supp. 2000).

[93]"It is the frequency with which these concerns have been raised, from the public, members of Congress and the media, that has prompted the research described in this report." Nat'l Highway Traffic Safety Admin., *supra* note 89, at 5.

[94]Nat'l Highway Traffic Safety Admin. mentioned in its report that "cellular telephones are owned by more than 50 million Americans." *Id.* at 1. Approximately four years later, there are "**123,227,016 current U.S. Wireless Subscribers."** CTIA, *CTIA's World of Wireless Communications* (2001), *at* http://www.wow-com.com (last visited Oct. 14, 2001).

[95]Nat'l Highway Traffic Safety Admin., *supra* note 89, at 3.

[96]*Id*. at 4.

- Addressing issues associated with use of cellular phones from vehicles to access emergency services.

- Encouraging enforcement of existing state laws to address inattentive driving behavior.

- Working with states on legislative options.

- Using the National Advanced Driving Simulator . . . and instrumented vehicles to study optimal driver/vehicle interfaces.

- Developing a sound basis for carrying out cost benefit analyses.[97]

National Highway Traffic Safety Administration explicitly recognized that wireless communications respond to "[s]ocietal pressures for increased efficiency, more leisure time, and an improved sense of safety."[98]

> The potential safety benefits of cellular telephone ownership are generally recognized and widely advertised. . . . [F]indings point out the broad range of safety benefits identified by users and the general trend emphasizing such use as a basis for having a cellular telephone available in a vehicle. Of note are the implications of the findings for the growth of the user population, particularly for non-business users, young drivers and women. The sense of security that the availability of a cellular telephone provides and its use in reporting emergencies are clearly major factors in the accelerated growth of the industry and in the support generated among law enforcement authorities for industry efforts at promoting safety benefits.[99]

Dramatic increases in popularity with and usage of cellular phones by drivers is attributed to phones' reduction in cost and size[100] along with their increased functionality.[101] The report observes "that manufacturers clearly

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[97]*Id.*

[98]*Id.* at 5. "The majority of owners state that they purchased their phones for safety reasons . . .." *Id.* at 18.

[99]*Id.* at 32-33. When surveyed, state police were "generally appreciative of the quick notification . . . afforded by cellular telephones[,]" but problems caused by redundant calls reporting the same emergency and calls reporting relatively frivolous incidents via a line dedicated to emergency response have arisen. *Id.* at 34.

[100]In 1995, approximately 3/4 "of all cellular telephones sold were tiny pocket models" with the remainder being mobile phones installed in cars and larger transportable devices. *Id.* at 18.

[101]*Id.* at 5. "Given the moderate costs, availability of service areas, and ease of use, it is not surprising that cellular telephones are being rapidly adopted as fixtures in the American way of life." *Id.* at 18.

recognize the potential risks of in-vehicle cellular telephone use" and mentions international and domestic legislative initiatives.[102] Details of user demographics[103] and reported cellular telephone patterns[104] are also included.[105] The report discusses its use of existent data sets along with their limitations.[106] Summarizing its findings from a review of scientific literature relating to cellular telephone use while driving, the administration said:

> Manual dialing can be disruptive of both vehicle control performance, and situational awareness and judgment. The incidence and magnitude of vehicle control disruption while driving on public roads appears to be less than that encountered in driving simulators or on test tracks, but may nonetheless pose a safety concern. On-road studies indicate that if hands-free voice communications activities have any detrimental effects, they are on driver situational awareness and not on vehicle control performance.[107]

The report is balanced and seemingly well presented.

> It is clear that trends in both cellular technology and patterns of use . . . have been shown to have both positive and negative implications for safety. It is also evident that significant deficiencies exist in available information and data that prevent a clear and conclusive determination of whether cellular telephone use while driving is a significant safety problem.[108]

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[102]*Id*. at 7.

[103]Demographics of cellular telephone users changed from middle-aged businessmen to encompass "all age groups, and social and economic classes, including those with less ability to task-share such as the elderly, and novice and occasional drivers." *Id*. at 17. "Cellular telephones are rapidly becoming standard accessories for teenage dates . . . and senior citizen motor trips." *Id*. at 31. "Note . . . the industry reports a continuation in the trend toward more users among the younger . . . and the older . . . age groups." *Id.* "The lower costs for phone purchase and monthly service have attracted users in lower income brackets as well as retired persons . . .." *Id*. at 32.

[104]Industrial surveys reported that between 1990 and 1994, primary use of cellular telephones switched from business purposes to personal purposes. *Id.* at 18.

[105]*Id*. at 7.

[106]*Id.* at 9. Though concluding that "there is a serious under-reporting bias in the data," the administration observed trends therein; "[t]he overwhelming majority of cellular telephone users were in the striking vehicle, and struck cars or other large objects that were in clear view of the driver." *Id.*

[107]*Id*. at 11. Very popular flip-phones "are typically difficult to operate with one hand" and "can be easily dropped." *Id.* at 21.

[108]*Id*. at 11. During 1996 and 1997, National Highway Traffic Safety Admin. surveyed thousands of randomly selected respondents at least 16 years old and approximately equally male and female. *Id*. at 37. Almost all cellular telephone owners said that they used their phones while driving, but most (65%) "replied that they talked on their phones on very few trips or never." *Id*. at 38.

The administration urged careful interpretation of available, deficient data and careful consideration of the impact of proposed solutions.[109] Declaring ergonomic considerations to be of paramount importance to the design and integration of all in-vehicle technologies, the report notes extensive differences among wireless communications devices in "design features that could influence ease-of-use and hence could potentially impact safety."[110] This becomes increasingly important as Intelligent Transportation Systems technologies[111] are being developed and can positively as well as negatively impact safety, yet "[l]ittle is currently known about the synergistic effects of advanced in-vehicle systems on highway safety."[112]

National Highway Traffic Safety Administration concluded that cellular telephone use while driving increases the risk of a crash at least in isolated cases.[113] The magnitude of the traffic safety problem related to cellular telephone use while driving is inconclusive because of inadequately reported crash records resulting in nonexistent data.[114] If the examined data and modeling results are to be believed, crashes will likely increase with increasing numbers of cellular telephones in the fleet.[115] The report deems it "unrealistic and ill-advised to suppose that drivers should have no advanced in-vehicle information systems at their disposal[;]" therefore, safety enhancements should come via good engineering and design of in-vehicle information systems, educating drivers about their potential risks and addressing adverse safety implications.[116]

As encouraged by National Highway Traffic Safety Administration,[117] our Commonwealth expanded its standard crash data elements to record the use of a cellular telephone during a crash as part of a normal crash investigation. Other recommendations for improved data collection and reporting are via telephone surveys and noting distraction indicators on citations and warnings for moving violations.[118] Educational and outreach materials should inform drivers of hazards of driving while distracted during cellular telephone use.[119] The recommended improved cellular telephone research and development involve National Advanced Driving Simulator and instrumented vehicles, ergonomic

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[109]*Id.* at 12. Hands-free dialing and hands-free conversation might lengthen conversations thereby increasing risk to the extent that conversations increase risk of distraction. *Id.*

[110]*Id.*

[111]These include route guidance, crash avoidance and collision notification systems. *Id.* at 15.

[112]*Id.* at 12.

[113]*Id.* at 13.

[114]*Id.*

[115]*Id.*

[116]*Id.* at 13-14.

[117]*Id.* at 14.

[118]*Id.*

[119]*Id.* "The cellular industry in general has placed considerable emphasis on safety." *Id.* at 20.

design guidelines to reduce workload and development of intelligent answerphone technology for automobiles.[120] The report recommends "a unique nationwide cellular emergency response number" and calls for a solution to redundant calls for the same incident that can overwhelm emergency services communications.[121] Citing the complex issues[122] and inconclusive empirical evidence, the report suggested caution in legislatively restricting cellular telephones but called for active enforcement of reckless and inattentive driving laws.[123] Indeed, our Commonwealth forbids driving a vehicle in careless, willful or wanton disregard for the safety of persons or property.[124]

Approximately seven years ago, a corporation was retained by a publisher to survey a representative sample of the national population and asked respondents "which activities they performed while driving which could divert their attention[.]"[125] Almost all mentioned listening to music or news and most mentioned consuming food and beverage as well as changing a tape or CD.[126] Given the seemingly innocuous and highly common amusement of listening to broadcast radio while driving, it now seems strange that car radios were viewed as a complex problem that led to serious consideration to ban or restrict them.

> A grave problem that developed in New Hampshire, spread to Massachusetts, and . . . now has all the motor vehicle commissioners of the eastern states in a wax. It's whether radios should be allowed on cars. Some states don't want to permit them at all—say they distract the driver . . .. The manufacturers claim that the sound of Rudy Vallee's voice is less disturbing than backseat conversation. Massachusetts leans toward the middle of the road. The commissioner there thinks the things should be shut off while you are driving . . .. The whole problem is getting very complex, but the upshot is that you'll probably be allowed to

[120]*Id*. at 14. Manufacturers have encouraged motorists to use hands-free equipment, memory-dial and voice activation features. *Id.* at 20.

[121]*Id*. at 15-16. "The principal safety relevant use of cellular telephones is to call in an emergency." *Id*. at 33.

[122]Mandating hands-free designs doesn't mitigate the distractive potential of cellular telephone conversation. If this mandate results in greater use of cellular telephones among drivers, potential risks could increase instead of decrease. All the while, unrestricted cellular telephone use might degrade driving and induce distraction caused crashes. *Id*. at 16.

[123]*Id*. Some foreign jurisdictions ban the use of hand held phones while driving. *Id.* at 22. For its investigation, National Highway Traffic Safety Admin. formed several focus groups to solicit perspectives on benefits and potential hazards of cellular telephone use by drivers. *Id*. at 38. All groups unanimously opposed any regulation of cellular telephone use; at least two groups regarded regulating only cellular phones to be inconsistent with unregulated use of CB, taxi and police radios. *Id*. at 42.

[124]75 Pa.C.S. §§ 3714, 3736.

[125]Nat'l Highway Traffic Safety Admin., *supra* note 89, at 35. This report is summarized *infra* pp. 55-56.

[126]Nat'l Highway Traffic Safety Admin., *supra* note 89, at 35.

take your radio anywhere, with possibly some restriction on the times when you can play it.[127]

Fatal Analysis Reporting[128] and National Automotive Sampling Systems[129] along with states' police crash reports are primarily used by National Highway Traffic Safety Administration "to identify emerging safety problems, monitor trends and evaluate the effectiveness of various counter-measures."[130] Police officers responding to a crash primarily tend to the injured, restore traffic flow, and cite violations of law.[131] Until 1994, Fatal Analysis Reporting and National Automotive Sampling Systems did not record cellular phone use as a possible driver-related factor, and most jurisdictions still don't have a data element therefor on their police crash reporting forms; consequently this data, if recorded, would appear in the narrative section thereof.[132] In 1994, only Minnesota and Oklahoma included data elements relating to cellular telephone use on their police crash reports.[133] "The lack of a systematic data collection protocol generally leads to under reporting of specific factors of interest."[134] Identifying pre-crash cellular telephone use was difficult for police and researchers partly because no state expressly limited phone use while driving, notwithstanding prohibitions of reckless and inattentive driving.[135] Focused efforts to locate and describe crashes where cellular telephones are known to have played a role are just getting underway in this country.[136]

"The Official Oklahoma Traffic Collision Report . . . includes data elements that record 'telephone installed' and 'telephone in use'."[137] If observed, the installed box should have been checked by the responding officer who then should have inquired if the phone was used at the time of the crash.[138] This could easily lead to underreporting because an officer would not have checked the box for a cellular phone not visible to him, consequently it would have been unlikely for him to then ask if the invisible phone was in use.[139] Evidence of underreporting is gleaned from the fact that "Oklahoma began recording cellular

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[127]*Id.* at 17 (quoting Nicholas Trott in 1930 *reprinted in The Farmers' Almanac 1995*).

[128]"The Fatal Analysis Reporting System is a census of all motor vehicle related fatalities that occur within 30 days following a crash and which are recorded by police crash reports in the 50 United States and the District of Columbia." *Id.* at 50.

[129]"The National Automotive Sampling System . . . uses trained researchers to" investigate "a statistically stratified random sample of all motor vehicle crashes that occur in 24 locations across the U.S. About 5,000 crashes are investigated each year . . .." *Id.* at 53.

[130]*Id.* at 49.

[131]*Id.*

[132]*Id.*

[133]*Id.* at 50.

[134]*Id.* at 49.

[135]*Id.* at 65.

[136]*See id.* at 50-51.

[137]*Id.* at 55.

[138]*Id.*

[139]*Id.*

telephone use on their police crash reports in July 1992" and "there were nearly as many observations of telephone in-use recorded in the second half of 1992 as there were for the entire year of 1993. . . . It is unlikely that the number of cellular telephones in cars . . . dropped since 1992 given the national growth."[140] Notwithstanding this early, systematic effort to collect data on phones and traffic collisions, "[t]he lack of rigorous guidelines for data collection compromise the utility of the data set."[141]

Minnesota revised its police crash report forms in 1991 to include "driver on car phone/CB - 2 way radio" among 31 other factors as apparently contributing to a crash whereon the responding officer could note up to two factors per driver.[142] "The pre-crash factors are often determined from interviews with involved parties" leading a Minnesota Office of Traffic Safety data analyst to compare "the accuracy of the cellular telephone/radio pre-crash factor to that for self reported seat belt usage after a crash."[143]

The 1995 National Automotive Sampling Survey's Crashworthiness Data System identified eight relevant cellular telephone cases representing an estimated 3,837 similar crashes nationally.[144] Of the eight drivers, seven were talking and one was dialing.[145]

> Drivers may become so absor[b]ed in their conversations that they are not aware of their behavior or of the driving environment. The NASS data cites driver inattention as a driver-related pre-crash factor in about 26% of all sampled crashes for 1995. Momentary distractions such as pushing a button on a radio would appear to have a different effect on driving behavior and ability when compared to engaging in telephone conversations that last for several minutes (and therefore several miles) of travel.[146]

National Police Agency of Japan identified 129 cellular telephone related crashes in June 1996; 76 percent of these involved rear end collisions and 74 percent were dialing and answering at the time of the crash.[147]

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[140] *Id.* at 58.

[141] *Id.* at 60. From the approximately 79,120 crashes reported to police in Oklahoma during 1999, 8.9 percent were contributorily caused by inattention. It appears that cellular telephones were in use in 0.4 percent of crashes caused by inattention. *See* Okla. Highway Safety Office, Okla. Dep't of Pub. Safety, 1999 Oklahoma Crash Facts, 10, 21, 52 (2000).

[142] Nat'l Highway Traffic Safety Admin., *supra* note 89, at 60, 62.

[143] *Id.* Minnesota's crash statistics from 2000 attribute driver inattention/distraction as a contributing factor in 13.8 percent of fatal crashes, 23.8 percent of injury crashes and 23.4 percent of property damage crashes. Office of Traffic Safety, Minn. Dep't of Pub. Safety, Minnesota Motor Vehicle Crash Facts 21 (2000).

[144] Nat'l Highway Traffic Safety Admin., *supra* note 89, at 53.

[145] *Id.*

[146] *Id.* at 54-55.

[147] *Id.* at 64.

> The . . . growth in cellular telephone use along with the implementation of increasingly complex functionality . . . heightens the importance of understanding the potential implications for safety as well as the nature of causal factors associated with any relevant crashes. . . . When crash data bases are studied, information is usually gleaned from information filled in by investigating officers. . . . Such information is usually contained in specific check-off . . . "boxes" on crash reporting forms. . . . [W]hen the potential source is unusual or relatively new, . . . searches on categorized . . . information may not uncover the true influence of the potential source on number of crashes.[148]

In these cases, narratives must be searched, retrieved and read.[149] North Carolina's Department of Motor Vehicles and University of North Carolina's Highway Safety Research Center used a keyword-narrative search approach to determine the extent to which cellular telephone usage in vehicles primarily contributed to crashes in 1989 and 1992-95.[150] The study found

> that the number of reported cellular telephone related crashes is relatively small, considering what might be expected based on anecdotal reporting. . . . [A]n earlier study using this same database . . . also found a relatively low number of reported crashes as being inattention/distraction related . . .. These findings are in sharp contrast with what would be expected on the basis of detailed crash investigations . . .. . . . Whether the reported number of crashes is in fact small or is a result of under-reporting remains to be determined.[151]

Findings more consistent with other data were found in the 1995 National Automotive Sampling System's Crashworthiness Data System, the first year that this system began collecting data on precrash inattention/distraction related factors.[152] "The 1995 findings indicate that inattention/distraction related crashes account for about 26 percent of tow-away crashes with 0.1 percent of all CDS tow-away crashes attributable to cellular telephones."[153] Given the indications of "relatively few cellular telephone related crashes in North Carolina" during the studied period and other research suggesting that attention related crashes should occur more frequently than found in the North Carolina data, the authors recognized a "need for improved reporting techniques to better identify and categorize these crashes. . . . In addition, the findings suggest an increase in cellular telephone related crash frequency as more cellular telephones become

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[148] *Id.* at 71.

[149] *Id.*

[150] *Id.* at 71-76. The conclusions on p. 83 state that the period is "from 1989 through 1995[,]" but the tables are included on pp. 74 through 76 are for only the five specified years.

[151] *Id.* at 83.

[152] *Id.*

[153] *Id.* (citation omitted).

available."[154] The data indicated a "wide range of causal factors associated with cellular telephone use[,]" but "the relative importance of conversation itself as an important causal factor"[155] was higher in the data from North Carolina than the data from Japan.

National Highway Traffic Safety Administration also reviewed human factors studies on cellular telephone use while driving in simulators, on test tracks and on the road. "The earliest published study on mobile telephone use and its impact on drivers" is from 1969 and was done on a closed course "simulating a hands-free phone application. . . . Results indicated that gap judgments were significantly degraded during the communications task and travel speed was reduced[;]"[156] however, travel speed was based on circuit completion, the dialogue was probably more demanding than normal cellular telephone conversations and there were no other vehicles on the course to avoid.[157] A study published in 1978 used an instrumented vehicle on a closed course to examine the effects different types of dials on driving while dialing.[158] This study is of limited value largely because of technological obsolescence. Rotary dials are obsolete or nearly so making it meaningless to compare that to push-button dials and other than that, the "dial designs and locations . . . had relatively minor impacts on driver lane position variability and apparently no significant effects on other measures of driving performance."[159]

A study published in 1985 used a driving simulator to examine the effects of voice communications on 60, fatigued truck drivers.[160] "This study empirically supports the professional driver's intuition that a concurrent task, like voice communications, can break the monotony of driving and help keep the driver awake" because performance on all driving measures was enhanced by a simple voice communications task compared to driving with no such task.[161] The limitations of this study are the uniformity of the subjects, namely professional drivers, and the scope of the inquiry; the drivers were tasked with simple rather than complex communications and were fatigued rather than alert.[162] In 1987, another study using a driving simulator to determine effects of cellular mobile phone usage on driver performance was published.[163] This time, both sexes of varying ages were tested on dialing and voice communications tasks as well as tuning a radio.[164] Results generally indicated that crashes and speeding tickets "were infrequent and not attributable to cellular telephone use of any kind[;]" however, lanekeeping degraded with manual dialing, especially for the console

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[154] *Id.* at 83, 84.
[155] *Id.* at 84.
[156] *Id.* at 87-88.
[157] *Id.* at 88. *See also id*. at 197-99.
[158] *Id.* at 88.
[159] *Id.* *See also id.* at 215-17.
[160] *Id.* at 89. *See also id.* at 201-03.
[161] *Id.* at 89.
[162] *Id.*
[163] *Id.*
[164] *Id.*

mounted phone and for subjects 55 years and older.[165] "Manual radio tuning was more disruptive of lane keeping than memory-dial and voice-dial . . .. The authors conclude that with the exception of manual dialing, their study results indicate no significant traffic safety problems."[166] In studies published in 1988, experiments related investigations of the impact of phone dialing on driving and talking on a hands-free device.[167] The former experiment used a standard, push-button phone rather than an actual cellular phone, varied its placement and permitted and forbade drivers to look at the closed course while dialing 11 digits; the subjects in the latter experiment were not driving while talking but playing computerized squash![168] In the dialing experiment, lane keeping was most disrupted when drivers were forbidden to look at the road while driving.[169] When drivers were allowed to look at the road while driving, drivers did so on 47 of the 50 runs dialing a low mounted phone and 37 of the 50 runs dialing a high mounted phone.[170] "This suggests that drivers can be sensitive to . . . some of the performance-degrading features of telephones in vehicles and . . . compensate for the degradation."[171] The report disregarded the results of squash playing subjects using a simulated, hands-free device for inapplicability to driving.[172]

Two researchers published studies in 1990[173] that used a driving simulator to study effects of hands-free mobile phone conversation on driver performance and 1991 to assess the impact of a voice communications task on elderly drivers.[174] The results were complex, but generally telephone conversation increased brake reaction time, reduced travel speed[175] on the easy (straight) stretches and the most pronounced lane deviation was on the hard (curvy) stretches.[176] The fact that brake reaction time increased on the easy routes but not on the hard routes "implies that test participants were somewhat sensitive to the primary driving task demands and attempted to manage their attention . . . accordingly."[177] The study comparing the younger drivers to the older drivers that was published in 1991 indicated that "the elderly drivers had longer average brake reaction times, showed greater lanekeeping variability during the conversation task, and drove faster than younger drivers while using

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[165] *Id.* at 90. "Consistent with other research, as a driver's age increases, any task competing for attention interacts with age to impair driving ability." *Id.* at 247.

[166] *Id.* at 90-91. *See also id.* at 200, 245-48.

[167] *Id.* at 91-92.

[168] *Id.* *See also id.* at 188-90.

[169] *Id.* at 91.

[170] *Id.*

[171] *Id.* at 92. *See also id.* at 256-58.

[172] *Id.* at 92. *See also id.* at 189-90.

[173] *Id.* at 182-85.

[174] *Id.* at 92-93.

[175] Although reduced travel speed may help a motorist to maintain control of his vehicle, "going substantially slower than the prevailing travel speed is . . . associated with traffic mishaps." *Id.* at 93.

[176] *Id.* at 92.

[177] *Id.*

the telephone."[178] A study in 1993 extended the driving simulator investigations to a car following situation and discovered that drivers had longer brake reaction times and decreased headways when driving with the voice communications task than without it.[179] The older drivers had longer brake reaction times than the younger drivers but allowed greater headways.[180] The relevance of this study to normal cellular telephone communications was deemed unclear because the communications materials may have been too extreme, driving in a simulator is inconsequential and drivers might adapt to cellular phone use while driving by modifying that usage over time.[181]

A study published in 1993 that used a car simulator to study usability of mobile phone features reported that lane deviation was greater with manual dialing than with voice input, and "age influenced both driving performance and dialing times."[182] A French study published in 1994 related that only two of 17 subjects were able to maintain a constant speed while telephoning in a driving simulator.[183] Speed variability can disrupt vehicular control, but the extent to which drivers would allow such disruptions to occur on the highway is less clear.[184]

A study published in 1989 reported on driving performance on public roads while engaged in instrument panel tasks.[185] Manually dialing seven digits on a telephone keypad "took less time to complete than a radio tuning task and demanded fewer glances, regardless of age."[186] Another study published in 1991 related the impact of telephone use on driver performance under different driving conditions on roads.[187] Particularly on quiet roads, lane deviation decreased while driving and conversing, perhaps because drivers' automatic information processing concurrently decreased, resulting in increased alertness during use of the cellular telephone.[188] "In general, the results of this study show that cognitively intensive cellular telephone communications tasks undertaken while driving may increase driver reaction time to objects and events."[189] Hands-free cellular telephones were recommended because "[s]teering wheel amplitudes were substantially higher with manual dialing[,]" even though the effect of those amplitudes "is comparable to that of tuning a radio while driving."[190]

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[178]*Id.* at 93. *See also id*. at 223-26.
[179]*Id.* at 93. *See also id*. at 221-22.
[180]*Id.* at 93.
[181]*Id.* at 93-94. *See also id*. at 186-87.
[182]*Id.* at 95. *See also id*. at 239-41.
[183]*Id.* at 95. *See also id*. at 227-28.
[184]*Id.* at 95.
[185]*Id.* *See also id*. at 213-14.
[186]*Id.* at 96.
[187]*Id.* *See also id*. at 194-96.
[188]*Id.* at 195.
[189]*Id.* at 96.
[190]*Id.* at 96, 195, 196 (citation omitted).

A study published in 1991 compared cellular telephone use with speaking to a passenger while driving on a road.[191] As measured by route completion time and drivers' eye movement, heart rate and subjective assessment of workload, "it suggests that cellular telephone conversations and conversations with a passenger need not be substantially different in terms of their effects on the driver."[192] A contrary result was reported in another study that year wherein test participants scored significantly lower on intelligence tests for conversations when using a cellular telephone opposed to those with passengers, probably because the passengers allowed for traffic when administering the test while the remote caller did not.[193] A 1993 road study comparing low complexity driving with and without conversation "indicated no evidence of change in driving behavior during" these phone conversations limited to two minutes involving arithmetic and memory.[194]

A study published in 1995 reported on male truck drivers driving on a road while dialing, radio tuning and engaged in a dialogue lasting one minute.[195]

> Speed variability was not practically significant and lane variability did not differ substantially among the dialing and radio tuning tasks. . . . Results obtained during the voice communications tasks indicated that there was no concurrent degradation in lanekeeping or speed maintenance measures during the conversations. However, there was a reduction in mirror sampling[196]

suggesting "that even a non-visual task like dialogue can affect driver situational awareness such as that maintained by mirror sampling."[197] A more interesting study from 1996 reported on the same tasks and conversational materials being tested in a simulator and on a road.[198] "Despite the similarity of tasks, materials, and procedures, numerous differences existed between the simulator" and on the road.[199] The pattern of differences suggest that "drivers in the simulator adopted a more lax attitude toward the driving task, . . . perhaps because there is no safety risk associated with degraded lanekeeping. On the road, the drivers maintained . . . consistent lanekeeping and speed control throughout . . . the

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[191] *Id.* at 96. *See also id*. at 204-06.
[192] *Id.* at 96, 97.
[193] *Id.* at 97. *See also id*. at 229-30. The researcher suggested investigating the possibility of a cellular phone system linked to route guidance or collision avoidance systems that could appropriately divert, record and interrupt cellular phone calls "based on driving circumstances." *Id.* at 97, 230, 232.
[194] *Id.* at 97.
[195] *Id.* at 98.
[196] *Id.* at 99.
[197] *Id.* *See also id.* at 249-51.
[198] *Id.* at 99.
[199] *Id.*

testing, thus providing evidence that they accorded appropriate priorities to" driving and phoning.[200]

An epidemiological approach is advantageous as it reflects actual driving; it is disadvantageous as it does not establish causation.[201] A 1996 study examined data of randomly selected drivers involved in crashes within the previous two years and compared them to a control group of randomly selected drivers who were crash free over the previous 10 years. Its findings suggested "a statistical association and not a causal relationship between cellular telephone use and crashes."[202] The drivers' risk was assessed via surveyed responses disclosing the frequency of attention diverting driver behaviors.[203] While "many other factors that influence driver attention have gone unmeasured[,]" the researchers "reported that talking more than 50 minutes per month on the cellular telephone while driving was associated with a 5.59-fold increase in crash risk."[204] Problematically, the difference between the case and the control group exceeded 90 percent, and there was no direct evidence that a cellular telephone was being used at the time of a crash.[205]

A much more famous "epidemiological study on the relationship between cellular telephone use and traffic safety is that of Redelmeier and Tibshirani."[206] They examined hundreds of Canadian drivers who had cellular telephones and were uninjured in traffic accidents but suffered substantial property damage.[207] Approximately 2/3 of the collision times were inexact because exact times were unavailable or inconsistent between sources.[208] They estimated that the risk of collision at least tripled "within 10 minutes after a cellular telephone call began as when the telephone was not used."[209] Maclure and Mittleman analyzed this data "and confirmed that the risk more than doubled within five minutes after the start of a call."[210] Redelmeier and Tibshirani also found that hands-free operation offered no safety advantage, that 39 percent of the drivers used the phone post collision to report the accident and that "the relative risk of having a crash while using a cellular telephone was estimated to be similar to the hazard associated with driving with a blood alcohol level 'at the legal limit.'"[211]

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[200]*Id.* *See also id.* at 210-12.

[201]*Id.* at 100.

[202]*Id.* at 100, 101.

[203]*Id.* at 100.

[204]*Id.* at 100-01.

[205]*Id.* at 101. *See also id.* at 254-55.

[206]*Id.* at 101. *See also id.* at 235-38. Their study is also separately summarized *infra* pp. 49-51.

[207]Nat'l Highway Traffic Safety Admin., *supra* note 89, at 101.

[208]*Id.*

[209]*Id.*

[210]*Id.* at 102.

[211]*Id.* Subsequently, Redelmeier and Tibshirani denied that their research indicated that using a cellular telephone while driving is equivalent to driving drunk. Donald A. Redelmeier and Robert J. Tibshirani, *Is Using a Car Phone Like Driving Drunk?* 10 Chance 5, 8 (1997).

As famous as this study is, its weaknesses should be equally famous. National Highway Traffic Safety Administration found substantial methodological flaws with this study. Only volunteers who were cellular telephone owners and who had accidents were included; owners who were accident free and drivers who were not cellular telephone owners were omitted.[212] The association was with crashes regardless of whether they were the cellular telephone owners' fault.[213] The approximately 1/3 of crashes whose times were exact were not separately analyzed from the total collisions, and, "[b]y any reckoning, the time of collision is subject to numerous sources of error."[214] Both analyses reflected 5- and 10-minute hazard intervals so that "[i]t is not known if the subject was actually on the cellular telephone at the time of the collision."[215] No causal link was established between cellular telephone use and crashes in this study

> [b]ecause of the many variables that can affect crash hazard probabilities but that cannot be equated with the . . . study design . . .. The implication of causality based on relative risk metrics would require very strong assumptions about the equality of baseline risk for each matched-pair in the study on all accounts except cellular telephone use. Such assumptions may not be plausible unless it can be assured that the situation characteristics . . . were the same across the two days. The implausibility of this is reflected in the fact that an adjustment factor of 35% was subsequently applied in their analysis because a subject may not have even been driving during the control period. . . . [T]he comparison in crash hazard exposure between cellular telephone use and driving while intoxicated is specious unless more data . . . are brought forth.[216]

In this epidemiological study, cellular telephone use averaged 2.3 minutes with most calls lasting less than two minutes while intoxicated drivers' impairment can be expected to endure throughout a trip.[217] "The comparison given in the article would suggest that cellular telephone use, per unit time, is actually much more hazardous than driving in an intoxicated state."[218]

National Highway Traffic Safety Administration summarized these simulator and test track studies by stating that compared to driving alone, manually dialing a cellular telephone can disrupt lanekeeping and speed maintenance and can sometimes be more disruptive than manually tuning a radio.[219] Compared to manually tuning a radio, manually dialing a cellular telephone did not disrupt lanekeeping and speed maintenance or those

[212]Nat'l Highway Traffic Safety Admin., *supra* note 89, at 102,104-05.
[213]*Id.* at 102.
[214]*Id.* at 103.
[215]*Id.*
[216]*Id.* at 104.
[217]*Id.*
[218]*Id.*
[219]*Id.* at 105.

disruptions were small; however, both can disrupt driving and crash data by then associated radio tuning with crash involvement.[220]

The administration summarized the voice communications tasks' effects on driving in these studies by stating that sufficiently simple and frequent voice communications enhanced driving for fatigued drivers, but the cognitively demanding conversational materials testing drivers in simulators and on test tracks degraded lanekeeping and speed or headway maintenance.[221] The conversational materials in these studies were not normal cellular conversations because they included intelligence tests and were unemotional.[222] Visual allocation of driver attention during a conversation on a cellular telephone "need not be any more demanding than conversation with a passenger[,]" but an observant passenger can converse while accommodating the traffic demands.[223]

It appears that manual dialing can disrupt vehicle control, situational awareness and judgment.[224] Fixed mount and hand-held architectures create different manual and visual demands: fixed mount may require more glance time to dial; a hand-held phone might not be dialable with one hand.[225] "On-road studies indicate that if the voice communications activities have any effects . . ., they are on driver situational awareness and not on vehicle control performance *per se.*"[226] In contrasting the conflict-free dialogues incorporating intelligence tests used in simulators where drivers have less motivation to avoid losing control to putatively normal cellular telephone conversations that are actually indulged in by motorists, the report identified a need to better understand characteristics of normal, actual cellular telephone communications so that they can be better represented in future studies.[227]

The epidemiological methodology seems appealing because it uses actual rather than experimentally contrived data,[228] but it carries difficulties as well. Association does not equal causation and the methodology did not assure that a cellular telephone was being used concurrent with the collision.[229] Redelmeier and Tibshirani's recent epidemiological study that was reviewed highlighted an increased risk of crashing associated with cellular phone use by drivers, yet examined only self-selected participants, did not distinguish whether the cellular phone users were at fault, didn't assure that the driver was using a cellular telephone at the time of the crash (in most cases an estimated time), made "very strong assumptions" in its relative risk metric "about the comparability in crash risk between periods where cellular telephone use preceded crash

[220] *Id.*
[221] *Id.* at 106.
[222] *Id.*
[223] *Id.* (citations omitted).
[224] *Id.* at 107.
[225] *Id.*
[226] *Id.* at 107-08.
[227] *Id.* at 108.
[228] *Id.*
[229] *Id.*

involvement and periods where it did not[,]" and included a substantial number of participants who might not have driven during the control period.[230]

Cellular telephones are beneficial because they are convenient and can be used to enhance productivity and safety.[231] On the other hand, "[d]river inattention . . . has been implicated in many traffic crashes[,]" and "[s]urvey results indicate that most people perceive cellular telephone use while driving as distracting."[232] Demographically expanding older drivers generally "find it more difficult to perform concurrent tasks and process information quickly" and "will often find it more challenging to operate cellular telephones that tend toward small displays and controls designed" for a younger population.[233]

> [I]t may not be obvious to other drivers if one spills a soda or scolds a child while driving, but the novelty and position of hand-held cellular telephones can quickly attract attention, and the relatively long duration of the activity further increases the likelihood that it will be noticed by other drivers.
>
> The consequent magnitude of public attention to cellular use by drivers may therefore not truly reflect a problem of sufficient magnitude to require some form of intervention, but rather the obvious nature of the behavior and associated consequences for driving. While the . . . evidence to suggest that use of cellular telephones while driving can increase the risk of crashes from several standpoints, there is little data that would allow one to determine and characterize . . . the magnitude of the problem.
>
> . . . .
>
> While limitations in the available data and the fast pace of change in the industry make it difficult to establish whether a problem exists at a level requiring . . . intervention, it is clear that the nature of the tasks imposed by cellular telephone use as well as trends in technology and usage raise many legitimate safety concerns.
>
> . . . .
>
> It should be noted that foreign laws restricting the use of cellular telephones in vehicles often restrict only the use of hand-held phones . . ..
>
> While the hands-free approach may . . . seem like an obvious solution to cellular telephone related safety problems, it presumes that crashes caused by cellular telephone use result primarily from dialing . . . or from reaching for, holding or dropping a phone. Although these factors certainly contribute to the crash picture, the data . . . suggest that conversation itself is the most prevalent

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[230]*Id.* at 109.
[231]*Id.* at 111.
[232]*Id.* at 111, 112 (citation omitted).
[233]*Id.* at 111(citation omitted).

> single behavior associated with cellular telephone related crashes in the United States.[234]

Conversing is typically lengthier than dialing, conversation may extend or hold cognition and may be emotional, and the remote converser can't observe the traffic.[235] "To the extent that conversation itself is associated with a higher risk of crashes . . ., the intended safety benefits of hands-free operation may paradoxically increase exposure to distraction-induced crash hazards" should the population of drivers willing to phone while driving increase substantially from the *status quo* in response to touted safety benefits of hands-free operation.[236]

New technologies and the adaptation of existing technologies to increase the availability of services to motorists may "increase driver workload beyond acceptable levels."[237] Human factors "encompass specific design considerations related to the display, controls, size, shape, location and other aspects of the systems."[238] Ergonomic enhancements may induce an unjustified sense of safety should drivers respond to them by increasingly indulging in distractive behavior made possible by design technology easing the demands of driving and operation of telematics.[239] In principle, the concerns from scores of years ago about distractions of car radios have been shown to be valid, but "[t]here does not appear to be an epidemic of crashes related to operation of the radio" highlighting "an acceptance of some degree of risk associated with the use of technology and the willingness of most drivers to adjust their behavior accordingly."[240] After reviewing all these studies, National Highway Traffic Safety Administration summarized its conclusions as follows:

> The cogency of a conclusion depends on the adequacy of evidence, the degree to which conclusions drawn logically follow from the evidence, and the degree to which no relevant information has been omitted from consideration. . . .
>
> **Does cellular telephone use while driving increase the risk of crash?** . . . "Yes," at least in isolated cases. . . .
>
> **What is the magnitude of the traffic safety problem related to cellular telephone use while driving?** . . . [T]he data that could serve as a basis for determining the magnitude of the crash problem do not exist. . . .
>
> **Will crashes likely increase with increasing numbers of cellular telephones in the fleet?** . . . "Yes" . . . it logically follows

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[234] *Id.* at 113, 114, 116.
[235] *Id.* at 116-17.
[236] *Id.* at 117.
[237] *Id.* at 121.
[238] *Id.*
[239] *Id.* at 122.
[240] *Id.* at 123.

> that if more cellular telephones are in use, then there will be more opportunity for distraction and, hence, there will likely be an increase in related crashes . . ..
>
> **What are the options for enhancing the safe use of cellular telephones by drivers?**[241]

Engineering and designing telematics to be as compatible with safe driving as possible "and educating drivers about potential risks associated with using this technology while driving."[242]

The authors recommended encouraging state authorities to "better identify and describe inattention or distraction-related crashes" and do so in a model "to achieve uniformity in data collection."[243] The authors also recommended that insurers share their information with National Highway Traffic Safety Administration.[244] "Educational materials should be developed and promoted that focus on the various ways that distraction . . . can increase the risk of crashes. . . . [R]esearch should seek to identify design solutions that minimize driver distraction as well."[245] Cellular telephone research should be behavioral and technological.[246]

> States are encouraged to actively enforce their reckless and inattentive driving laws . . .. . . . An effort should be initiated to examine the cost-benefit tradeoffs of legislative actions related to cellular telephone use while driving. Potential costs of unrestricted cellular telephone use may include those associated with distraction-induced crashes and degraded driving performance. Benefits of unrestricted cellular telephone use include more efficient use of commuting time, emergency service notification capability, and the conveniences attendant to closer communications . . ..
>
> Costs of legislative restrictions may include more expensive . . . equipment, restricted access while driving . . ., unforeseen secondary consequences . . ., and enforcement . . .. Potential benefits of empirically grounded legislation would include savings in personal injury, property damage, and crash-caused congestion . . . costs. . . .
>
> [I]t is recommended that in considering legislation, states be encouraged to base their deliberations on all available research

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[241] *Id.* at 123-24.
[242] *Id.* at 124.
[243] *Id.* at 125.
[244] *Id.* at 126.
[245] *Id.* at 126-27.
[246] *Id.* at 127.

studies, empirical observations and data that are available to them, particularly with regard to the dynamic nature of the technology and the manner in which it is used. Only when such considerations are carefully evaluated can we be assured that the outcomes will be as intended.[247]

## THE EFFECT OF CELLULAR PHONE USE UPON DRIVERS

The following studies highlight a potential hazard from a distraction caused by interactive conversation. Especially complex or intense conversations can slow responses and preclude detection of stimuli.

<u>The Effect of Cellular Phone Use upon Driver Attention</u>. Approximately 10 years ago, National Public Services Research Institute published "The Effect of Cellular Phone Use Upon Driver Attention," a study at least partially funded by AAA Foundation for Traffic Safety.[248] This relatively early study recognized that cellular phones used by millions of drivers could sizably affect transportation.[249] The study concluded, "Complex phone conversations created the greatest distraction and simple conversations the least, with tuning the radio falling in between."[250] This study observed that cellular phone conversations are no more distractive than conversations with passengers but predicted that conversations with drivers would increase significantly with increasing availability of cellular phones.[251] Perceptual responses of drivers rather than interference with vehicular control were expected to be the greater threat to safety caused by drivers using phones.[252] This is because:[253]

- perception plays a far greater role in automobile accidents than does vehicular control;

- selectively placing calls along with dialing aids such as voice activation can reduce interference with vehicular control; and,

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[247] *Id.* at 129-31.

[248] James & A. Scott McKnight, Nat'l Pub. Serv. Research Inst., *The Effect of Cellular Phone Use upon Driver Attention*, 1 (1991), *available at* http://www.aaafts.org/text/research/cell/cell0toc.htm (last visited June 20, 2000).

[249] *Id.*

[250] *Id.* at 2.

[251] *Id*. at 3.

[252] *Id*. at 4.

[253] *Id*.

- perception undergoes the greatest decline among older drivers, the demographic whose driving is most affected by telephone use.[254]

Because conversational distraction is largely mental, the nature of a conversation greatly influences the demand it places upon attention.[255]

This study attempted "to assess the effect of telephone use upon the driver's ability to meet the perceptual and cognitive demands of the highway traffic environment."[256] Specifically it attempted to answer:

- "What effect do placing calls and carrying on conversations have upon perceptually- and cognitively-mediated responses to highway traffic situations?

- How do these effects relate to the complexity of the conversation?

- How do these effects vary across highway traffic situations?

- How do any of these effects vary with age?"[257]

The study defined distraction to be "a diversion of attention from driving produced by some situation."[258] It tested participants placing a call and conversing casually and intensely[259] against responses while tuning a radio.[260] To measure distraction, inherently unobservable, drivers' vehicular control responses were measured during simulated highway traffic scenes[261] assuming that "the distraction should be apparent in a *difference* between vehicle control responses when the potentially distracting influence of the telephone is present versus the response which occurs in the absence of any distraction."[262] Whether and how long it took a driver to respond were recorded.[263] Young, mid-range and older drivers were tested.[264] The participants were shown videotaped driving

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[254]"Research has shown significant age-related decrement in general attention, selective attention, attention sharing and spatial judgment. . . . The attentional processes that must be shared when placing, receiving, or carrying on telephone conversations while driving are known to be vulnerable to age-related effects." *Id.* "Age has evidenced relationships with a number of psychophysical processes that bear tangentially upon use of cellular phones while driving. Age-related declines have been noted in information processing . . ., problem solving . . . and short term memory . . .." *Id.* at 5.

[255]*Id.* at 4.

[256]*Id.* at 5.

[257]*Id.*

[258]*Id.*

[259]*Id.*

[260]*Id.* at 7.

[261]*Id.* at 7-8.

[262]*Id.* at 8.

[263]*Id.*

[264]*Id. at 9.*

scenes and responded to them via simulated vehicular controls.[265] Each participant was tested with no distraction, tuning a radio, placing a call, and conversing simply and complexly.[266]

All potentially distracting conditions increased the length of time to respond and the proportion of situations missed entirely.[267] When too distracted to respond at all, "complex conversations were significantly more distracting than simple conversations."[268] Placing a call was not more distracting than casual conversation, but it delayed responses.[269] "[T]he deficiencies of older drivers significantly exceed those of the other two age groups in telephone calling . . ., and simple phone calls . . ., but not complex calls . . .."[270] Prior experience with cellular phones did not really impact their degree of distraction for response time and the likelihood of responding at all.[271]

> The three tasks associated with use of cellular phones . . . all led to significant increases in time to respond to highway traffic conditions and in the likelihood in failure to respond at all. . . . [C]omplex conversations . . . led to the greater degree of performance decrement—about on par with tuning a radio. . . . [P]lacing cellular phone calls yielded increases in response time similar to that of complex conversations, but increases in non-response that were similar to simple conversations. . . . The proportion of drivers age 50 and over failing to respond to highway traffic conditions while using cellular phones was two to three times greater than that of younger subjects. . . . [T]he oldest subjects took significantly longer to respond than their younger counterparts when placing calls, but evidenced no slower response time than the two other age groups when conversing on the phone. . . . Prior experience with cellular phones appeared unrelated to the degree of distraction involved in using cellular phones.[272]

The study concluded that simple, casual conversation and placing calls did not divert attention excessively, but conversations requiring intense

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[265] *Id.* at 9-10. These included an accelerator, brake, steering wheel and turn signal. *Id.* at 12.

[266] *Id.* at 12-13.

[267] *Id.* at 16.

[268] *Id.* "Looking at the proportion of subjects who were distracted from responding at all, the complex conversations yielded the greatest interference, while placing calls and carrying on simple calls yielded the least interference and tuning the radio fell somewhere in between." *Id.*

[269] *Id.*

[270] *Id.* at 17. "The effect of phone use upon older drivers seems more to prevent them from noticing various highway traffic conditions than to retard their response to them." *Id.* at 18.

[271] *Id.*

[272] *Id.* at 21. Tuning a radio was equally, highly distractive for all age groups. *Id.*

concentration were most distractive.[273] While performance decrement was comparable to tuning a radio, an intense phone conversation is likely to last longer than tuning a radio.[274] The authors questioned whether conversational distractions differ between those via cellular phones and those with passengers. Statistically, most drivers are alone when involved in a crash; therefore, the authors speculated that cellular phones would increase conversations with drivers and those conversations might be more intense than conversations with passengers.[275] The two implications from this study are:

- drivers should not engage in intense phone conversations when moving; and,

- if any demographic should not use cellular phones while driving, it is the older age group.[276]

The authors offered the following conclusions:

> 1. All forms of cellular phone usage lead to significant increases in . . . non-response to highway traffic situations and increase in time to respond.
>
> 2. Complex, intense conversation leads to the greatest increases in likelihood of overlooking significant highway traffic conditions, and the time to respond to them. The distracting effect is similar to that of tuning a radio. The effect of placing calls or engaging in casual conversation is less of a problem, although, calling tends to retard responses.
>
> 3. The distracting effect of cellular phone use among drivers over age 50 is two- to three-times as great as that of younger drivers and encompasses all three aspects of cellular phone use . . ..
>
> 4. Prior experience with cellular phones appears to bear no relation to the distracting effect of cellular phone use.[277]

Investigation of the Use of Mobile Phones while Driving. To assess the need for regulating drivers' usage of mobile phones, one needs to accurately evaluate the risk therefrom.[278] Because this usage adversely affects driving performance and reports vary widely by how much, better data needs collected

[273] *Id.*
[274] *Id.* at 22.
[275] *Id.*
[276] *Id.*
[277] *Id.* at 23.
[278] Alasdair Cain & Mark Burris, Ctr. for Transp. Research, Investigation of the Use of Mobile Phones While Driving i-ii (1999).

nationally.[279] Demographics of wireless subscribers now resemble that of the U.S. population.[280]

As did National Highway Traffic Safety Administration approximately two years prior, this report reviewed relevant literature on the topic. Among the reviewed studies was an epidemiological one using data from accident reports filed in Oklahoma between 1992 and 1995 "to determine statistical associations between traffic fatalities and the use or presence of a mobile phone."[281] Of the fatal accidents, 4.2 percent had mobile phones and 7.7 percent of those fatalities "were reported to be using the phone at the time of collision."[282] Those using a phone during a collision "had a nine-fold risk of a fatality over those without a phone."[283] Generalizing about the studies' results, the authors said that adverse effects were repeatedly found for driver reaction time, mental workload and lane position.[284]

> The epidemiological studies generally find that younger drivers are more at risk, while the on-road and simulator studies tend to find that older drivers are more susceptible to a mobile-phone-related crash. Given that the mobile phone's main effect is distraction of the driver, with resulting detrimental effects on reaction time and attention to road conditions, it would appear that older people, with their already-reduced reaction abilities, are more at risk from mobile phone use. The fact that young people appear more at risk in the epidemiological studies suggests that the crashes experienced by mobile phone users may be more due to factors other than mobile phone use.[285]

Fatality Analysis Reporting System (FARS) began recording mobile telephone use as possible driver-related factor in 1994.[286]

> A major problem with FARS is that data is skewed due to the way the Oklahoma data have been coded. In this state, a tick in the "mobile telephone installation" box has been taken to indicate a mobile-telephone-related crash. Further analysis of the data showed that less than 10 percent of the Oklahoma crashes were actually mobile-phone-related. Experience with the Oklahoma data has shown that even with check boxes included in the report, correct coding of mobile phone related crashes is not straightforward.[287]

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[279]*Id.* at i.
[280]*Id.* at 5 (citation omitted).
[281]*Id.* at 15.
[282]*Id.*
[283]*Id.*
[284]*Id.* at 18.
[285]*Id.* at 19.
[286]*Id.* at 20.
[287]*Id.*

At the time this data was being collected, officers responding to crashes in Oklahoma were to look for a mobile phone. If one was installed, he was to check that box on his report and ask if it was being used during the crash. If so, he was to check that box on his report.[288] This was when approximately 3/4 of all these phones were hand-held.[289] A recurring problem with indistinctly coding usage is that it remains unknown whether the driver was dialing, receiving a call or conversing during the crash.[290]

The authors, Cain and Burris, considered that the most notable aspects from data released National Police Agency of Japan about car-phone related accidents during the first six months of 1997 and 1998 are:[291]

1. They represented 0.34 percent of all accidents in Japan.

2. The most hazardous activity associated with using a mobile phone was receiving a call.

3. More than 3/4 of the mobile-phone-related accidents were rear-end collisions.

Summarizing the various data, Cain and Burris concluded that "it appears that most mobile-phone-related crashes occur due to drivers moving from their lane or colliding with a stopped vehicle in their lane, mainly due to inattention."[292] Mobile-phone-related crashes are probably underreported absent a specified element therefor on crash reports, but a check box does not assure accurate reporting if the element is in correctly or indiscriminately completed.[293]

The authors cautioned against promoting hands-free devices as being safe and averred that a governmental, national media campaign promoting "safe use of mobile phones while driving may prove extremely beneficial. . . . The need to legislate mobile phone use cannot be considered until there is a clear, quantifiable understanding of the relative risks involved."[294] The authors cited a 1997 British report concluding "that mobile phones would be unlikely to be a significant factor in accidents if" phones are used in light traffic, drivers dial pre-programmed numbers, conversations are casual and all use a hands-free kit.[295] "It is difficult to determine the best course of action" here absent large, real world data.[296]

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[288] *Id.* at 21.
[289] *Id.*
[290] *Id.*
[291] *Id.* at 23.
[292] *Id.* at 24.
[293] *Id.*
[294] *Id.* at 26, 30.
[295] *Id.* at 35.
[296] *Id.* at 38.

Driven to Distraction: Dual-task Studies of Simulated Driving and Conversing on a Cellular Phone. In a study published in 2001, phone conversations doubled "the failure to detect simulated traffic signals and" slowed "reactions to those signals that were detected."[297] This study evaluated the assumption commonly reflected by legislative proposals that drivers' "source of any interference from cell phones use is due to peripheral factors such as dialing and holding the phone."[298] The study reported the results of a controlled experiment "to assess the possible causal relationship between cell phone use and automobile accidents" by seeking to determine the extent and nature of interference with driving from cell phone conversations.[299]

A control group listened to a radio while simulating driving; the other group conversed on a phone while simulating driving.[300] The simulated driving was maneuvering a cursor via joystick to align it with a moving target on a computer display and braking via thumbing a button on top of the joystick when a red light was detected.[301] The probability of missing a simulated traffic signal more than doubled when conversing on the phone with no reliable difference between those conversing on a hands-free phone and those holding a phone.[302]

> [D]isruptive effects of the phone conversation were greater when participants were talking than when they were listening. . . . These data . . . demonstrate that the phone conversation itself results in significant slowing in the response to simulated traffic signals, as well as an increase in the probability of missing these signals. Moreover, the fact that hand-held and hands-free cell phones resulted in equivalent dual-task deficits indicates that the interference was not due to peripheral factors . . ..[303]

An additional control group listened to part of a recorded book while simulating driving and answered 10 multiple choice questions afterwards to assess their comprehension of the verbal material.[304] This listening did not significantly impair the simulated driving leading the experimenters to conclude that engagement in the phone conversation interfered with simulated driving rather than simply listening attentively to verbal material.[305] Both the increase in miss rates and increase in reaction times "from single to dual-task conditions was greater for the cell phone group than for the control group."[306]

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[297]David L. Strayer & William A. Johnston, Driven to Distraction: Dual-task Studies of Simulated Driving and Conversing on a Cellular Phone 2 (manuscript on file with J. St. Gov't Comm'n).

[298]*Id.* at 3.

[299]*Id.* at 4, 5.

[300]*Id.* at 5.

[301]*Id.* at 6.

[302]*Id.* at 7.

[303]*Id.* at 8.

[304]*Id.* at 9.

[305]*Id.* at 10.

[306]*Id.*

A second experiment required phone conversers to repeat words read to them and say words beginning with the last letter of a word read to them while simulating driving.[307] Participants in cell phone conversations missed twice as many simulated traffic signals and took longer to react to the detected signals.[308] Deficits were equivalent for those holding a phone with those on hands-free phones.[309] The experimenters contend that these data show that conversing on a cell phone while driving can interfere with the latter. "[L]egislative initiatives that restrict hand-held devices but permit hands-free devices are not likely to reduce interference from the phone *conversation*."[310] This interference with central attentional processes will impair appropriate driver reactions to unpredictable events.[311] Conversations with passengers can be modulated under difficult driving circumstances, but difficult driving circumstances are unlikely to be similarly detected by a remote converser.[312] While the experimenters showed no safety benefit for conversing on a hands-free device over a hand-held phone, they did acknowledge that dialing a phone while driving can interfere with driving.[313]

The Influence of the Use of Mobile Phones on Driver Situation Awareness. Subjects with little or no experience of driving while using a hands-free mobile phone were tested via simulation to determine their ability to control a vehicle and maintain a clear picture of the traffic situation while conversing on a phone.[314] The route was 15.5 miles and performances were measured between miles four and 11. Participants were asked three questions to determine their situational awareness.[315] For every question at both locations, there were more than twice as many correct answers when answered without a phone conversation than with a phone conversation.[316] A difference in reaction times to appearance of a square during a phone conversation were slower when a phone conversation just started.[317] Drivers on the phone averaged 200 meters more to adapt to a new speed limit than those not on a phone.[318]

> The results have shown that a young well-educated group of drivers were able to engage in a difficult carphone conversation and cope with basic control elements of driving reasonably well.

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[307] *Id.* at 11.

[308] *Id.* at 13.

[309] *Id.*

[310] *Id.* at 15. There is also evidence of the converse, driving disrupts the cell-phone conversation. *Id.* at 19.

[311] *Id.* at 14, 15.

[312] *Id.* at 15.

[313] *Id.* (citations omitted).

[314] Andrew Parkes & Victor Hooijmeijer, The Influence of the Use of Mobile Phones on Driver Situation Awareness *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/2.PDF (last visited Oct. 29, 2001).

[315] *Id.*

[316] *Id.*

[317] *Id.*

[318] *Id.*

> However even this group showed a dramatic fall off in situation awareness due to the level of concentration demanded by the carphone conversation. It is clear that more research is required into the nature and duration of typical carphone conversations, and into the behavioural and performance consequences for a wider group of drivers, in both simulated and real world environments.[319]

Legislation focusing solely on hand held devices "does not address the full extent of the problem."[320]

## MOBILE PHONES: IMPACTS ON ROAD ACCIDENTS

When read in conjunction, these studies highlight the unreliability of data from various sources and locales.

Driving and Using Mobile Phones: Impacts on Road Accidents. After randomly sampling 2,000 Kuwaiti drivers, researchers strongly recommended banning drivers from using mobile phones while a vehicle is moving.[321] The increasingly frequent use of mobile phones by drivers is unlimited to North America. Likewise, concerns abroad also relate to driver error. Driver error is faulted in almost 90 percent of Arabian accidents, but that error is usually speed.[322] This survey's sample showed that 73 percent of Kuwaiti drivers owned a mobile phone; another sample showed that 83 percent of Kuwaiti adults owned or rented a mobile phone.[323] Kuwaiti cell phone users averaged 1.4 calls during a daily trip.[324] Because of public officials' belief that these calls can significantly adversely affect road safety, the research intended to learn their likely contribution to road accidents.[325]

Like most places on earth, official data on road accidents in Kuwait were too incomplete to use, so the researchers pretested a bilingual questionnaire to use on 2,032 randomly selected employees with medium- and high-incomes who owned a car or were licensed to drive.[326] The completed questionnaires that were analyzed amounted to a little over 80 percent of the sample.[327] Less than

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[319] *Id.*
[320] *Id.*
[321] P. A. Koushki et al., *Driving and Using Mobile Phones: Impacts on Road Accidents*, Transp. Research Record 1694, at 27 (Paper No. 99-0064).
[322] *Id.*
[323] *Id.*
[324] *Id.*
[325] *Id.* at 27, 28.
[326] *Id.* at 28.
[327] *Id.*

half of the drivers over age 50 owned a mobile phone, while 60 percent or more of the younger drivers owned one.[328] A little more than 20 percent said that they did not use a mobile phone while driving.[329] Likewise, a little more than 20 percent said that they crashed at least once since acquiring a mobile phone, a period that averaged 2-1/2 years.[330] Those who used a phone once during an average trip had three times as many damaging accidents and four times as many injurious accidents since owning a phone than those who did not use a phone while driving.[331] Among those using mobile phones a lot while driving, the drivers over 50 suffered the highest rate of damaging accidents, "possibly because of their slower perception and reaction[,]" but no injurious ones, "perhaps because of the lower traffic speeds characteristic of elderly drivers."[332] Among those drivers using a phone once during an average trip, the least experienced (those under age 20) suffered the highest rate of injurious accidents.[333] Those with larger numbers of children along for trips had higher damaging accident rates, probably due to additional distraction resulting from their presence; however, those with more than five children had the lowest injurious accident rate, perhaps because of the slower speeds common among the older individuals sampled.[334]

"The study revealed that individuals in the study sample who were on the mobile phone once during an average urban trip experienced three times as many accidents involving property damage and four times as many injurious traffic accidents as those who never used their mobile phones."[335] Regardless of age, family, and other factors, "accidents increased with increasing frequency of mobile-phone use during a trip."[336] Citing the obvious danger, the researchers recommended forbidding drivers to phone while in a moving vehicle.[337]

This is a reasonable recommendation for Kuwait but might not be for Pennsylvania. Unlike the United States, "[r]oad accidents are the chief cause of death in the Arab world."[338] As bad as our data is, "accident statistics in the Arab world are extremely sketchy and . . . nearly 60 percent of road accidents . . . are not reported."[339] In the region, accidents might be considered fatal only when victims died at the scene or en route to a hospital.[340] National Highway Traffic Safety Administration considers accidents to be fatal when a victim dies within 30 days. Only 57 percent of the hundreds of records for fatal accidents in Kuwait

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[328] *Id.* at 29.
[329] *Id.*
[330] *Id.*
[331] *Id.* at 30.
[332] *Id.*
[333] *Id.*
[334] *Id.* at 32.
[335] *Id.*
[336] *Id.*
[337] *Id.*
[338] *Id.* at 27.
[339] *Id.*
[340] *Id.*

over three years showed the cause.[341] Our cultures are markedly different. To motivate Americans to thoroughly respond to a similar survey, the researchers would have likely had to satisfactorily assure confidentiality. To motivate Kuwaitis to thoroughly respond, they assured confidentiality and appealed to the predominant religious belief.[342] In Kuwait, low income laborers were excluded from the prospective sample because they own neither mobile phones nor cars.[343] It is perfectly possible that low income Americans could own either. Most tellingly, the researchers characterize Kuwait's population of drivers as "inexperienced, undertrained, and undisciplined" and the law enforcement environment as "relaxed."[344] Indeed, among the sample, the average age was 28.4 and the average years of driving experience was 8.4.[345]

Recent Human Factors Issues in the Use of Embedded Telematics Devices in a Vehicle. Since most owners say that they use their portable cellular phones while driving, motor manufacturers decided to design their products to incorporate this technology. General Motors did so by creating OnStar, a cellular phone system embedded in its vehicles. This study compared a census of OnStar calls placed to its center for personal assistance to the same system's automatic notification of deployed air bags.[346] During the period studied, OnStar allowed calls to a service advisor and emergency calls.[347] It has since added a third button to allow personal calls.[348]

OnStar's complete database of 8.1 million phone calls over a five-year period was analyzed.[349] Of all the calls that began or whose files were closed within 10 minutes preceding an automatic notification of an air bag deploying from the same vehicle, there were only nine cases in which the phone could have been used.[350] The frequency of an air bag deploying from a crash within 10 minutes after calling an advisor via OnStar occurred approximately once per million calls.[351]

- In one of those nine cases, there was no voice call.
- In two of those cases the driver was on the phone during the crash.
- In the remaining six cases, it is unlikely that the drivers were still on the phone.

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[341] *Id.* at 28.
[342] *Id.*
[343] *Id.*
[344] *Id.* at 32.
[345] *Id.* at 28, 29.
[346] Richard A. Young, Recent Human Factors Issues in the Use of Embedded Telematics Devices in a Vehicle 3 (2001) (manuscript on file with J. St. Gov't Comm'n).
[347] *Id.* at 4.
[348] *Id.*
[349] *Id.* at 8, 9.
[350] *Id.*
[351] *Id.* at 13.

"The frequency of association is about one air bag crash per four million phone calls when the phone is actually" being used during the crash.[352]

In one of those nine cases, the air bag deployed while the car was parked.[353] For the remaining eight cases whose vehicles were moving during the crash, there was no specific indication that a call contributed to a crash and other factors were identified that might have contributed thereto: fatigue, daypart, location, lost, stress and unfamiliar vehicle.[354] Given these actual crashes and their other possible causes, "the frequency of a call uniquely causing an air bag crash approaches zero air bag crashes per" 8,000,000 calls via OnStar.[355]

Association between Cellular-telephone Calls and Motor Vehicle Collisions. This epidemiological study is probably the most famous study to attempt to determine "whether using a cellular telephone while driving increases the risk of a motor vehicle collision."[356] The authors, Redelmeier and Tibshirani, studied 699 drivers who had cellular telephones and suffered substantial property damage but no personal injury from a motor vehicle collision occurring in 1994 and 1995 in Ontario.[357] "Thirty-nine percent of the drivers called emergency services after the collision, suggesting that having a cellular telephone may have had advantages in the aftermath . . .."[358] The authors associated the use of cellular telephones in a motor vehicle with a quadrupled risk of collusion during the call.[359]

Redelmeier and Tibshirani examined telephone records of the subjects for the day of collision and the preceding seven days.[360] They analyzed this data via case-crossover, in which each person was his own control by comparing his activity on the day of colliding "with a comparable period on a day preceding the collision."[361] The hazard interval included any telephone calls "during the 10 minutes before the estimated time of the collision."[362] After surveying approximately 1/7 of the subjects, the estimates of relative risk were adjusted to assume that more than 1/3 of the subjects were not driving during the control interval.[363] The collision times were regarded to be exact for almost 1/3 of the subjects and inexact for the remainder.[364] National Highway Traffic Safety Administration found this methodology substantially flawed.

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[352]*Id.* at 10.
[353]*Id.* at 11.
[354]*Id.* at 12.
[355]*Id.*
[356]Donald A. Redelmeier & Robert J. Tibshirani, *Association between Cellular-telephone Calls and Motor Vehicle Collisions* 336 New Eng. J. Med. 453, 453 (1997).
[357]*Id.* at 454.
[358]*Id.* at 453.
[359]*Id.*
[360]*Id.* at 454.
[361]*Id.* (citation omitted).
[362]*Id.* (citation omitted).
[363]*Id.*
[364]*Id.* at 455.

> The implication of causality based on relative risk metrics would require very strong assumptions about the equality of baseline risk for each matched-pair in the study on all accounts except cellular telephone use. Such assumptions may not be plausible unless it can be assured that the situation characteristics . . . were the same across the two days. The implausibility of this is reflected in the fact that an adjustment factor of 35% was subsequently applied in their analysis because a subject may not have even been driving during the control period.[365]

The authors said, "The primary analysis, adjusted for intermittent driving, indicated that cellular-telephone activity was associated with a quadrupling of the risk of a motor vehicle collision . . .. . . . Telephones that allowed the hands to be free did not appear to be safer than hand-held telephones."[366] The associated, increased risk "appeared stronger for collisions on high-speed roadways than for collisions in . . . low-speed locations . . .."[367]

Redelmeier and Tibshirani attribute a dearth of motor vehicle collisions associated with this rapidly growing technology to the brevity and infrequency of cellular telephone calls in vehicles.[368] The lack of safety advantage with hands-free telephones can be explained by the possibility of resulting motor vehicle collisions being caused by attentional rather than dexterous limitations.[369] "Regardless of the explanation, our data do not support the policy followed in some countries of restricting hand-held cellular telephones but not those that leave the hands free."[370] The authors indicated an association not a causation

> between the use of cellular telephones while driving and a subsequent motor vehicle collision. . . . [T]he data do not indicate that the drivers were at fault in the collisions; it may be that cellular telephones merely decrease a driver's ability to avoid a collision caused by someone else.
>
> We caution against interpreting our data as showing that cellular telephones are harmful and that their use should be restricted. Even if a causal relation with motor vehicle collisions were to be established, drivers are vulnerable to other distractions that could offset the potential reductions in risk due to restricting the use of cellular telephones. . . .

[365]Nat'l Highway Traffic Safety Admin., supra note 89, at 104. This study is also discussed *supra* pp. 32-35.
[366]Redelmeier & Tibshirani, *supra* note 356, at 455.
[367]*Id.*
[368]*Id.* at 456.
[369]*Id.* (citation omitted).
[370]*Id.*

> The role of regulation is controversial, but the role of individual responsibility is clear.[371]

Four years after this study was published, Redelmeier and Tibshirani commented that their "research might have underestimated the risks associated with using a cellular telephone while driving" because their calculation did not compare "the risk of collision under ideal circumstances of no distractions."[372] While driving with usual background distractions, they found that drivers were four times more likely to collide when using a cellular telephone compared to not using a cellular telephone.[373] If the ideal circumstance of no distractions hardly ever occurs, its relevance as a baseline is unclear. The point of using actual data from the real world is to obtain accurate data of what actually occurred. They then commented that "[m]aking calls on a cellular telephone is distinctly more risky than listening to the radio, talking to passengers and other activities commonly occurring in vehicles."[374] Since they associated a particular distraction with actual crashes, it's curious that they would assert this because the averment is unsupported by crash statistics.[375]

Redelmeier and Tibshirani further contended that their analysis could have underestimated "the risk associated with using a cellular telephone while driving" because only drivers with a cellular phone who had collided and consented to the research were included.[376] Their analysis seems to likely have overstated this risk because they solely examined the most frequently occurring accidents, those that result in property damage only.[377] This likely skewed their calculated risk upwards, but they don't think so because they found a higher risk for calls in high-speed locales relative to low-speed locales and know that a higher velocity generates a greater impact thereby increasing likelihood of injury.[378] Even if that didn't skew their calculation upwards, this fact probably did: they associated the risk of using a cellular telephone while driving only among drivers who actually crashed. In other words, they eliminated the less frequently occurring crashes, those that injure and kill, and ignored drivers using cellular telephones who have never crashed!

Suggesting that they underestimated the risk, Redelmeier & Tibshirani now say that regulating drivers' use of cellular telephones "may be justified, more cost-effective . . . and especially attractive."[379]

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371 *Id.* at 457.

372 Donald A. Redelmeier & Robert J. Tibshirani, *Commentary (Car Phones and Car Crashes: Some Popular Misconceptions)* 164 Can. Med. Ass'n J. 1581 (2001).

373 *Id.*

374 *Id.*

375 *See* table 7, *infra* p. 96.

376 Redelmeier & Tibshirani, *supra* note 372, at 1582.

377 *Id.*

378 *Id.*

379 *Id.*

Wireless Telephones and the Risk of Road Accidents. This epidemiological study sought to objectively verify "whether an association exists between cell phone use and accidents."[380] A questionnaire was sent to 175,000 drivers licensed to drive passenger vehicles asking about "exposure to risk, driving habits, opinions . . ., accidents within the last 24 months" and cell phone usage.[381] Out of the 38,300 completed questionnaires, 36,079 consented to the disclosure of data from their wireless services and their driving records.[382] "The relative risks for accidents . . . is 38% higher for cell phone users than it is for nonusers[,]" but risks diminish if other variables are factored in.[383] The heavy users suffer approximately twice the risk that minimal users suffer.[384] These relative risks are less than 1/10th of the risk described by Redelmeier and Tibshirani.[385] This study claimed that the case-crossover design applied by Redelmeier and Tibshirani to this kind of data overestimated the true risk.[386] Given the often inaccurately reported time of collision and the short average duration of calls, this study's authors suspect that calls placed after an accident could easily have been erroneously classified by Redelmeier and Tibshirani as have been placed prior thereto.[387] Moreover, Redelmeier and Tibshirani's "comparison with a control day is debatable since the driving activity on that day is unknown."[388] Almost all of those surveyed for this study use a cell phone while driving, drive more kilometers annually and drive more often after 8 p.m. than the nonusers.[389] Given their and others' results, these authors encouraged safety measures for users and a consideration of "the association between frequency of calls and the risk of accident."[390] Although a few countries restrict or forbid phoning while driving, "[i]t would be premature to ban all cell phone use without better data and without examining the contributions of cell phones to road safety."[391]

## SURVEYS

Although of varying quality, these surveys reveal what respondents say they do while driving and share some of their perceptions. The more useful

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380 Claire Laberge-Nadeau et al., Université de Montréal, Wireless Telephones and the Risk of Road Accidents xiii (Can. Council of Motor Transp. Adm'rs trans., 2001).

381 *Id.*

382 *Id.*

383 *Id.* at xiv.

384 *Id.*

385 *Supra* pp. 49-51.

386 Laberge-Nadeau et al., *supra* note 380, at xiv.

387 *Id.*

388 *Id.*

389 *Id.* at xv.

390 *Id.*

391 *Id*. at 6.

surveys resulted from observations of thousands of motorists during daylight and calculated that between 3 and 4 percent of drivers are using a phone.

Survey to Measure Prevalence of Driver Cell Phone Use. As part of National Occupant Protection Use Survey during October and November 2000, National Highway Traffic Safety Administration's National Center for Statistics and Analysis observed 12,000 drivers at controlled intersections in 50 U.S. geographical areas.[392] It observed 3 percent of drivers actively using a hand-held cell phone at any given time during daylight.[393] Having learned from its telephonic survey during late last year and earlier this year that approximately 73 percent of the drivers who said that they usually have a wireless phone in their car[394] use a hand-held phone and approximately 22 percent use hands-free equipment, it estimated that 3.9 percent of drivers were using a phone anytime during daylight.[395] This estimation is for all passenger vehicles, but usage varied therein from a high of 4.8 percent for vans and sport utility vehicles to a low of 1.9 percent for pickup trucks.[396] Weekday usage was substantially higher than weekend usage, and usage drops substantially during rush hour.[397]

North Carolina Cell Phone Study. University of North Carolina Highway Safety Research Center likewise observed 14,059 vehicles at scores of locations statewide.[398] According to its preliminary results, 3.1 percent of drivers were observed actively using a hand-held cell phone during daylight.[399] The higher usages were in utility vehicles, in vehicles with no passengers, and during the late afternoon commute.[400]

Network of Employers for Traffic Safety. Network of Employers for Traffic Safety recently announced that 39 percent of respondents to its latest survey "engage in distracting activities while driving for work[,]" and 94 percent of respondents "indicated doing something distracting while driving."[401] Reported by 90 percent of respondents, talking with passengers ranked as the top

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[392] Carra, *supra* note 20. This was the first time that a national survey of drivers using cell phones was based upon actual observation rather than telephonic interviews. *Id.*

[393] *Id.*

[394] "The 2000 Motor Vehicle Occupant Safety Survey . . . estimated that 54 percent of drives 'usually' have some type of wireless phone in their vehicle with them." Nat'l Highway Traffic Safety Admin., *supra* note 11.

[395] Carra, *supra* note 20. Sampling error for the overall estimate is 0.5%. *Id.*

[396] *Id.*

[397] *Id.*

[398] Donald Reinfurt, Remarks at Nat'l Conf. of State Leg's Driver Focus and Tech. Forum (Sept. 11, 2001).

[399] *Id.*

[400] *Id.*

[401] News Release, NETS, Campaign Targets Distracted Driving & Safety Belt Use (Sept. 10, 2001), *available at* http://www.trafficsafety.org/newsroom/091001 (last visited Oct. 17, 2001). Respondents were surveyed during Aug. 2001. *Id.*

distractive activity.[402] The results of this survey are similar to results of other surveys in recent years by this network and other organizations.[403] "Driver surveys indicate the most common distractions are: tuning a radio, eating, drinking beverages, conversing . . ., reading and writing, . . . and personal grooming."[404]

Work-related distractions include "reviewing notes, talking on the phone, making lists, or using a computer."[405] Compared to the general public, substantially fewer respondents "who routinely engage in distracting activities" perceive these activities to be dangerous.[406] "U.S. Department of Transportation estimates that driver distraction is a factor in 25 to 50 percent of all crashes" amounting to thousands daily.[407] Network of Employers for Traffic Safety is a partnership to improve safety and health by reducing the number of traffic crashes on and off the job.[408] Its poll taken in June 2000 "found that distracted driving was cited as the fourth most serious driving safety issue, following drunk driving, aggressive driving and speeding."[409] The network advises that crashes caused by inattention are "predictable, preventable and within the driver's control."[410]

Traffic/Public Safety Study on Driver Distraction. During 1996, Wisconsin Department of Transportation's Bureau of Transportation Safety contracted with a corporation to study that state's "residents' perceptions regarding driver distraction and how car phones might help to improve traffic/public safety."[411] That year, inattentive driving caused 17.7 percent of motor vehicle crashes in that state.[412] The two most frequently perceived distractions were fatigue and car phone use as cited by 34.3 percent and 23.6 percent of respondents,

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[402]*Id.* When surveyed during June 2000, 70% said that they routinely talk to passengers while driving and 47% said that they adjust controls while driving. News Release, *infra* note 404.

[403]News Release, *supra* note 401.

[404]News Release, NETS, Leading Employers Join to Combat Distracted Driving (June 10, 2000), *available at* http://www.trafficsafety.org/newsroom/06272000.cfm (last visited Oct. 17, 2001).

[405]News Release, *supra* note 401.

[406]*Id.*

[407]*Id.*

[408]*Id.*

[409]News Release, *supra* note 404.

[410]News Release, *supra* note 401.

[411]Knupp and Watson, Inc., Wis. Dep't of Transp., Traffic Public/Safety Study: Driver Distraction Summary 1 (1997).

[412]For crashes in Wisconsin during 1999, the highest percentage of primary driver contributing factors was inattention, 17.1%. The only higher percentage was for no driver cause, 25.4%; speed was after inattention, 13.7%, and disregard of signal was a close third. Wis. Dep't of Transp., 1999 Wisconsin Traffic Crash Facts 51 (2000). Also for crashes that same year in Wisconsin, inattention was cited the most times for driver possible contributing circumstances, 25,190, with failure to yield right-of-way a close second, 24,907. *Id.* at 54. A possible contributing circumstance was cited for a driver in 74% of the total crashes that year. *Id.*

respectively.[413] The two most frequently perceived causes of distractively caused crashes were fatigue and daydreaming, cited by 57 percent and 10.7 percent of respondents, respectively, with car phones being a close third.[414]

About the time of this survey, a distracted driver task force was charged "[t]o increase driver safety through education, information, proper equipment usage and enforcement that enables drivers to focus their attention on the driving task." The task force called for a coordinated and comprehensive educational campaign on distracted driving, involving public, private and law enforcement support. The task force concluded that drivers must be more courteous and made aware of many intrusions affecting their behavior. Although not the major cause of inattentive driving, wireless subscribers should be educated on phoning. Also, police must better enforce the law against inattentive driving.

In the approximately five intervening years since this survey, the perceptions of Wisconsin's residents may have changed because a telephonic survey of 1,002 last season showed that 73 percent of them favor forbidding holding a phone while driving.[415]

Prevention Magazine Report. In this report, almost everyone surveyed said that he or she listens to music or news while driving and a supermajority said that they consume food and beverage while driving.[416] A similarly sized supermajority said that they change a CD or tape while driving.[417] The survey showed that at that time, approximately 1/3 try to scan a map or follow written directions while moving and approximately 1/5 talk on a phone while driving.[418]

*Prevention's* report issued in 1996 asserted that "America's roadways have never been safer."[419] By then, the death rate per 100,000,000 vehicle miles had dropped to approximately half of the rate it was in 1980[420] and is now at a historically low level.[421] Less than half of those surveyed obey the speed limit.[422] Aside from speeding, the report considered cellular telephones to threaten safety.[423] It seems curious that cellular telephone use by drivers would be identified as a potential danger because 95 percent of car phone owners denied

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[413] Knupp and Watson, Inc., *supra* note 411, at 2.
[414] *Id.*
[415] Vikki Ortiz, *Most in State Poll Want to Ban Cell Phone Use while Driving*, Milwaukee J. Sentinel, Aug. 30, 2001, at A1.
[416] Prevention Rep., *Auto Safety in America 1995*, at 17 (1995)
[417] *Id.*
[418] *Id.* at 17, 18.
[419] Prevention Rep., *Auto Safety in America 1996*, at 1 (1996)
[420] *Id.*
[421] News Release, U.S. Dep't of Transp., Secretary Mineta Announces Progress, Setbacks for Highway Safety in 2000 (Sept. 24, 2001), *available at* http://www.nhtsa.dot.gov/nhtsa/announce/press/pressdisplay.cfm?year=2001&filename=pr49-01.html (last visited Oct. 17, 2001).
[422] Prevention Rep., *supra* note 419, at 1.
[423] *Id.*

having "come close" to crashing while talking on a phone.[424] This information was obtained during fall 1995 via a nationwide telephone survey developed by research associates assisted by National Highway Traffic Safety Administration.[425]

Less than 1/3 of those surveyed followed all three of *Prevention's* auto safety measures: always being belted, never driving after drinking and obeying the speed limit.[426] A little more than 1/4 said that they talk on their phones during 1/2 or more car trips; a little more than 3/5 said that they rarely or never talk on a phone while driving.[427] Only 2 percent said that they crashed "with someone who was driving while talking on a car phone."[428] According to most car phone owners, talking on them isn't more distractive than tuning a radio while driving.[429]

## MEASURING EYE MOVEMENT WHILE DRIVING

These studies highlight attempts to objectively measure visual behavior while actually driving in attempts to better understand attention, especially with concurrent tasks.

A Technical Platform for Driver Inattention Research. Developmental corporations and institutes of technology are integrating systems to study how inattention affects driving behavior. To positively impact "risk prevention and road safety[,]" Volvo Technological Development Corporation and Linköping Institute of Technology "hope to guide development of human-system interfaces by learning about the visual demands of interiors and about visual behavior in general. . . . Driver inattention is the most prevalent primary cause of collisions . . .."[430] A technical platform is being developed "to collect real-time data on driver visual behavior, recognize what the driver is doing . . ., predict" what he would likely do next and assist him.[431] There are more visual demands placed on a driver than those from new information systems. Substantial and longstanding visual demands causing crashes include those from fatigue, loose objects, interactions with passengers and involuntary, visual occlusion.[432] Aside from prohibiting inattentive driving, the risks therefrom can be reduced by developing

[424] *Id.*
[425] *Id.*
[426] *Id.* at 2.
[427] *Id.* at 2, 8.
[428] *Id.* at 2.
[429] *Id.* at 8-9.
[430] T. Victor, A Technical Platform for Driver Inattention Research 1, 2 *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/7.PDF (last visited Oct. 30, 2001).
[431] *Id.* at 2.
[432] *Id.* (citation omitted).

human-systems interfaces that minimize distraction, automating vehicular control and systematically supporting attention.[433]

"It is expected that changes in visual scanning patterns and gaze fixations . . . will occur with the introduction of modern in-vehicle information systems . . .."[434] Researchers have found:[435]

1. A correlation between risk taking and average glance duration.

2. Difficulties in perception and task demands increasing fixation pauses.

3. Differences between experts and novices using information systems.

4. Increased glance times and frequency with increased age.

To study glance duration and frequency under specific driving situations, a system was developed to track head and eye movements.[436] This system is integrated with vehicle performance data and a lane tracker.[437] "Preliminary road tests show that the Volvo/ANU system robustly tracks head pose, gaze, and eye closure in real-time, in real vehicle environments."[438] The researchers believe that this technical platform "provides a unique opportunity to study how inattention affects driving behavior."[439]

Measuring Distraction via the Peripheral Detection Task. Whether induced by a critical scenario or messages from a driver support system, this test sensitively measures peaks in workload.[440] Due to their similarity, workload is measured as a proxy for distraction because inattention can result from the lack of ability to sufficiently attend to all concurrent tasks or from one task requiring so much attention that other things are missed.[441] "If workload is predictable, the driver will generally try to control" it, "by making the primary driving task easier."[442] Even if short, increases in workload can be dangerous especially when sudden or unanticipated.[443] To overcome interpretational problems measuring subjectively evaluated workload and the limited utility of measuring time spent gazing at a visual display, this test measures "workload or attentional

[433] *Id.*
[434] *Id.* (citation omitted).
[435] *Id.* (citations omitted).
[436] *Id.* at 2, 3.
[437] *Id.* at 3.
[438] *Id.* at 4.
[439] *Id.* at 5.
[440] M. H. Martens & W. van Winsum, Measuring Distraction: The Peripheral Detection Task 1 *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/34.PDF (last visited Oct. 30, 2001).
[441] *Id.*
[442] *Id.*
[443] *Id.*

distraction" by "measuring the detection of stimuli in the functional visual field."[444] This test presented a small, red square in front of a subject driving in simulated traffic.[445] If detected within two seconds, the reaction was timed; if it took longer than two seconds to detect, it was regarded as undetected.[446]

Compared to the controlled condition, reaction times increased and more signals were missed with critical incidents on a motorway, such as a lead vehicle unexpectedly braking or an unexpected obstacle appearing.[447] "These results indicate that both" reaction time "and misses are sensitive to differences in driving situation."[448] Performance on the peripheral detection task "also strongly deteriorated when a speech warning message was presented compared to group of subjects that did not receive any message for the critical scenario."[449] Performance on the task "proved to be sensitive to variations in primary (driving) task demand and to variations between the demand or distraction of in-vehicle messages."[450] The evidence suggests that peripheral detection task "measures the variations in selective attention, in which the selectivity of attention increases with workload (cognitive tunnelling)."[451]

Measuring Driver Visual Distraction with a Peripheral Detection Task. "The Peripheral Detection Task is a method for measuring the amount of driver mental workload and visual distraction in road vehicles."[452] In-vehicle systems could be evaluated by this method to determine how distractive they are for people to use while driving.[453] These authors concluded that this task "is a good tool for measuring visual distraction and mental workload in a real car[,]" but has to be validated "across a wider range of driving and in-vehicle tasks."[454] Under this task, drivers have to respond to peripherally viewable targets; it should be effective for visual distraction and attentionally induced distraction.[455] This task was previously tested in a simulator and was tested on a real road for this paper.[456]

A small, red light emitting diode was randomly reflected for one second via heads-up display whereupon the driver had up to two seconds to record

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[444] *Id.* at 1, 2.
[445] *Id.* at 2.
[446] *Id.* at 3.
[447] *Id.* at 4-5.
[448] *Id.* at 5.
[449] *Id.* at 6.
[450] *Id.*
[451] *Id.*
[452] S. Olsson & P. C. Burns, Measuring Driver Visual Distraction with a Peripheral Detection Task 1 *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/6.PDF (last visited Oct. 30, 2001).
[453] *Id.*
[454] *Id.*
[455] *Id.* at 2.
[456] *Id.*

noticing it.[457] While driving on a motorway and country road, drivers had to determine the frequency tuned on a radio and select a specific station, and turn on a CD-player and play a specific track on a specific CD.[458] The cognitive task was counting backwards.[459] While doing these, pulse, subjective mental effort, reaction and target hit rates were measured.[460] The mean reaction times on the baseline were

> significantly faster than the counting task and the CD task on the motorway. On the country road, the counting task had significantly slower reaction times than the other tasks and baseline. . . . Significantly more targets were missed during the three tasks than for the baseline driving on the motorway and country roads. More targets were also missed during the CD task on the motorway than during the radio task . . . and counting task . . ..[461]

The targets were presented on the windscreen in an area corresponding to where pedestrians and road signs might appear.[462] This task might be used to establish unacceptable degradations in performance so that a composite of reaction time and misses could be an absolute criterion.[463] The peripheral detection task is "a good tool for measuring driver workload because data collection is automated[,]" but additional measures such as speed and lane tracking should be examined to validate it.[464]

<u>Effects of Verbal and Spatial-imagery Tasks on Eye Fixations while Driving</u>. A Spanish study published in 2000 investigated "the effects of mental tasks on visual search behavior while driving" under the assumption that eye movement reflects attention.[465] This is important because

> [v]isual perception is the main source of information when driving, and attention is crucial to visual perception. . . . [T]he study of attention while driving has neglected the relevance of mental activity itself, its potential interference with the driving task, its significance . . . of risk, and . . . the possible differences between different types of mental activities.[466]

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[457] *Id.* at 2-3.
[458] *Id.* at 3.
[459] *Id.*
[460] *Id.* at 4.
[461] *Id.* at 4, 5.
[462] *Id.* at 6.
[463] *Id.*
[464] *Id.* at 7.
[465] Miguel A. Recarte & Luis M. Nunes, *Effects of Verbal and Spatial-imagery Tasks on Eye Fixations while Driving*, J. of Experimental Psychol.: Applied (Mar. 2000), *available at* http://www.apa.org/journals/xap/xap6131.html (last visited Mar. 31, 2000).
[466] *Id.*

Pupillary dilation was considered indicative of attentional workload.[467] Previous research associated decreased duration of fixation with a greater need for visual inspection and "stated that eye movement rate often reflects the rate of thoughts[.]"[468] Better established is that duration of fixation increases

> with the amount of information to be extracted. Previous research has established that high attentional workload produces attentional focus narrowing. . . . [T]he focus narrowing was deduced from spatial variability reduction of fixations and peripheral processing impairment. If this narrowing effect is attentional, then it should also occur when the increment of attentional demands is due to concurrent cognitive tasks instead of to an increase of visual scene complexity . . .. Additionally, if eye movements in dynamic environments reflect the assignment of attentional resources to objects or locations, then this attentional narrowing should cause a reduction of the functional visual field, which could be relevant to road safety."[469]

Participants were asked to perform a mental task while driving an instrumented car in real traffic for approximately 20 minutes each time on different types of roads along unfamiliar routes.[470] A task was either verbal or spatial-imagery and two of each of these were tasked on each route.[471] Drivers' pupillary size and fixation was analyzed for driving during a task and driving during no task and speed and glances at mirrors and dashboard were also analyzed.[472] Eyes were measured via a video-based eye tracking system that did not restrict the visual field.[473] Seventy-seven per cent of the fixations were from driving with no task, 11 percent of the fixations were from driving during a verbal task and 85 percent were from driving during a spatial-imagery task.[474] Participants subjectively rated the similarity of their experimental driving with their everyday driving; the averaged rating among the participants was 75 on a scale of 100.[475]

> [P]erforming mental tasks while driving caused an increased attentional workload on ordinary thought, as shown by pupillary dilation. . . . [F]ixation duration increased when participants performed a spatial-imagery task. . . . These results may have theoretical implications, because the observed effects do not

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[467] *Id.*
[468] *Id.* (citations omitted).
[469] *Id.* (citations omitted).
[470] *Id.*
[471] *Id.*
[472] *Id.*
[473] *Id.*
[474] *Id.*
[475] *Id.*

> seem to depend on external events, from which more or less information must be extracted, but rather on mental processes.[476]

Vehicle driving speed was not reduced during the mental tasks, but glances directed to the interior mirror while on the highways decreased during the verbal and spatial-imagery tasks to approximately 2/7 and 1/7, respectively, of the rate of frequency during normal (no task) driving.[477] On both highways and roads, "the frequency of visual inspection of the offside mirror decreased when a mental task was performed."[478] The frequency of fixations on the dashboard decreased during the tasks to a rate of less than 1/4 on the highways and 1/3 on the roads of what they were during no task driving.[479] The percentage of glances at the speedometer decreased especially sharply during the tasks; "the information it provides is not as relevant for safe driving as that provided by the rear view mirrors."[480]

The experimenters did not associate any differences of speed or traffic density.[481] There were marked differences of variability of fixations with higher variability during the verbal tasks than with the spatial-imagery tasks.[482] The experimenters attributed narrowed visual inspection to reduced attentional focus rather than just the consequence of reduced glances to mirrors and the dashboard.[483] The changes in visual inspection patterns during the mental tasks were qualitatively different depending upon the tasks and were detected on roads and highways.[484]

> With regard to the implications for driving, the spatial reduction of the visual inspection window, including the reduction of the inspection of mirrors, could be interpreted as a predictor of decreased probability of detecting traffic events, particularly when performing mental spatial-imagery tasks. However, considering the limitations of interpreting eye movements in terms of attention, this cannot simply be assumed. The issue of whether the narrowing of the visual inspection window causes loss of peripheral visual capacity and visual information processing . . . remains open. Practically speaking, such visual concentration may be no worse than driving with disperse attention and gaze . . .. A more direct demonstration . . . is necessary to discover whether events occurring in the visual periphery while driving are more poorly detected when performing a mental task or whether

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[476] *Id.*

[477] *Id.* There were no glances to the interior mirror while performing a mental task on a road, but there were relatively few glances thereon when no task was performed.

[478] *Id.*

[479] *Id.*

[480] *Id.*

[481] *Id.*

[482] *Id.*

[483] *Id.*

[484] *Id.*

> information . . . is more poorly processed when performing a task. On the one hand, any reduction of information availability can be interpreted as a higher risk level. On the other hand, this is only true if, while driving normally, all our attentional resources are focused on relevant driving information so that any reduction in visual processing would imply less availability of this information. . . . While looking at the road scenario, there is a lot of information that is irrelevant in a specific driving context. . .. . . . [W]e do not know whether the eliminated glances correspond to relevant or irrelevant information, as far as road safety and optimization of the driving strategy are concerned.[485]

The similarity of mental tasks used in this experiment to everyday mental activities such as calculating and listening remains unknown.[486]

## ROUTE GUIDANCE SYSTEMS

These papers describe the same test.[487] Voice recognition technology proved better to use than visual-manual methods. On other than the voice destination entry system and cell phone, younger drivers performed better than older drivers.

<u>Individual Differences and In-vehicle Distraction while Driving: A Test Track Study and Psychometric Evaluation</u>. Participants drove an instrumented vehicle on an oval test track with very light traffic while entering destinations on commercially available route guidance systems, dialing on a commercially available wireless cellular telephone and manually tuning an after-market car radio.[488] "In-vehicle task completion time, average glance duration away from the road ahead, number of glances away from the road ahead and number of lane exceedences were recorded."[489] This performance was correlated to performance on

> an automated battery of temporal visual perception and cognitive tasks . . . to determine the extent to which individual driver

[485] *Id.* (citations omitted).

[486] *Id.* The verbal tasks consisted of repeating words starting with a letter indicated by the experimenter; the spatial-imagery task consisted of generating a letter, rotating it and responding to queries about the image. *Id.*

[487] Nat'l Highway Traffic Safety Admin., U.S. Dep't of Transp., Driver Distraction with Wireless Telecommunications and Route Guidance Systems (2000).

[488] Louis Tijerina et al., Individual Differences and In-vehicle Distraction while Driving: A Test Track Study and Psychometric Evaluation *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/4.PDF (last visited Oct. 30, 2001).

[489] *Id.*

> differences could account for observed performance differences. . . . Driver distraction or workload reflects three major influences: the nature of the in-vehicle device or task, the driving conditions under which that task is pursued, and the individual abilities of the driver.[490]

Some results among test track measures are intuitive. "[T]ask time is highly correlated with glance frequency to the device."[491] Rather than attempt to detail the numerous, specific results, a general assessment is summarized.

> The variability shared in common between a given measure of test track performance and the "best" subset of test battery measures is modest at best. This perhaps reflects the relative contribution of individual differences . . . to in-vehicle task completion while driving. . . . It would not be surprising to find that the specifics of the task and driving conditions at the time of task execution, combined with driver motivation, fatigue, and the like command a much larger share of the variability in task outcomes. There is also random errors that arise in device use and a variation in error recovery that also increase response variability.
>
> When each dependent measure was examined within the context of specific test battery components, there was high face validity to predictor sets. Thus, better task time was associated with better temporal acuity, faster processing and higher cognitive capabilities. Likewise, reduced glance frequency was associated with better dynamic visual and temporal acuity, better pattern comparison performance and faster processing of information. These relationships and degree of overlap suggests that . . . it may be possible to tune in-vehicle tasks to the specific cognitive and temporal capabilities of individual drivers . . ..[492]

Driver Workload Assessment of Route Guidance System Destination Entry while Driving on a Test Track. Participants drove an instrumented passenger car on a 7.5 mile, multilane test track with light traffic while entering destinations into four commercially available route guidance systems, dialing a cellular phone and tuning a radio.[493] Measurements were taken for visual allocation, driver–vehicle performance, and time.[494] The older (55 years and

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[490] *Id.*

[491] *Id.*

[492] *Id.*

[493] Louis Tijerina et al., Driver Workload Assessment of Route Guidance System Destination Entry while Driving: A Test Track Study 1 *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/10.PDF (last visited Oct. 30, 2001). This paper was presented in proceedings of the 5th Intelligent Transportation Systems World Congress in 1998 and is likely the first published data "on the demands of route guidance system destination entry while driving." *Id.*

[494] *Id.* at 4.

older) drivers averaged almost twice as much time as the younger (35 years and younger) drivers entering destinations into the route guidance systems, three of which involved visual-manual demands with the fourth involving voice in- and output.[495] All the Point-of-Interest "destination entry tasks took significantly longer than manually dialing an unfamiliar 10-digit number . . . or manually tuning a modern radio . . ..."[496] There was almost no difference between the older and younger drivers in time it took to vocally enter destinations on the one voice data entry system tested.[497] The older drivers glanced at the Point-of-Interest destination entry almost twice as many times as the younger drivers.[498] Of course, the voice data entry system drew the fewest glances among all the devices (including the cell phone and radio), but drew more than twice the number of glances to a note card than any other system.[499] The average mean glance duration to the voice destination entry system was approximately one second and ranged from approximately 2.5 to 3.2 seconds for the other systems and comparison tasks.[500] "These mean single glance durations are disturbingly long."[501] Older drivers averaged approximately eight lane exceedences per 10 trials entering destinations and younger drivers averaged less than two lane exceedences per 10 trials.[502] There were no lane exceedences while entering destinations vocally and less than one lane exceedence per 10 trials while dialing the cell phone.[503] There were approximately two lane exceedences per 10 trials while tuning the radio and on one of the visual-manual destination entry systems; the remaining two destination entry systems numbered approximately nine lane exceedences per 10 trials.[504] While entering destinations, the older drivers had their eyes off the road more than twice the duration that the younger drivers did.[505] Dialing the cell phone and tuning the radio required the least amount of time that eyes were off the road.[506] Among all the devices, the ones that caused the least difference between younger and older drivers in time that eyes were off the road were the voice destination entry system and the cell phone.[507] The device that allowed the longest average single glance duration to the road scene ahead during the in-vehicle tasks was the voice destination entry system.[508]

> [O]n average, all three systems with visual-manual methods of destination were associated with lengthier completion times, longer eyes-off-road-ahead times, longer and more frequent

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[495]*Id.* at 2-3, 5, 7.
[496]*Id.* at 5.
[497]*Id.* at 5, 7.
[498]*Id.*
[499]*Id.*
[500]*Id.*
[501]*Id.* at 5.
[502]*Id.* at 5, 8.
[503]*Id.*
[504]*Id.*
[505]*Id.* at 6, 8.
[506]*Id.*
[507]*Id.*
[508]*Id.*

> glances to the device, and greater numbers of lane exceedences than the voice system. . . . Regardless of system, the destination entry task took substantially longer to complete than 10-digit cellular telephone dialing or radio tuning to a specific frequency.
> . . . .
> These data suggest voice recognition technology is a viable alternative to visual-manual destination entry while driving. . . . Further research must also . . . examine the effects of voice interaction on the selective withdrawal of attention that degrades object and event detection while leaving visual allocation to the road ahead and vehicle control largely intact. In the interim, these data suggest that destination entry with visual-manual methods is ill-advised while driving.[509]

## DIVIDED ATTENTION ABILITY OF YOUNG AND OLDER DRIVERS

"[O]lder drivers spend more time than young drivers acquiring information from an in-vehicle display" because of "diminished perceptual and cognitive abilities."[510] This study measured drivers' ability to obtain information while constantly switching between near and far visual tasks and steer while performing the divided attention task.[511] It also compared drivers' "performance relative to two display formats."[512] The younger drivers were 23 to 46 years old; the older drivers were 58 to 76 years old.[513] During this experiment via simulation, drivers were to report four digits superimposed on a road scene ahead and the same amount of information displayed 18 degrees below and 32 degrees to the right of the driver's straight-ahead plane.[514] For both displays, the younger drivers averaged significantly more correct responses than the older drivers.[515] For both age groups, there were significantly more correct responses when the information was superimposed on the road scene than when displayed down to the right.[516] Average performance by the young drivers was significantly better than that of the older drivers meaning that they kept position in lane better, but lane positional errors increased for both groups as intervals between the display of information decreased.[517] "[O]lder drivers performed more poorly than the young drivers when attaining information from inside the vehicle" and "when

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[509] *Id.* at 1, 6.

[510] Ronald R. Mourant et al., Divided Attention Ability of Young and Older Drivers 1 *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/9.PDF (last visited Oct. 30, 2001).

[511] *Id.*

[512] *Id.*

[513] *Id.* at 1-2.

[514] *Id.* at 2.

[515] *Id.* at 4, 5.

[516] *Id.* at 5.

[517] *Id.* at 9.

reading the information that was superimposed at a far distance. . . . [T]he amount of the difference between young and older drivers increased with task difficulty."[518]

## THE INTERACTION OF NON-DRIVING TASKS WITH DRIVING

"Drivers often perform tasks . . . that don't relate to control of their vehicle. This experiment evaluates the impact on simulated driving of performing non-driving tasks."[519] One way to reduce congestion and its resultantly high costs is "to provide travelers with devices which would give them timely information for route selection and congestion avoidance."[520] Experimental subjects were required to maintain speeds, keep the car centered and quickly respond to simulated brake lights while performing secondary tasks.[521] Older drivers' driving performance was significantly degraded while doing some tasks and the map device caused the greatest problem.[522] "This study showed that there were objective reasons for considering the evaluation of trade-offs between providing drivers with information requiring a high degree of visual attention and traffic safety."[523]

The loading tasks used auditory, visual and tactile senses.[524] In a previous study at the same laboratory, researchers found that a driver's attention was "most important" rather the direction of gaze when evaluating a Radio Broadcast Data System to determine if "drivers would be less distracted if they did not need to read the display thus taking their eyes from the road."[525] The authors recognize the trend of increased information in the driving environment placing "greater attentional demands on the driver" and

> are aware that division of attention among multiple tasks leads to degradation of primary . . . performance, especially in high demand . . . conditions. . . . What is . . . unknown is the relationship between the division of attention and safety in terms of collision. We *do* know that attention is implicated far more in driving safety than simple visual function. . . . As divided attention is clearly a critical factor in safety, it is central to an understanding

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[518] *Id.* at 10.
[519] Wende L. Dewing et al., The Interaction of Non-driving Tasks with Driving technical report documentation page (1995) (manuscript on file with J. St. Gov't Comm'n).
[520] *Id.* at 1.
[521] *Id.*
[522] *Id.*
[523] *Id.* at 2.
[524] *Id.* at 3.
[525] *Id.* at 3-4.

> of how in-vehicle intelligent-traveler communication devices can be used.[526]

If "the display becomes the center of attention and primary demands such as headway and velocity control are neglected[,]" a crash can result.[527] Drivers can visually sample the view while performing a secondary task such as tuning a radio and not crash each time they look at a radio but might crash in an unusual circumstance.[528] "However, increasing the time attention is spent looking inside the vehicle increases proportionately the opportunity of collision."[529] A head-up display keeps a driver from having to look down at the display, but he can still be attentionally captured thereby leaving him blind as if looking in a different direction, especially if fatigued.[530]

> The general finding is that as the driver devotes more . . . attention to an increasingly difficult driving task, performance . . ., up to some difficulty level, does not change but performance on the secondary task deteriorates. However, eventually the increasing difficulty of the secondary tasks will degrade primary task performance. This is the basis for the hypothesis that secondary tasks will increase the mental workload of the driver until the driver becomes overloaded and driving performance fails. If traffic is heavy or the weather is bad, overload may happen with very little secondary task loading.[531]

A loading task "imposes a load on attention, cognitive function and/or motor function. Theories of human information processing generally predict that cognitive and motor performance will decrease as a function of the number of tasks being processed concurrently."[532] Theories of attention include the classic single channel and the multiple resource.[533] The former asserts that "human attention can concentrate on only a single task at any given time" so that processing is serial; the latter asserts that humans can parallel process multiple tasks.[534] Both of these theories may be correct.[535]

> [T]he effect of doing more than one thing while driving may depend both on what exactly is being done while driving and what specific driving behaviors are examined. . . . [C]ertain combinations of mental and physical behaviors may affect certain aspects of driving while having little or no effect on other aspects

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[526] *Id.* at 4.
[527] *Id.* at 5.
[528] *Id.*
[529] *Id.*
[530] *Id.*
[531] *Id.* at 5-6.
[532] *Id.* at 6.
[533] *Id.* (citations omitted).
[534] *Id.*
[535] *Id.*

> of driving. . . . [A]n empirical demonstration of the relative safety of one particular combination of loading tasks should not be taken to generalize to any other combination which has not yet been tested.[536]

Research has often used and continues to use "loading tasks chosen more for their experimental and theoretical convenience than for ecological validity."[537] Counting dots displayed on a screen, responding to colored cues, mentally mathematically calculating and tracking an object with a joystick while simulating driving "are not the kinds of multiple tasks in which motorists routinely engage."[538] This experiment used "simple behaviors in which motorists routinely engage while driving, . . . to assess the effects of these behaviors on various critical aspects of actual driving behavior."[539] The tasks for this experiment were conversing via intercom, simulating a hands free cellular phone conversation, reading an electronic map mounted at the center of the dashboard and tactilely searching for an object inside a container while simulating driving on a straight stretch of a two-lane highway with no oncoming or cross traffic.[540] Lane drift, speed and response time to simulated brake lights from a leading vehicle were measured.[541]

Equal numbers of 20 males and females were divided into groups under 49 years old and over 52 years old.[542] "Older subjects never performed as well as younger subject[s] for any of the tasks or task combinations. . . . There is an obvious age effect with older subjects taking longer to respond to the stimulus lights than younger subjects."[543] Speed maintenance and steering also "showed significant age effects."[544]

By themselves, the talking and finding tasks were insignificant and became significant when combined with the map task.[545]

> Talking and Finding activities do not unduly degrade driving performance while the Map Task does cause unwanted degradation in driving. Within the constraints imposed by this experiment we find support for the idea that attending to a cellular phone conversation or groping about in purses or briefcases are relatively safe activities while using a map display of the kind used here is not. . . . [W]e believe that the amount of attention,

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[536] *Id.* at 6-7.

[537] *Id.* at 7.

[538] *Id.* (citations omitted).

[539] *Id.*

[540] *Id.* at 13-14, 15. The conversations were about issues, interests and personal experiences. *Id.* at 15.

[541] *Id.* at 17, 18.

[542] *Id.* at 22.

[543] *Id.* at 23, 27.

[544] *Id.* at 29.

[545] *Id.* at 29-30.

particularly visual attention, required while using the device left too little attention to be devoted to controlling the car and responding to outside stimuli.[546]

The general finding is that different secondary tasks impacted driving differently rather than simply having an additive effect.[547] "We believe we have shown objective reasons for considering the evaluation of trade offs between providing drivers with information and driving safely."[548]

## ISSUES IN THE EVALUATION OF DRIVER DISTRACTION ASSOCIATED WITH IN-VEHICLE INFORMATION AND TELECOMMUNICATIONS SYSTEMS

"Increased productivity is a pressing national goal as people find themselves spending long periods of time engaged in the seemingly monotonous task of driving."[549] Intelligent Transportation Systems "can make long commutes more an opportunity to complete useful pursuits and less a matter of 'lost time.'"[550] This paper was written "to examine some key issues associated with the safety evaluation of in-vehicle information and telecommunications systems, specifically in the context of driver distraction."[551] Attention can be withdrawn via eyelid closure from fatigue, glances away from the road and thoughts.[552] This withdrawal can result in "degraded vehicle control and degraded object and event detection."[553] When attention is withdrawn due to thoughts, vehicle control might not degrade but object and event detection could because visual scanning and sampling may deteriorate.[554] Biomechanics can also interfere with attention.[555]

Safety was indirectly measured by measuring safety-relevant distraction effects of drivers: eye glance behavior, vehicular performance, controls, subjective assessments of workload and task completion time.[556] There is no unanimity in what factors *prima facie* relate to safety.[557] One common

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[546] *Id.* at 30.
[547] *Id.*
[548] *Id.*
[549] Louis Tijerina, Issues in the Evaluation of Driver Distraction Associated with In-Vehicle Information and Telecommunications Systems 1 *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/3.PDF (last visited Oct. 30, 2001).
[550] *Id.*
[551] *Id.*
[552] *Id.* at 2.
[553] *Id.*
[554] *Id.*
[555] *Id.*
[556] *Id.* at 2-3 (citations omitted).
[557] *Id.* at 3.

measurement of vehicular performance is lanekeeping. "[S]ome argue that if there is no one nearby, if the lane exceedence is small or of short duration, if the lane exceedence reflects the driver's strategy for reducing workload during concurrent task execution . . .. there is no safety implication at all."[558] This reasoning "honors the wisdom of the driver to generally make good choices. On the other hand, it flies in the face of accident statistics that indicate drivers by and large get into trouble precisely when they think everything is fine, i.e., in daytime, dry pavement, moderate traffic density situations."[559]

When evaluating safety, in-vehicle task demand and its incidences of execution are critical.[560] Legislative initiatives mandate hands-free phones to enhance traffic safety.[561]

> [T]he increased ease of use that might accompany hands-free operation might also increase the incidence of cellular phone use while driving. Drivers who previously used hand-held units might use their cellular phones more frequently. They may use the cell phone over a broader range of speed regimes, road types, and driving situations . . .. Drivers who previously would not have used the cellular phone while driving might now begin to do so because of the perception that hands-free operation is "safe." Drivers might engage in longer voice communications with hands-free units now they do not have to hold the phone to their ears.
> . . . .
> [A] comprehensive safety evaluation should consider both the demand when a device is used, and also the incidence of device use. The latter has been woefully overlooked in highway safety research for many years.[562]

It is difficult to estimate benefits and detriments of safety-relevant technology generally and Intelligent Transportation Systems particularly.[563] Hazard analysis was suggested to predict safety in lieu of crash counts because crashes are too rare to rely upon those counts as predictive of safety.[564] This analysis assumes that more frequently observable incidents are related to crashes.[565] Those incidents are measured on a small-scale and extrapolated to estimate the number of crashes to estimate safety.[566] These incidents include driver errors and near misses.[567] Definitions for near misses vary making "it virtually impossible to compare and contrast studies . . . in meaningful ways to

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[558] *Id.*
[559] *Id.* (citation omitted).
[560] *Id.*
[561] *Id.* (citation omitted).
[562] *Id.* at 3, 4-5.
[563] *Id.* at 5.
[564] *Id.* (citation omitted).
[565] *Id.*
[566] *Id.*
[567] *Id.* at 6.

assess the validity" of this type of approach.[568] One might think to define a near miss in terms of evasive maneuvers, but this "is illogical in light of the fact that in a large percentage of crashes . . ., there is no precrash evasive maneuver."[569] These extrapolations are inherently unreliable. For example, if the incident is a near miss when a device is being used, then there will always be zero crashes per incident![570] Driver errors can be divided into intended and unintended but with no reliable accuracy and can only be inferred when there is an observable hazard.[571] Because of the differences between damage only and injury accidents, it "appears that severe accidents should not be directly estimated from minor traffic conflicts."[572] One proposal to predict safety from correlated data is Heinrich's Triangle for ADVANCE Baseline Study, which takes more frequently occurring measures to predict the rate of occurrence of rarer measures.[573] The data starts at Driver Error (Hazard Not Present) and goes to Driver Error (Hazard Present), continues to Near Miss and then Non-injury Accident and concludes with Injury Accident.[574] While *prima facie* reasonable, "even if the correlations between A and B and B and C are as high as 0.7 . . ., the relationship is completely indeterminate" because "the correlation between A and C can range from perfect" to none.[575] "At some point, a crash is a *fait accompli* . . .. It is also . . . hard to observe, and so is virtually useless for prediction."[576]

The author of this paper, Louis Tijerina, suggests that the compelling evidence linking distraction and traffic safety will show a systematic trend toward higher rates of crash hazard exposure with increasing distraction from an in-vehicle device, rather than simply "finding that drivers with cell phones had higher rates of crashes than drivers without cell phones" or, conversely, "that drivers had fewer crashes with than without a Collision Avoidance System."[577] This is analogous to the persuasive link that smoking causes cancer.[578] A systematic trend is important to establish causation because simply lower crash rates of drivers with collision avoidance systems could otherwise equally plausibly be explained by assuming that reckless drivers do not use that technology.[579] To be persuasive empirically, one needs to show that:[580]

1. The more demanding a device is to use, the greater the risk of crashing.

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[568]*Id.*
[569]*Id.* at 9 (citation omitted).
[570]*Id.*
[571]*Id.*
[572]*Id.* at 7, 9.
[573]*Id.* at 5, 6.
[574]*Id.* at 8.
[575]*Id.* at 9.
[576]*Id.*
[577]*Id.*
[578]*Id.*
[579]*Id.* at 10.
[580]*Id.* at 11.

2. The more use of a device, the more likelihood of crashing.

3. Those who stop using a device while driving have lower rates of crashes than those who don't.

4. There is a particular type of crashes caused by distracted driving such as rear-end and they have similarly contributing factors such as looked but did not see.

5. Distracted drivers have higher rates of near-misses and errors.

6. There are abnormally high rates of factors with certain systems such as looked but did not see cases increasing with usage of voice-based systems.

7. Drivers with certain devices have lower rates of crashes than those with other devices, such as those with hands-free cellular phones compared to drivers who hold a phone.

8. Evidence of passive exposure by showing higher rates of passengers being injured while riding with motorists who use a device while driving compared to passengers riding with motorists who do not use that device while driving.

These implications would "have moderate to strong empirical correlational support and" be "persuasive because it is so coherent. . . . It is clear that safety evaluation of driver distraction associated with in-vehicle information and telecommunications systems is a complex undertaking. The prediction of safety benefits or costs is difficult at best."[581] In the "belief that the prospects to predicting the number of crashes that might arise with the use of a particular" Intelligent Transportation Systems "technology are poor[,]" Tijerina concluded that the more useful goal in evaluating safety might be eliminating improper driver behavior or operational problems.[582] He also recommended evaluating safety when iteratively testing products during their life cycle to continuously improve them.[583]

[581] *Id.* at 11, 12.
[582] *Id.* at 12.
[583] *Id.*

**SPEECH-BASED INTERACTION WITH IN-VEHICLE COMPUTERS: THE EFFECT OF SPEECH-BASED E-MAIL ON DRIVERS' ATTENTION TO THE ROADWAY**

"This study uses a car-following task to evaluate how a speech-based e-mail system affects drivers' response to a periodically braking lead vehicle."[584] Palmtop and wearable computers paired with cellular communications technology allow new information systems to be placed in motor vehicles thereby enhancing mobility and productivity, but possibly distracting drivers and undermining safety.[585]

> [C]onsistent with the visual and motor demands of driving—a speech-based interface allows drivers to keep their hands on the wheel and eyes on the road. However, little research has addressed the cognitive load of a speech-based interface for in-vehicle computers and none has examined its effects on driver performance.[586]

The potential for distraction from visual displays are recognized, but few researchers have addressed the distractive potential of auditory displays and verbal controls.[587] Speech-based interfaces share characteristics with vocal communications experienced during a cellular telephone conversation, and the latter's potential to distract drivers and degrade safety has been suggested by research.[588] A poorly designed speech-based "interface may distract drivers and increase reaction time."[589]

There are competing theories of attention, namely multiple resource and single channel, limited-capacity.[590] The former's resources are independent so that time on a common, centralized processor can be shared efficiently by speech-based resources associated with audition, verbal working memory and vocal response along with driving-based resources associated with vision, spatial working memory and manual response.[591] Under the latter theory, limited capacity of centralized processing undermines safe, dual performance.[592] "More important than the specific attentional resources may be the strategies of task

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[584] John D. Lee et al., Speech-based Interaction with In-vehicle Computers: The Effect of Speech-based E-mail on Drivers' Attention to the Roadway 1 *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/27.PDF (last visited Oct. 30, 2001).

[585] *Id.*

[586] *Id.*

[587] *Id.* at 2. (citations omitted).

[588] *Id.*

[589] *Id.*

[590] *Id.*

[591] *Id.*

[592] *Id.* (citation omitted).

management."[593] When not fully aware of distraction induced by speech-based interaction, drivers may fail to compensate.[594]

Differences between conversing in person or on a phone and with a computer can include vocal quality, recollection of commands and systematic syntax, spatial navigational demands from a complex menu, interaction modulated according to a driving situation, and flexibility by a driver to abort interaction.[595] "As the driving environment becomes more complex, more attentional resources are needed to maintain performance."[596] The interaction between a complex driving environment and a complex in-vehicle system could increase a driver's cognitive load undermining his awareness of the roadway and delay his responses.[597]

While interacting with e-mail systems on simulated simple and complex drives, young drivers' reaction time to an erratically braking vehicle was measured along with their subjective mental workload and situational awareness.[598] Responses were slower on both drives when the e-mail system was available.[599] Responses were approximately equal during the complex drive with no e-mail as they were during the simple drive with e-mail available.[600] The differences in complexity between the two e-mail systems tested did not significantly affect reaction times.[601] The complexity of the driving environment did not significantly affect the subjectively reported workload.[602]

> Safe use of in-vehicle information systems depends on whether interactions interfere with driving, whether drivers recognize the interference, and whether drivers can modulate their attention to the in-vehicle system to minimize the consequence of this interference. . . . These results show that a speech-based e-mail system can constitute a distraction similar to that of simple verbal reasoning tasks performed with a hands-free cellular telephone.[603]

There was "a 30% increase in reaction time and a large increase in subjective workload due to the cognitive demands of speech-based interaction."[604] Complexity of the e-mail system increased subjective workload and perceived distraction but not reaction time.[605]

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[593] *Id.* (citations omitted).
[594] *Id.*
[595] *Id.* at 3.
[596] *Id.*
[597] *Id.*
[598] *Id.* at 3, 4-5.
[599] *Id.* at 6.
[600] *Id.*
[601] *Id.*
[602] *Id.* at 7.
[603] *Id.* at 7, 8.
[604] *Id.* at 8.
[605] *Id.*

> Speech-based interaction draws upon some of the same cognitive resources as driving and so can distract drivers just as visual displays and manual controls can. . . . [I]n this experiment, drivers generally recognized that speech-based interaction imposes a cognitive load and that increasing the complexity of the interaction imposes a greater load and is perceived as more distracting. . . . Future research should examine how well this perceived distraction corresponds to the actual level of distraction. These results suggest speech-based interfaces should not be used indiscriminately . . ..[606]

In evaluating the relevance of this study, several observations should be considered. Driving in this experiment was simulated so that drivers' risks differed than on an actual roadway and may have allowed them to pay more attention to the in-vehicle system than they might have had they been actually driving.[607] Drivers were exposed to the speech-based system for approximately one hour so that their long-term adaptation to the system was undiscovered.[608] Other likely factors that could have added to the cognitive load of speech-based interactions were not manipulated.[609] The study tends to demonstrate that speech-based interaction can undermine driving safely if drivers fail to appropriately modulate their attention to accommodate demands on their cognitive resources.[610]

## COST-BENEFIT ANALYSIS

Activities that are distractive to drivers cause crashes. These crashes result in specific, direct costs to individual persons as well as general, indirect costs to society through higher insurance rates. The amount of direct and indirect costs from driving distractions is substantial. But most activities that can potentially distract drivers confer significant benefits to drivers and other members of society—*this is the reason the activities are undertaken in the first place*. Indeed, the benefits from these activities are also important.

The benefits from activities that are potentially distractive to drivers derive their value from our very mobile society. In informal discussions of these activities, the benefits related to mobility are often underemphasized. On the other hand, many of the major costs from the activities are more visible. Consequently, the costs tend to be overemphasized.

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606 *Id.* at 9.
607 *Id.*
608 *Id.*
609 *Id.*
610 *Id.*

Cost-benefit analysis is a formal, economic model with which to determine the worth of an activity by attempting to quantify the costs and benefits associated with the activity. Applied to driving distractions, the costs are the total direct and indirect costs associated with the distractive activities. The benefits are the total current and future benefits of these activities, with future benefits discounted to determine their present values. Benefits minus costs are net benefits.

On balance, are the net benefits from activities that distract vehicle drivers positive or negative; i.e., do benefits exceed costs, or vice versa? Under this approach, the answer to this question should ultimately determine whether activities that are even potentially distractive to drivers ought to be permitted, prohibited or restricted. A positive net benefit indicates that an activity has economic value.

The cost-benefit calculus for most driver distractions is difficult to specify in theory, let alone measure with precision given currently available data. To date, attempts have been made to apply formal cost-benefit analysis to the most common of the new technologies that is viewed as a driving distraction: cell phone use by drivers in vehicles.[611] These studies contain many important assumptions and reflect the current lack of reliable information. These limitations are acknowledged to influence the studies' conclusions. Nonetheless, the studies illustrate how the methodology of cost-benefit analysis can be applied to the topic of driving distractions in general and might be developed into a policy tool.

Both of the following studies from Harvard Center for Risk Analysis and Hahn et al. valuably contribute to the consideration of activities that might potentially distract motorists. Focusing on an important, specific driving distraction, they show how the cost-benefit methodology might be applied to the topic of driving distractions in general. They attempted to delineate the important benefits and costs related to cellular phone use by drivers and provide a serious attempt to quantify the benefits and costs. Most importantly, they show why the cost-benefit approach should be applied to the topic of driver distractions: *a proper evaluation of this topic must consider both the benefits and costs relating to driving distractions*. They emphasized that better data and further research on benefits and costs are needed to make the cost-benefit model into a relevant policy tool.

<u>Cellular Phone Use while Driving: Risks and Benefits</u>. Although unquantified, the major benefits and costs of cellular phone usage by drivers in

[611]In the future, other driver activities may become equally or more important, such as using fax machines, surfing the Net, using navigational systems, employing more sophisticated entertainment systems, etc.

vehicles were delineated in a recent study by the Harvard Center for Risk Analysis.[612]

Benefits of cell phone use by vehicle drivers:

- Personal benefits[613] (including preventing unnecessary trips, diminishing the tendency to speed, contributing to security and peace of mind, improving mental alertness, facilitating privacy in communication and expanding productivity for commuters).

- Family/household benefits[614] (including more efficient execution of household responsibilities, parental and familial peace of mind, and more time at home).

- Social network benefits[615] (including increased social connectedness and coordinating social engagements).

- Business benefits[616] (including increased productivity and efficiency and increased responsiveness to clients and co-workers).

- Community benefits[617] (including improved knowledge of emergencies, apprehending criminals and decreased times responding to accidents).

This list includes both individual and societal benefits. Individually, these benefits are not readily quantifiable from existing data sources.

Costs of cell phone use by vehicle drivers:[618]

- The costs of injuries that are minor, serious, crippling and even fatal.
- The costs of property damage.
- Related health care costs.
- Litigation expenses.
- The costs of insurance administration.
- The costs of lost work time.
- The costs of other adverse ramifications of collisions.

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[612]Karen S. Lissy et al., Harvard Ctr. for Risk Analysis, Cellular Phone Use While Driving: Risks and Benefits (2000).

[613]*Id.* at 41-43.

[614]*Id.* at 44.

[615]*Id.* at 45.

[616]*Id.* at 46.

[617]*Id.* at 46-48.

[618]Harvard Ctr. for Risk Analysis calls these "risks" rather than costs. The two are synonymous. The list excludes increases in insurance premia, an important indirect cost from this activity.

Likewise, these costs affect both individuals and society. Some of the costs can be estimated using driver performance studies that utilize experiments to simulate the ways in which cellular phone use affects driver behavior, case reports of crashes involving cell phones that rely on empirical data gathered from police accident reports, and epidemiological studies that apply modern statistical tools to individual-level data on cell phone use and vehicle traffic crashes.[619] Other costs are very difficult to determine.

Using Redelmeier and Tibshirani's relative risk associated with phoning while driving,[620] researchers at Harvard Center for Risk Analysis calculated "the average annual probability of death to a driver using a cellular phone" to be about six chances per 1,000,000 drivers.[621] This was compared to other, voluntary risk factors such as unrestrained drivers in a vehicle with air bags calculated to be about 49 annual fatalities per 1,000,000 drivers and driving for six hours annually with a blood alcohol concentration of 0.1 percent calculated to be about 31 annual fatalities per 1,000,000 drivers.[622] They also calculated the average annual probability of death to a motorist being killed by a driver while phoning to be 1.5 per 1,000,000 individuals in United States. This was compared to other, involuntary risk factors such as pedestrians killed by a motor vehicle calculated to be 22.2 annual fatalities per 1,000,000 individuals in United States and sober drivers being killed by a driver with measurable alcohol in his blood calculated to be 17.6 annual fatalities per 1,000,000 individuals in United States.[623] However, these researchers believe that their estimate of risk associated with phoning while driving is more uncertain than their estimates for the other risks.[624]

Using Hahn and Tetlock's quantified monetary costs of banning cellular phones while driving and Redelmeier and Weinstein's estimated health benefits therefrom expressed in quality adjusted life years saved, researchers at Harvard Center for Risk Analysis calculated the cost to be $700,000 per quality adjusted life year saved.[625] Harvard Center for Risk Analysis expressly acknowledges the uncertainty of this estimate noting that it could be as low as $50,000 per quality adjusted life year saved, yet still regards prohibiting phoning while driving to be an inefficient policy to save lives and reduce injuries from traffic crashes relative to other promotions.[626] In contrast, the center calculates lap/shoulder belts and daytime running lights to cost less than zero per quality adjusted life year saved and the reduction of rural interstate speed limits to 55 miles per hour to cost $82,000 per quality adjusted life year saved.[627] "The 'costs' of a lower speed limit are primarily the time/productivity costs to motorists . . ., the sort of 'inconvenience' cost that is central to the policy debate about using cellular

[619] Lissy et al., *supra* note 612, at 14.
[620] *Supra* pp. 49-51.
[621] Lissy et al., *supra* note 612, at 35, 36.
[622] *Id.* at 37.
[623] *Id.* at 38.
[624] *Id.*
[625] *Id.* at 54-55.
[626] *Id.* at 56, 58.
[627] *Id.* at 57.

phones while driving."[628] After asserting that "it is impossible to determine whether the effectiveness of a policy is worth the costs," the center advocated considering economic efficiency when deciding a public policy even though it is not necessarily the single, decisive factor.[629]

Policymakers are reasonably uncertain whether to restrict or prohibit the use of cellular phones while driving because of "the weak scientific database on risks and benefits."[630] The risk may be "too small to be detected in overall crash" statistics yet large enough to be a serious concern.[631] The substantial benefits of phoning while driving receive "much less study and attention than the risks."[632] Although a necessarily preliminary finding, prohibiting the use of cellular phones while driving appears to be relatively inefficient policy to save lives and prevent injuries when compared to other highway safety policies.[633]

Unsurprisingly, the center recommended better scientific research and risk management.[634] When examining policies adopted abroad to address phoning while driving, one should account for differences in cultural norms.[635] When studying crashes and the role of driver distractions, confounding variables such as mileage driven and risk taking should be included.[636]

Should You Be Allowed to Use Your Cellular Phone while Driving? Hahn et al. make a credible effort to quantify the net benefits of cellular phone usage by drivers.[637] They approach this task by asking the cost-benefit question in its more popular form: is the banning of cellular phones by drivers a bad idea? Their computation of the net benefits from a cell phone ban provides an affirmative answer to this regulatory question.[638]

To estimate the benefit of cell phone usage by drivers (the *cost of a ban*), the study adopted a demand function for industry-wide cell phone use estimated by Hausman and an industrial marketing survey on phone use by drivers made by the Yankee Group.[639] It was then assumed that a demand function with

[628] *Id.*
[629] *Id.* at 58.
[630] *Id.* at 62.
[631] *Id.*
[632] *Id.*
[633] *Id.*
[634] *Id.* at 64.
[635] *Id.* at 65.
[636] *Id.* at 66-67.
[637] Robert W. Hahn et al., *Should You Be Allowed to Use Your Cellular Phone while Driving?* 23 Regulation 46 (2000). This is an update of an earlier study by Robert W. Hahn and Paul C. Tetlock, The Economics of Regulating Cellular Phones in Vehicles, AEI-Brookings J. Ctr. for Reg. Stud., Working Paper 99-9 (1999).
[638] *Id.*
[639] Hahn et al., *supra* note 637, at 47-48.

similar properties (regarding price elasticity of demand[640]) applies to drivers who use cell phones in vehicles.[641] Such a demand function encompasses the numerous, individual benefits enumerated by Harvard Center for Risk Analysis. The study used Hausman's demand function and the Yankee Group's survey responses to compute the amount of money that drivers would need to be paid to be indifferent to a ban on using cell phones in vehicles. They estimated this amount, either the benefits to drivers from cell phone usage in vehicles or the cost of a ban, to total "about $25 billion."[642]

To estimate the cost of cell phone usage by drivers (the *benefit of a ban*), the authors used state and national accident data related to cell phone use, an estimate of the monetary costs of motor vehicle crashes calculated by National Highway Traffic Safety Administration, the epidemiological study by Redelmeier and Tibshirani, and Viscusi's estimate of the willingness to pay to reduce mortality and morbidity risks.[643] Based on a number of crucial assumptions regarding the extrapolation of state vehicle crash data to the national level and these three studies, a range was computed representing lower and upper bounds of the cost of drivers' cell phone use. A plausible point estimate of this cost, or the benefit of a ban, is approximately $4.6 billion.[644]

The estimated net benefit of a ban on cell phone use by drivers is therefore $4.6 billion minus $25 billion, or about *minus* $20 billion.[645] The cost of a ban on such use, then, appears to greatly exceed the benefit of a ban. Therefore, an outright ban on cell phone usage by drivers would not be socially optimal.

Notwithstanding this conclusion, the authors acknowledged that "[a] great deal of uncertainty exists in many of the parameter values used in our model."[646] The range used for lives saved per year is 10 to 1000 and they chose 300 fatalities per year for their calculation.[647] The range used for percentage of time cellular phones are used by drivers is 40 to 70 percent and they chose 60 percent.[648] While their best estimate of benefits is $4.6 billion, the range is $110 million to $21 billion![649] While their best estimate of costs is $25 billion, the range

[640]The price elasticity of demand is the buyer's response to changes in a commodity's price. This response depends mostly on the availability of good substitutes to the commodity.

[641]Hahn et al., *supra* note 637, at 47.

[642]*Id.* at 48.

[643]*Id.* at 49.

[644]*Id.* at 49-50.

[645]*Id.*

[646]*Id.* at 50.

[647]*Id.* at 49, 50.

[648]*Id.* at 48, 50.

[649]*Id.* at 50.

is $10 billion to $87 billion![650] While their best estimate of net benefits is negative $20 billion, the range is negative $87 billion to positive $6.8 billion![651]

The study also posed a related regulatory question: instead of an outright ban on cell phone usage by drivers, should a restriction requiring drivers to use hands-free devices be adopted? Using a revised accident rate attributable to this restriction, and the shopping costs for the hands-free devices, they concluded that the net benefit from this restriction is still probably negative, but less than the net benefit computed for the ban.[652] The result is somewhat less clear to them because of a wide degree of uncertainty in the reduction in the number of fatalities and injuries related to the hands-free mandate, but such regulation is probably not warranted. [653]

The authors again acknowledged that their estimates are subject to a great deal of uncertainty. They pointed out that their price elasticity assumption might not be appropriate.[654] They admitted that they do not account for how drivers might substitute other forms of risk for the cell phone ban.[655] They know that their results would be greatly affected by the amount of enforcement of such a ban.[656] However, they concluded that reasonable estimates of benefits and costs do not support governmental intervention in this area. Besides, the market itself is moving towards a possible solution: voice-activated cell phones in vehicles. Instead of a ban on phones or other regulation, they recommended that governments should more systematically monitor the problem and increase the information flow relating to net hazards of cellular phones on vehicular accidents.[657]

> The general lesson . . . from this analysis is that . . . a problem does not, by itself, warrant government intervention. Our review . . . suggests that drivers' cellular phone usage does lead to an increase in accidents and fatalities. It is not obvious, however, that feasible government policies would significantly reduce the size of the problem. . . . Our analysis suggests that the case has yet to be made for regulating drivers who use cellular phones . . . .[658]

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[650]*Id.*
[651]*Id.*
[652]*Id.* at 50-52.
[653]*Id.* at 51.
[654]*Id.* at 52-53.
[655]*Id.* at 53.
[656]*Id.*
[657]*Id.* at 54.
[658]*Id.*

**THE ROLE OF DRIVER INATTENTION IN CRASHES; NEW STATISTICS FROM THE 1995 CRASHWORTHINESS DATA SYSTEM**

In 1995, National Highway Traffic Safety Administration began to use its Crashworthiness Data System "to obtain more in-depth information on driver inattention-related crash causes, including drowsiness and many forms of distraction."[659] The three major forms of inattention for that year were "distraction," "looked but did not see" and "sleepy/fell asleep" and respectively accounted for 11.7 percent, 8.9 percent and 3.1 percent of the crashes.[660] "Driver inattention . . . is probably the most prevalent cause of traffic crashes."[661] A classic study on crash causation was published in 1979 and "found that some form of 'recognition failure' was involved in 56% of the in-depth crash cases analyzed."[662] In descending percentages of frequency, the four principal forms of recognition failure were improper lookout, inattention, internal distraction and external distraction.[663] After examining hundreds of case files from Crashworthiness Data and General Estimates Systems, researchers reported in 1994 that recognition errors primarily caused 45 percent of the cases sampled.[664] A 1994 study by a General Motors scientist reviewed 1,000 Michigan police accident reports and found 17 percent of the crashes were attributed to daydreaming and distraction with another 18 percent attributed to improper lookout.[665]

"[A]vailable statistics on driver inattention, including drowsiness, are not definitive . . . primarily because studies to date have generally been based on samples of questionable representativeness . . . and because Police Accident Report-based data are generally superficial" and unscientific.[666] Crashworthiness Data System is an annual study by 24 field research teams of approximately 5,000 towaway crashes involving passenger vehicles.[667] Crashworthiness Data System may be the best available data because it is broadly representative and more in-depth than police accident reports.[668] General Estimates System samples the full population of police-reported vehicular crashes, so that these estimates number approximately 6,000,000 annually and include towaway and nontoway crashes, and passenger as well as other types of vehicles.[669] "[I]t was estimated that 13.8% of driver involvements in 1995 passenger vehicle towaway

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[659] Jing-Shiarn Wang et al., The Role of Driver Inattention in Crashes; New Statistics from the 1995 Crashworthiness Data System (manuscript on file with J. St. Gov't Comm'n).

[660] *Id.*

[661] *Id.*

[662] *Id.* (citation omitted).

[663] *Id.*

[664] *Id.* (citation omitted).

[665] *Id.* (citation omitted).

[666] *Id.*

[667] *Id.*

[668] *Id.*

[669] *Id.*

crashes, and 23.8% of the crashes themselves, involved driver inattentiveness as a causal factor[,]" but there were substantial percentages of data categorized as unknown.[670] A little more than 80 percent of the driver distraction/inattention crashes occurred during clear weather, presumably due to drivers being more attentive in adverse weather or because inattention "is more likely to stand out as a crash factor under clear weather conditions" absent the supposition that precipitation contributed to causing an accident.[671] Almost all the crashes attributed to "looked but did not see" occurred on roads with speed limits of 50 miles per hour and below, whereas almost half of the crashes attributed to sleepiness occurred on roads with speed limits of 65 miles per hour and higher.[672] The drivers identified as sleepy and distracted were mostly male; those identified as "looked but did not see" were mostly female.[673]

The report cautioned, "Crash investigation is inherently a retrospective, reconstruction process rather than an empirical process. There are no 'instant replays.' Therefore, even the best and most in-depth crash investigations are, to some extent, conjectural."[674]

By using data developed for AAA Foundation for Traffic Safety, the immediately following section, statistics, extends the examination of statistics from Crashworthiness Data System by disclosing them for the years 1995-99 and adds statistics from our Commonwealth for the years 1999 and 2000.

[670] *Id.*
[671] *Id.*
[672] *Id.*
[673] *Id.*
[674] *Id.*

page 84 blank

# STATISTICS

## DRIVERS AND THE DRIVING ENVIRONMENT: PENNSYLVANIA V. THE UNITED STATES

In this section, drivers and the driving environment in Pennsylvania and the United States are compared. The following variables will be related to vehicle crashes, vehicle crash fatalities and vehicle driver distractions.

Total Population and Licensed Drivers by Age. In 1999, the total population in the United States was 272.7 million. Licensed drivers in the United States totaled 187.2 million, or 68.6 percent of the national population. Pennsylvania's population totaled 12 million. There were 8.5 million licensed drivers in Pennsylvania, or 70.7 percent of the Commonwealth's population. The proportion of persons in all age categories of licensed drivers was similar in Pennsylvania and the United States: (1) over 90 percent of persons in the primary working ages of 20 to 64 were licensed to drive; (2) about 78 percent of the persons aged 65 and above held driver's licenses; and (3) only 13 percent of the persons less than 20 years old were licensed drivers. (Table 1)

Because Pennsylvania had a greater proportion of persons aged 50 and over, the proportion of these licensed drivers aged 50 and over was greater in the Commonwealth than the United States. Nationally, about 35 percent of licensed drivers were more than 50 years old. In Pennsylvania, this percentage was about 39 percent. (Table 1A)

Licensed Drivers by Sex. In 1999, about 71 percent of the males and 67 percent of the females in the United States were licensed to drive. About 74 percent of the males and 67 percent of the females in Pennsylvania held driver's licenses. (Table 2)

Since the distribution of the population by sex was similar in the Commonwealth and the nation, the proportions of licensed drivers by sex were also similar. In Pennsylvania and the nation, slightly more than 50 percent of the licensed drivers were males and slightly less than 50 percent females. (Table 2A)

TABLE 1

TOTAL POPULATION AND LICENSED DRIVERS BY AGE
PENNSYLVANIA V. THE UNITED STATES

| | Driver ages | | | | | |
|---|---|---|---|---|---|---|
| | Less than 20 yrs. | 20-29 yrs. | 30-49 yrs. | 50-64 yrs. | 65+ yrs. | Total |
| United States 1999 | | | | | | |
| Total population | 78,185,295 | 36,234,689 | 83,895,581 | 39,835,223 | 34,540,025 | 272,690,813 |
| Licensed drivers | 9,610,142 | 33,266,702 | 79,351,760 | 38,145,187 | 26,796,630 | 187,170,420 |
| Ratio | 12.3% | 91.8% | 94.6% | 95.8% | 77.6% | 68.6% |
| Pennsylvania 1999 | | | | | | |
| Total population | 3,174,575 | 1,443,946 | 3,647,934 | 1,828,625 | 1,898,936 | 11,994,016 |
| Licensed drivers | 400,403 | 1,334,426 | 3,477,444 | 1,792,494 | 1,473,509 | 8,478,276 |
| Ratio | 12.6% | 92.4% | 95.3% | 98.0% | 77.6% | 70.7% |

SOURCE: Population--Bureau of the Census, U.S. Dep't of Commerce, "Population Estimates for the U.S., Regions, Divisions, and States by 5-Year Age Groups and Sex: Annual Time Series Estimates, July 1, 1990, to July 1, 1999, and April 1, 1990, Census Population Counts", 2000. Licensed drivers--Fed. Highway Admin., U.S. Dep't of Transp., Highway Statistics Series, 1999.

TABLE 1A

DISTRIBUTION OF TOTAL POPULATION AND LICENSED DRIVERS BY AGE
PENNSYLVANIA V. THE UNITED STATES

| | Driver ages | | | | | |
|---|---|---|---|---|---|---|
| | Less than 20 yrs. | 20-29 yrs. | 30-49 yrs. | 50-64 yrs. | 65+ yrs. | Total |
| United States 1999 | | | | | | |
| Total population | 28.6% | 13.3% | 30.8% | 14.6% | 12.7% | 100.0% |
| Licensed drivers | 5.1 | 17.8 | 42.4 | 20.4 | 14.3 | 100.0 |
| Pennsylvania 1999 | | | | | | |
| Total population | 26.5% | 12.0% | 30.4% | 15.3% | 15.8% | 100.0% |
| Licensed drivers | 4.7 | 15.7 | 41.0 | 21.2 | 17.4 | 100.0 |

SOURCE: Population--Bureau of the Census, U.S. Dep't of Commerce, "Population Estimates for the U.S., Regions, Divisions, and States by 5-Year Age Groups and Sex: Annual Time Series Estimates, July 1, 1990, to July 1, 1999, and April 1, 1990, Census Population Counts", 2000. Licensed drivers--Fed. Highway Admin., U.S. Dep't of Transp., Highway Statistics Series, 1999.

TABLE 2

TOTAL POPULATION AND LICENSED DRIVERS BY SEX
PENNSYLVANIA V. THE UNITED STATES

| | Driver sex | | |
| --- | --- | --- | --- |
| | Male | Female | Total |
| United States 1999 | | | |
| Total population | 133,276,559 | 139,414,254 | 272,690,813 |
| Licensed drivers | 94,166,321 | 93,004,099 | 187,170,420 |
| Ratio | 70.7% | 66.7% | 68.6% |
| Pennsylvania 1999 | | | |
| Total population | 5,765,533 | 6,228,483 | 11,994,016 |
| Licensed drivers | 4,281,901 | 4,196,375 | 8,478,276 |
| Ratio | 74.3% | 67.4% | 70.7% |

SOURCE: Population--Bureau of the Census, U.S. Dep't of Commerce, "Population Estimates for the U.S., Regions, Divisions, and States by 5-Year Age Groups and Sex: Annual Time Series Estimates, July 1, 1990, to July 1, 1999, and April 1, 1990, Census Population Counts", 2000. Licensed drivers--Fed. Highway Admin., U.S. Dep't of Transp., Highway Statistics Series, 1999

TABLE 2A

DISTRIBUTION OF TOTAL POPULATION AND LICENSED DRIVERS BY SEX
PENNSYLVANIA V. THE UNITED STATES

| | Driver sex | | |
| --- | --- | --- | --- |
| | Male | Female | Total |
| United States 1999 | | | |
| Total population | 48.9% | 51.1% | 100.0% |
| Licensed drivers | 50.3 | 49.7 | 100.0 |
| Pennsylvania 1999 | | | |
| Total population | 48.1% | 51.9% | 100.0% |
| Licensed drivers | 50.5 | 49.5 | 100.0 |

SOURCE: Population--Bureau of the Census, U.S. Dep't of Commerce, "Population Estimates for the U.S., Regions, Divisions, and States by 5-Year Age Groups and Sex: Annual Time Series Estimates, July 1, 1990, to July 1, 1999, and April 1, 1990, Census Population Counts", 2000. Licensed drivers--Fed. Highway Admin., U.S. Dep't of Transp., Highway Statistics Series, 1999.

Registered Vehicles by Type. In 1999, the mix of vehicles by type in the Commonwealth varied slightly from the United States mix. In the United States, about 61 percent of the vehicles were automobiles and 39 percent other vehicles. Primarily, other vehicles include trucks and buses. In Pennsylvania, over 67 percent were automobiles and 33 percent other vehicles.

Between 1995 and 1999, the number of registered automobiles in the United States actually declined by 2.7 percent. The number of other vehicles grew by over 28 percent. During this same interval, the number of registered automobiles in Pennsylvania increased by about 1 percent, and other vehicles by about 19 percent. (Table 3)

TABLE 3

REGISTERED VEHICLES BY TYPE
PENNSYLVANIA V. THE UNITED STATES

| | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|
| United States | | | | | |
| Automobiles | 136,066,045 | 129,728,341 | 129,748,704 | 131,838,538 | 132,432,044 |
| Other | 65,463,976 | 76,636,815 | 78,004,956 | 79,778,015 | 83,876,579 |
| Total | 201,530,021 | 206,365,156 | 207,753,660 | 211,616,553 | 216,308,623 |
| Pennsylvania[1] | | | | | |
| Automobiles | 6,013,649 | 5,935,633 | 6,050,365 | 6,131,725 | 6,071,724 |
| Other | 2,466,877 | 2,704,605 | 2,774,582 | 2,847,089 | 2,936,876 |
| Total | 8,480,526 | 8,640,238 | 8,824,947 | 8,978,814 | 9,008,600 |

1. Excludes registered farm trucks.

SOURCE: Fed. Highway Admin., U.S. Dep't of Transp., Highway Statistics Series, 1995-99.

Roadway Mileage and Annual Vehicle Miles by Type. In 1999, the United States had about 3.9 million miles of public roadways. Vehicles traveled almost 2.7 trillion miles over these roadways. Pennsylvania had about 119.4 thousand miles of public roadways. Vehicle miles traveled on these roadways totaled more than 102 billion. (Table 4)

TABLE 4

PUBLIC ROAD MILES AND ANNUAL VEHICLE MILES BY TYPE
PENNSYLVANIA V. THE UNITED STATES

| | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|
| United States | | | | | |
| Public road miles | | | (miles) | | |
| Rural | 3,092,520 | 3,092,773 | 3,108,493 | 3,064,650 | 3,071,181 |
| Urban | 819,706 | 826,677 | 836,108 | 841,654 | 846,064 |
| Total | 3,912,226 | 3,919,450 | 3,944,601 | 3,906,304 | 3,917,245 |
| Annual vehicle miles | | | (millions of miles) | | |
| Rural | 933,285 | 960,063 | 999,920 | 1,033,310 | 1,063,630 |
| Urban | 1,489,490 | 1,522,139 | 1,560,452 | 1,592,057 | 1,627,705 |
| Total | 2,422,775 | 2,482,202 | 2,560,372 | 2,625,367 | 2,691,335 |
| Pennsylvania | | | | | |
| Public road miles | | | (miles) | | |
| Rural | 85,376 | 85,750 | 85,403 | 85,143 | 85,096 |
| Urban | 33,272 | 33,202 | 33,727 | 34,138 | 34,285 |
| Total | 118,648 | 118,952 | 119,130 | 119,281 | 119,381 |
| Annual vehicle miles | | | (millions of miles) | | |
| Rural | 40,378 | 41,830 | 43,394 | 43,987 | 45,614 |
| Urban | 54,142 | 54,816 | 54,621 | 55,921 | 56,400 |
| Total | 94,520 | 96,646 | 98,015 | 99,908 | 102,014 |

SOURCE: Fed. Highway Admin., U.S. Dep't of Transp., Highway Statistics Series, 1995-99.

As might be expected, the proportions of urban and rural public roadways in Pennsylvania and the United States differed. In the United States, about 78 percent of the roadways were rural and 22 percent urban. In the Commonwealth, about 71 percent of the roadways were rural and 29 percent urban.

Moreover, the proportions of vehicle miles traveled on the two types of roads differed in the Commonwealth and the United States. In the United States, about 40 percent of the annual vehicle miles were traveled on rural roads and 60 percent on urban roads. In Pennsylvania, about 45 percent of the annual vehicle miles were traveled on rural roads and 55 percent on urban roads.

In both Pennsylvania and the United States, annual vehicle miles traveled grew rapidly between 1995 and 1999. Somewhat surprisingly, in both cases, total vehicle miles traveled on rural roads grew faster than total vehicle miles traveled on urban roads.

## CELLULAR PHONE USAGE IN VEHICLES

The incidence of the wide range of driver actions that can be considered as driving distractions is vast and cannot be quantified. One technological device that will be included in the taxonomy of driver distractions below is the cellular phone. Limited information on the subscriptions to and usage of this widely used device is available.

In 1999, total cellular phone subscribers in the United States numbered more than 86 million, or about 1 cell phone for every 3 persons. From 1995 through 1999, cell phone subscriptions in the nation grew by more than 150 percent. (Table 5)

TABLE 5

ESTIMATED CELL PHONE SUBSCRIBERS

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|
| United States | 33,785,661 | 44,042,992 | 55,312,293 | 69,209,321 | 86,047,003 | 109,478,031 |

SOURCE: Cellular Telecomm. & Internet Ass'n (CTIA), CTIA's Semi-annual Wireless Industry Survey, 2000.

According to the 2000 Motor Vehicle Occupant Safety Survey, an estimated 54 percent of drivers "usually" have some type of wireless phone in their vehicles, and 73 percent reported using a wireless phone while driving.[675] Also, approximately 73 percent of drivers who said they have a wireless phone with them use a hand-held cell phone, and an additional 22 percent use hands-free equipment.[676] Overall hand-held cell phone usage by drivers of passenger vehicles was estimated to be 3 percent at any given time during daylight.[677] The University of North Carolina Highway Safety Research Center similarly observed motor vehicles in North Carolina and found 3.1 percent using cell phones.[678] In 1999, a Personal Communications Industry Association survey found that 15 percent of cell phone owners used their cell phone for more than one hour per month while driving, 15 percent for 30-60 minutes, 20 percent for 10-30 minutes, and 39 percent for less than 10 minutes per month; 11 percent of the persons surveyed did not respond.[679]

For proprietary reasons, no cell phone subscriber data are available for Pennsylvania. However, it can be assumed that the rate of cell phone subscriptions in the Commonwealth is at least equal to that in the nation as a whole; cell phone subscriptions in Pennsylvania might even be greater than the United States average. Likewise, there are no data on cell phone usage in Pennsylvania. There is no basis to believe that the use of this device in the Commonwealth differs greatly from the average usage throughout the nation.

## THE RELATIONSHIP OF DRIVER DISTRACTION CRASHES TO TOTAL VEHICLE CRASHES AND THE DRIVING ENVIRONMENT

Because of the differing vehicle types and crash coverages included in national and state traffic crash data sets, the relationship of vehicle crashes caused by driver distractions to total vehicle crashes and the driving environment in Pennsylvania and the United States is somewhat muddled. Nevertheless, a reconciliation of crashes by category serves to introduce the topic of traffic crashes caused by driver distractions in Pennsylvania.

In 1999, there were nearly 6.3 million total vehicle crashes in the United States (in 2000, total crashes increased to 6.4 million). About 3.2 million passenger vehicles were involved (at least one vehicle was towed from the scene of each of the accidents). In Pennsylvania, there were about 144.2 thousand total vehicle crashes (147.3 thousand in 2000). About 226.4 thousand total passenger vehicles were involved (229.8 thousand in 2000). Total United

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675 Nat'l Highway Traffic Safety Admin., *supra* note 11.
676 *Id.*
677 *Id.*
678 Reinfurt, *supra* note 398.
679 Lissy et al., *supra* note 612, at 12.

States vehicle crashes in 1999 were less than those during any of the preceding four years. Total Pennsylvania traffic crashes in 1999 were greater than those during any of the preceding four years. (Table 6)

In 1999, vehicles involved in crashes that were related to driver distractions were estimated to total 265 thousand in the United States. In Pennsylvania, driver distractions were recorded to be primary contributing factors in 2,448 crashes (2,358 crashes in 2000). In the United States, this number was lower in 1999 than any of the preceding four years except 1997. In Pennsylvania, the number of crashes involving driver distractions in 1999 was lower than in any year from 1995 through 1998.

TABLE 6

TRAFFIC CRASHES, PASSENGER VEHICLES, AND DISTRACTED DRIVER
PENNSYLVANIA V. THE UNITED STATES

| | 1995 | 1996[a] | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|
| United States | | | | | | |
| Total motor vehicle traffic crashes | 6,699,000 | 6,770,000 | 6,624,000 | 6,335,000 | 6,279,000 | 6,394,000 |
| Passenger vehicles [1] | 3,400,000 | 3,500,000 | 3,700,000 | 3,300,000 | 3,200,000 | -- |
| Distracted driver vehicles [2] | 322,000 | 279,000 | 182,000 | 371,000 | 265,000 | -- |
| Pennsylvania | | | | | | |
| Total reportable traffic crashes [3] | 136,804 | 142,867 | 143,981 | 140,972 | 144,171 | 147,253 |
| Passenger vehicles [4] | -- | 224,361 | 225,565 | 223,374 | 226,357 | 229,829 |
| Distracted driver crashes [5] | -- | 6,425 | 3,380 | 3,066 | 2,448 | 2,358 |

1. Includes automobiles, pickup trucks, light vans, sport utility vehicles, and a few non-passenger vehicles whose air bags may have deployed in the crash. These vehicles must be towed from the crash scene to be included.

2. The AAA foundation study cautions against using distracted crash data for individual years because of year-to-year variability in the sampling process. The annual numbers are given here only for large scale comparisons to the Pennsylvania data.

3. Reportable crashes are defined as involving death within 30 days, any type of injury, and/or vehicle(s) requiring towing from the scene.

4. Includes all passenger cars and light trucks involved in the crash.

5. Distracted driver is reported as any contributing factor of a crash in 1996. Then, it is only reported as a primary contributing factor in 1997-2000.

a. *Pennsylvania Crash Facts and Statistics* had considerable layout changes in 1996.

SOURCE: U.S. total crashes--Nat'l Highway Traffic Safety Admin., U.S. Dep't of Transp., Traffic Safety Facts 1999 and Traffic Safety Facts 2000 Overview. U.S. passenger vehicles & driver distractions--AAA Found. for Traffic Safety, The Role of Driver Distraction in Traffic Crashes, 2001. Pennsylvania data--Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., Pennsylvania Crash Facts & Statistics, 1995-2000.

Figure 1 summarizes the relationship of total motor vehicle traffic crashes to the driving environment in the United States from 1995 through 1999, licensed drivers, registered vehicles, vehicle miles traveled and cell phone subscriptions have all increased, while the number of crashes has remained static, causing total vehicle crashes per unit of these variables to decrease. The relationships among distracted crashes and the driving environment in the United States are excluded from figure 1 because of the year-to-year variability in the distracted crashes data.

## DRIVER DISTRACTIONS AND TRAFFIC CRASHES: PENNSYLVANIA V. THE UNITED STATES

Staff of the Joint State Government Commission examined the police accident reports for all traffic crashes in Pennsylvania related to driver distractions during the years 1999 and 2000 and collected and analyzed the specific driver distraction data. For this effort, traffic crashes involving driver distractions were identified by the Pennsylvania Department of Transportation (PennDOT). The police accident reports included those completed by the Pennsylvania State Police (from State Police records) and by local police departments throughout the Commonwealth (from PennDOT records).[680]

To place Pennsylvania's driver distraction-related traffic crashes in context, this section compares the data collected for the Commonwealth to estimates computed for the United States in a study prepared for the AAA Foundation for Traffic Safety by the University of North Carolina Highway Safety Research Center.[681] The comparison uses identical taxonomy and appears in appendix E on page 180. The Commonwealth crash data were collected for a different time period than the United States estimates, were based on some significant differences in crash coverages and definition of terms, and were based on an entire population rather than a sample.[682] Nevertheless, a comparison of the two studies is useful because of the similarities and differences found in these two major efforts to quantify the importance of specific driver distractions in traffic crashes. The comparison points to the need for additional study of the driver distraction problem.

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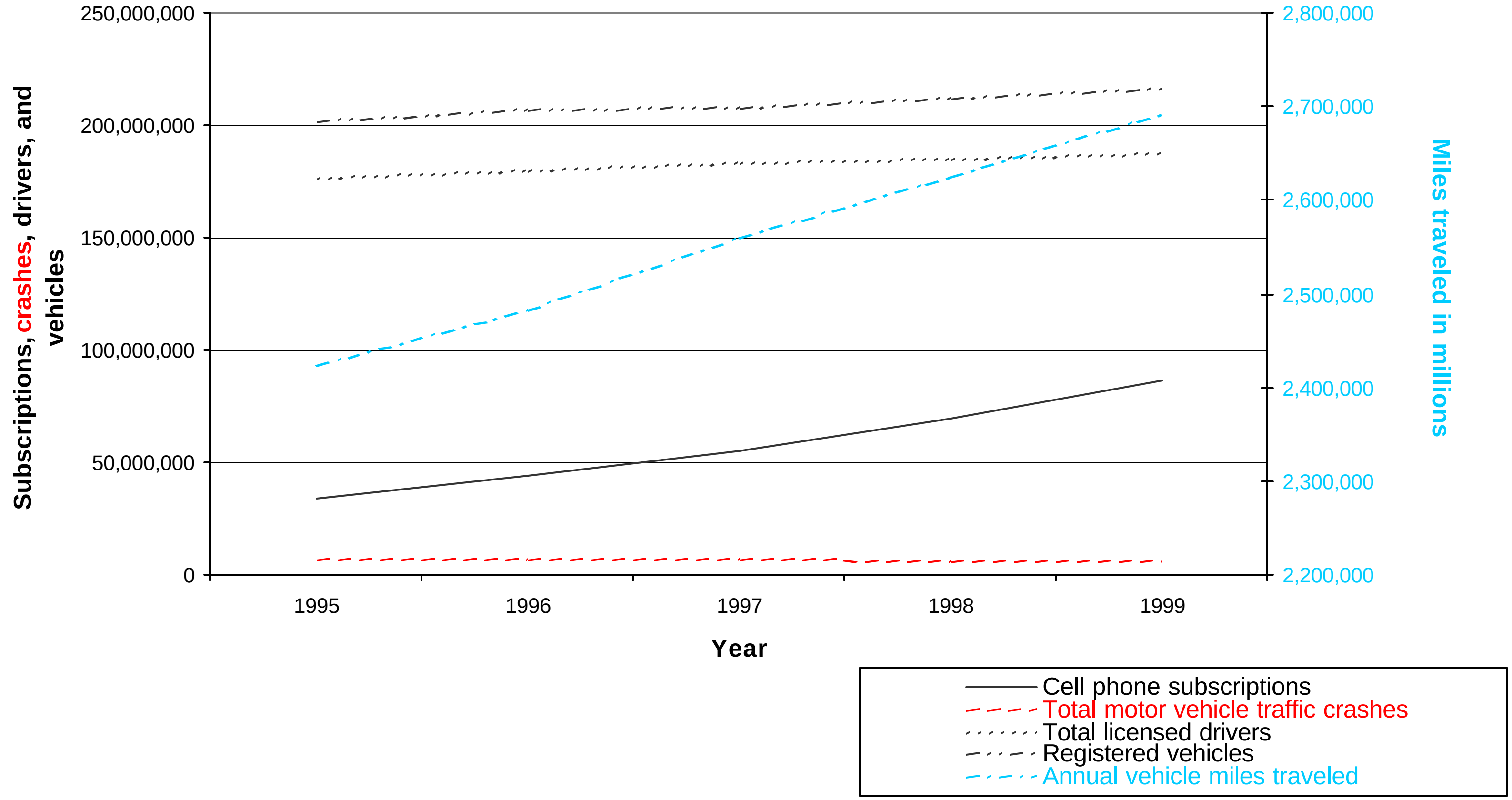
[680]The methodology for the collection and analyses of the Pennsylvania driver distraction data is given *infra* p. 161.

[681]Stutts, et al., *supra* note 12.

[682]The United States estimates were made for 1995 through 1999; the Pennsylvania data were collected for 1999 and 2000. The United States estimates were made only for crashes that involved at least one towed passenger vehicle; the Pennsylvania data were collected for all reportable crashes that involved at least one driving distraction as a contributing, causal factor.

page 94 blank

**FIGURE 1**
**CELL PHONE SUBSCRIPTIONS, TOTAL MOTOR VEHICLE CRASHES, TOTAL LICENSED DRIVERS, TOTAL REGISTERED VEHICLES, AND ANNUAL VEHICLE MILES TRAVELED[1]**
**UNITED STATES 1995-99**




1. Left scale: subscriptions, crashes, drivers, and vehicles. Right scale: miles traveled.

SOURCE: Total crashes--Nat'l Highway Traffic Safety Admin., U.S. Dep't of Transp., Traffic Safety Facts 1999. Cell phone subscriptions--Cellular Telecomm. & Internet Ass'n (CTIA), CTIA's Semi-annual Wireless Industry Survey, 2000. Total licensed drivers & registered vehicles--Fed. Highway Admin., U.S. Dep't of Transp., Highway Statistics Series, 1995-1999.

Summary of Specific Driver Distractions. From 1995 through 1999, there were 1.419 million motor vehicles in United States traffic crashes that involved driver distractions, according to the estimate made for the AAA foundation's study. Based on weighted data, this represents 8.3 percent of all motor vehicles reported in Crashworthiness Data System that crashed during those years.[683] This percentage includes a substantial number of unknown cases of the driver's attention status. If unknown cases are distributed the same as the known cases, then 12.9 percent of those vehicles that crashed had distracted drivers.[684] For 1999 and 2000, a total of 10,415 driver distractions were cited as contributing factors in 10,315 traffic crashes reported in Pennsylvania, according to the Commission staff's data. This represents 3.5 percent of all traffic crashes reported in our Commonwealth during those years. In Pennsylvania, 46 percent of the driver distractions were primary contributory factors, and 54 percent nonprimary contributory factors, in traffic crashes.

For the years 1995 through 1999, a distribution of the specific driver distractions pertaining to the AAA foundation's study is given in table 7 and figures 2 and 3. The percentages disclosed herein from the AAA foundation's study are weighted. For the years 1999 and 2000, these exhibits also show the distribution of driver distractions contained in the Commission data.[685]

The distributions of driver distractions for the United States and Commonwealth contain both important similarities and differences. In the United States estimates, the "outside object, person, or event" and "other distraction" categories combine to represent 55 percent of the total distractions, whereas in the Pennsylvania data, these two categories represent about 44 percent of the total. Conversely, the "moving object in vehicle", "using other device/object brought into vehicle", "adjusting vehicle/climate controls", "eating and/or drinking", "using/dialing cell phone", and "smoking related" categories are all much more important in Pennsylvania than the United States.

Table 7A provides a further distribution of Pennsylvania distractions by contributory factor, primary and nonprimary. These data are not available for the United States.

Whether the mix of the specific driver distractions involved in Pennsylvania traffic crashes is truly different from the mix estimated for the United States or whether this difference is merely based on differing methodologies in the two compilations is unknown. In any case, the differences are significant and indicate the need for further study.

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[683] Stutts et al., *supra* note 12, at 9.

[684] *Id.* at 10.

[685] In order to facilitate comparisons between the two studies, the taxonomy of specific driver distractions contained in the AAA foundation's study was adopted for this study.

TABLE 7

DISTRIBUTION OF SPECIFIC DRIVER DISTRACTIONS
PENNSYLVANIA V. THE UNITED STATES

| Driver distraction | United States 1995-99 | Pennsylvania 1999-2000 |
| --- | --- | --- |
| Outside object, person, or event | 29.4% | 21.9% |
| Adjusting radio/cassette/CD | 11.4 | 10.2 |
| Other occupant | 10.9 | 10.2 |
| Moving object in vehicle | 4.3 | 8.2 |
| Using other device/object brought into vehicle | 2.9 | 5.7 |
| Adjusting vehicle/climate controls | 2.8 | 5.2 |
| Eating and/or drinking | 1.7 | 5.1 |
| Using/dialing cell phone | 1.5 | 5.2 |
| Smoking related | 0.9 | 4.7 |
| Other distraction | 25.6 | 21.6 |
| Unknown distraction | 8.6 | 2.0 |
| Total | 100.0 | 100.0 |

SOURCE: U.S. data--AAA Found. for Traffic Safety, The Role of Driver Distraction in Traffic Crashes, 2001. Pennsylvania data--provided by the Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., 2001; Traffic Accident Records Unit, Pa. State Police, 2001.

**FIGURE 2**
**DISTRIBUTION OF SPECIFIC DRIVER DISTRACTIONS**
**UNITED STATES 1995-99**

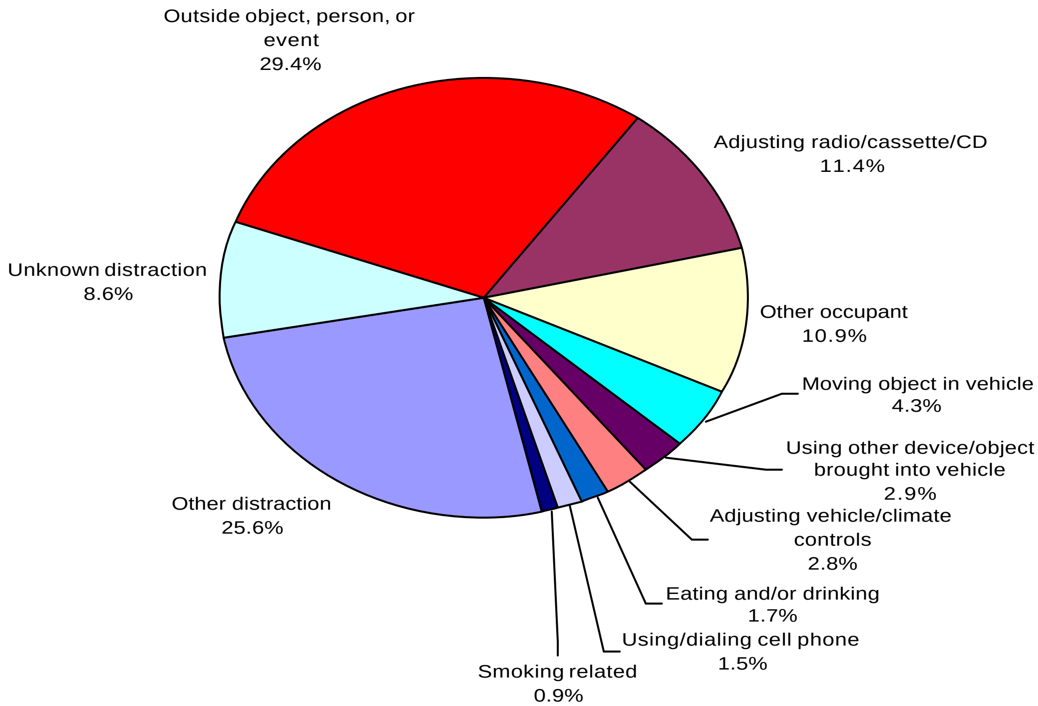
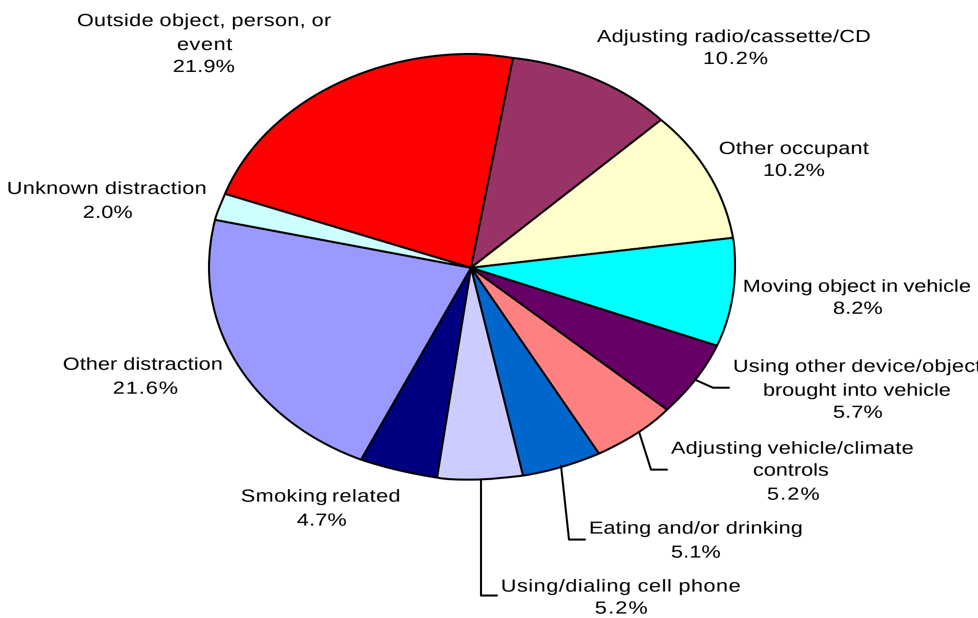



**FIGURE 3**
**DISTRIBUTION OF SPECIFIC DRIVER DISTRACTIONS**
**PENNSYLVANIA 1999-2000**




SOURCE: U.S. data--AAA Found. for Traffic Safety, The Role of Driver Distraction in Traffic Crashes, 2001. Pennsylvania data--provided by the Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., 2001; Traffic Accidents Records Unit, Pa. State Police, 2001.

TABLE 7A

DISTRIBUTION OF SPECIFIC DRIVER DISTRACTIONS
BY CONTRIBUTING FACTOR
PENNSYLVANIA
1999-2000

| Driver distraction | Contributing factor | |
|---|---|---|
| | Primary | Non-primary |
| Outside object, person, or event | 10.9% | 31.2% |
| Adjusting radio/cassette/CD | 13.6 | 7.4 |
| Other occupant | 10.6 | 9.9 |
| Moving object in vehicle | 11.2 | 5.6 |
| Using other device/object brought into vehicle | 7.4 | 4.2 |
| Adjusting vehicle/climate controls | 5.8 | 4.7 |
| Eating and/or drinking | 7.0 | 3.6 |
| Using/dialing cell phone | 6.2 | 4.4 |
| Smoking related | 6.5 | 3.0 |
| Other distraction | 19.3 | 23.5 |
| Unknown distraction | 1.5 | 2.5 |
| Total | 100.0 | 100.0 |

SOURCE: Provided by the Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., 2001; Traffic Accidents Records Unit, Pa. State Police, 2001.

Driver Distractions by Age of Drivers. Table 8 shows the distributions of specific driver distractions by the ages of drivers for the United States and Pennsylvania. In the data, several distraction categories are obviously related to certain driver ages.

In the United States and Pennsylvania, the "adjusting radio/cassette/CD", and "other occupant" distraction categories were related relatively often to traffic crashes involving drivers who are 29 years old or less. On the other hand, the "outside object, person, or event" and "other distraction" categories were related more to the crashes involving older drivers. When compared thereto, cellular phone distractions were significantly lower in those age categories.

The finding that distractions involving events that are "external" to vehicles were more often related to crashes involving older drivers may be especially important given the aging of the driving population, especially in the Commonwealth. (See Table 1A).

TABLE 8

DISTRIBUTION OF SPECIFIC DRIVER DISTRACTIONS BY AGE OF DRIVERS
PENNSYLVANIA V. THE UNITED STATES

| Driver Distraction | Driver Ages | | | | |
|---|---|---|---|---|---|
| | Less than 20 yrs. | 20-29 yrs. | 30-49 yrs. | 50-64 yrs. | 65+ yrs. |
| United States 1995-99 | | | | | |
| Outside object, person, or event | 27.0% | 29.0% | 27.5% | 33.3% | 42.8% |
| Adjusting radio/cassette/CD | 28.9 | 7.9 | 7.3 | 0.6 | 0.2 |
| Other occupant | 10.7 | 17.8 | 9.8 | 1.5 | 2.6 |
| Moving object in vehicle | 5.0 | 2.4 | 6.5 | 3.6 | 0.1 |
| Using other device/object brought into vehicle | 1.3 | 2.7 | 4.2 | 4.4 | 1.4 |
| Adjusting vehicle/climate controls | 3.1 | 2.1 | 3.3 | 3.4 | 1.8 |
| Eating and/or drinking | 1.1 | 1.4 | 1.1 | 7.9 | 0.5 |
| Using/dialing cell phone | 0.1 | 0.7 | 3.3 | 0.1 | 2.3 |
| Smoking related | 0.9 | 1.1 | 1.0 | 0.3 | 0.0 |
| Other distraction | 19.4 | 22.6 | 25.7 | 34.5 | 45.0 |
| Unknown distraction | 2.5 | 12.4 | 10.5 | 10.3 | 3.2 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Overall | 23.0 | 26.8 | 34.0 | 9.2 | 7.1 |
| Pennsylvania 1999-2000 | | | | | |
| Outside object, person, or event | 18.1% | 20.2% | 22.8% | 26.5% | 31.1% |
| Adjusting radio/cassette/CD | 19.1 | 12.1 | 6.2 | 3.3 | 1.9 |
| Other occupant | 7.9 | 12.8 | 11.2 | 6.5 | 7.5 |
| Moving object in vehicle | 8.5 | 7.2 | 8.0 | 9.4 | 9.7 |
| Using other device/object brought into vehicle | 4.5 | 5.4 | 6.3 | 6.6 | 6.1 |
| Adjusting vehicle/climate controls | 6.9 | 4.7 | 3.9 | 5.0 | 8.2 |
| Eating and/or drinking | 4.8 | 4.4 | 5.9 | 5.8 | 4.3 |
| Using/dialing cell phone | 3.2 | 5.8 | 6.9 | 5.1 | 1.2 |
| Smoking related | 4.3 | 5.4 | 5.1 | 3.6 | 1.8 |
| Other distraction | 20.9 | 20.0 | 21.8 | 25.4 | 24.7 |
| Unknown distraction | 1.7 | 1.9 | 1.8 | 2.7 | 3.4 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Overall[1] | 22.8 | 27.5 | 33.1 | 9.8 | 6.4 |

1. Because of 45 records with unknown age, overall does not sum to 100 percent.

SOURCE: U.S. data--AAA Found. for Traffic Safety, The Role of Driver Distraction in Traffic Crashes, 2001. Pennsylvania data--provided by the Bureau of Highway & Traffic Eng'g, Pa. Dep't of Transp., 2001; Traffic Accidents Records Unit, Pa. State Police, 2001.

Driver Distractions by Sex of Drivers. Table 9 gives the distributions of specific driver distractions by the sex of drivers for the United States and Pennsylvania.

Distractions for male drivers were 63.1 percent of the total for the United States for 1995-99 and 60.3 percent of the total for Pennsylvania for 1999-2000. The percentages of distractions for male drivers was much higher that those for female drivers even though the percentages of male and female drivers who were licensed to drive were very similar in both cases. (*See* Table 2A)

Driver Distractions by Roadway Characteristics. Table 10 shows the percentages of specific driver distractions by several selected roadway characteristics for the United States and Pennsylvania.

In both Pennsylvania and the United States, most driver distraction categories were related to lower speed limits (less than 45 mph). Drivers may have been distracted to a greater degree in slower traffic situations because of boredom, frustration or familiarity with surroundings. A greater percentage of several distractions, including "adjusting radio/cassette/CD", "moving object in vehicle", "using other device/object brought into vehicle", "adjusting vehicle/climate controls", and "using/dialing cell phone" occurred at higher speeds in Pennsylvania than the nation as a whole. These may have been somewhat related to differences in the mix of urban and rural roads in the two areas. (*See* Table 4)

Distractions related to non-level gradients were somewhat less prevalent in Pennsylvania than the United States as a whole. Nevertheless, slightly more than one quarter of all distractions in the Commonwealth were linked to this roadway characteristic.

The same is generally true regarding distractions related to roadway intersections and junctions. However, the link between distractions and crashes at intersections and junctions was weaker for many categories of distractions in the Commonwealth. External distractions, other distractions and unknown distractions were closely related to traffic crashes at intersections and junctions. However, several internal distractions were also strongly related to such crashes: distractions involving "other occupant" and "using/dialing cell phone." It is these internal distractions and this roadway characteristic that have received much attention in recent news stories. The lower percentage of distractions related to intersections and junctions in Pennsylvania possibly occurred at least partially because the Commonwealth has a larger proportion of vehicle miles traveled on rural roads than does the United States.

TABLE 9

DISTRIBUTION OF SPECIFIC DRIVER DISTRACTIONS BY DRIVER SEX
PENNSYLVANIA V. THE UNITED STATES

| Driver distraction | Driver sex | |
|---|---|---|
| | Male | Female |
| United States 1995-99 | | |
| Outside object, person, or event | 28.9% | 30.5% |
| Adjusting radio/cassette/CD | 10.3 | 13.1 |
| Other occupant | 11.2 | 10.6 |
| Moving object in vehicle | 4.2 | 4.7 |
| Using other device/object brought into vehicle | 2.2 | 4.1 |
| Adjusting vehicle/climate controls | 2.3 | 3.6 |
| Eating and/or drinking | 2.0 | 1.3 |
| Using/dialing cell phone | 1.7 | 1.2 |
| Smoking related | 0.9 | 0.9 |
| Other distraction | 28.3 | 22.0 |
| Unknown distraction | 8.0 | 8.1 |
| Total | 100.0 | 100.0 |
| Overall | 63.1 | 36.9 |
| Pennsylvania 1999-2000 | | |
| Outside object, person, or event | 22.2% | 21.4% |
| Adjusting radio/cassette/CD | 11.9 | 7.7 |
| Other occupant | 8.1 | 13.4 |
| Moving object in vehicle | 7.6 | 9.0 |
| Using other device/object brought into vehicle | 5.5 | 5.9 |
| Adjusting vehicle/climate controls | 4.8 | 5.8 |
| Eating and/or drinking | 5.6 | 4.4 |
| Using/dialing cell phone | 5.4 | 5.0 |
| Smoking related | 5.1 | 3.9 |
| Other distraction | 21.8 | 21.4 |
| Unknown distraction | 2.0 | 1.9 |
| Total | 100.0 | 100.0 |
| Overall[1] | 60.3 | 39.6 |

1. Because of 8 records with unknown sex, overall does not sum to 100 percent.

SOURCE: U.S. data--AAA Found. for Traffic Safety, The Role of Driver Distraction in Traffic Crashes, 2001. Pennsylvania data--provided by the Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., 2001; Traffic Accident Records Unit, Pa. State Police, 2001.

TABLE 10

PERCENTAGES OF SPECIFIC DRIVER DISTRACTIONS
BY ROADWAY CHARACTERISTICS[1]
PENNSYLVANIA V. THE UNITED STATES

| | Roadway characteristics | | |
|---|---|---|---|
| Driver distraction | Speed limit greater than 45 mph | Non-level gradient | Intersection/ junction |
| United States 1995-99 | | | |
| Outside object, person, or event | 24.3% | 32.0% | 51.8% |
| Adjusting radio/cassette/CD | 18.8 | 49.1 | 30.6 |
| Other occupant | 23.3 | 37.5 | 61.7 |
| Moving object in vehicle | 9.7 | 67.8 | 50.8 |
| Using other device/object brought into vehicle | 13.7 | 52.9 | 43.9 |
| Adjusting vehicle/climate controls | 12.8 | 26.4 | 46.8 |
| Eating and/or drinking | 33.0 | 29.6 | 27.4 |
| Using/dialing cell phone | 8.9 | 19.6 | 56.5 |
| Smoking related | 17.1 | 36.0 | 36.3 |
| Other distraction | 20.0 | 35.5 | 49.4 |
| Unknown distraction | 14.8 | 21.8 | 68.8 |
| Overall | 20.2 | 36.4 | 50.4 |
| Pennsylvania 1999-2000 | | | |
| Outside object, person, or event | 18.6% | 23.2% | 39.4% |
| Adjusting radio/cassette/CD | 22.9 | 28.1 | 21.7 |
| Other occupant | 18.8 | 26.5 | 32.5 |
| Moving object in vehicle | 16.7 | 28.7 | 22.3 |
| Using other device/object brought into vehicle | 22.8 | 26.1 | 26.1 |
| Adjusting vehicle/climate controls | 21.6 | 26.8 | 24.2 |
| Eating and/or drinking | 18.7 | 26.4 | 21.2 |
| Using/dialing cell phone | 14.3 | 28.6 | 32.7 |
| Smoking related | 14.8 | 27.4 | 14.0 |
| Other distraction | 14.9 | 23.8 | 33.4 |
| Unknown distraction | 12.0 | 18.8 | 37.5 |
| Overall | 18.0 | 25.5 | 30.1 |

1. The reciprocals of the percentages represent the absence of the roadway characteristics.

SOURCE: U.S. data--AAA Found. for Traffic Safety, The Role of Driver Distraction in Traffic Crashes, 2001. Pennsylvania data--provided by the Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., 2001; Traffic Accident Records Unit, Pa. State Police, 2001.

Driver Distractions by Accident Environment Characteristics. Table 11 shows the percentages of specific driver distractions related to several selected crash characteristics for the United States and Pennsylvania.

Several distraction categories stand out as being important in non-daylight crashes at both the national and state levels: "adjusting radio/cassette/CD", "using/dialing cell phone" and "smoking related" distractions. A common thread is that these distractions all involve significant physical motions by drivers in limited lighting conditions. Several other distraction categories that involve significant driver motions also had strong but somewhat lesser correlations to non-daylight driving conditions.

Only one distraction category was strongly related to adverse weather conditions at the national level: "adjusting radio/cassette/CD." This category is markedly less important at the state level. This finding is somewhat counterintuitive; it might be expected that motion-intensive actions would be most dangerous in adverse weather. It may be that drivers compensate for adverse weather by curtailing this type of activity while driving.

Driver Distractions by Number of Vehicle Occupants. Table 12 lists the percentages of specific driver distractions related to traffic crashes that involve more than one vehicle occupant for the United States and Pennsylvania. At the national level, the "adjusting radio/cassette/CD", "adjusting vehicle/climate controls" and "unknown distraction" categories were notably higher than in Pennsylvania.

Recommendations regarding air bag safety may be in conflict with driver distractions. PennDOT suggests children age 12 and under should ride buckled up in the back seat.[686] A driver's backward glance towards a child may trigger a vehicle crash. Ironically, the airbag deployment would be considered a success for the driver, even though the crash could have been avoided had the driver not been distracted by looking backward.[687] In 1999-2000, about 37 percent of other occupant distraction crashes in Pennsylvania involved children.[688] At least 25 percent of the children were located in the rear seats of the vehicles.

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[686] Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., Pennsylvania Crash Facts & Statistics 34 (2000).

[687] E-mail from Dr. Leonard Evans, President, Science Serving Society (July 17, 2001, 16:47 EST) (on file with J. St. Gov't Comm'n).

[688] The data excludes the ages of children, so child-related descriptors were used.

TABLE 11

PERCENTAGES OF SPECIFIC DRIVER DISTRACTIONS
BY ACCIDENT ENVIRONMENT CHARACTERISTICS[1]
PENNSYLVANIA V. THE UNITED STATES

| | United States 1995-99 | | Pennsylvania 1999-2000 | |
|---|---|---|---|---|
| Driver distraction | Non-daylight | Adverse weather | Non-daylight | Adverse weather |
| Outside object, person, or event | 29.9% | 16.2% | 25.1% | 11.8% |
| Adjusting radio/cassette/CD | 63.7 | 46.0 | 46.4 | 11.1 |
| Other occupant | 38.9 | 16.4 | 34.0 | 11.4 |
| Moving object in vehicle | 40.4 | 4.0 | 19.9 | 8.5 |
| Using other device/object brought into vehicle | 26.4 | 2.2 | 21.6 | 10.7 |
| Adjusting vehicle/climate controls | 40.6 | 5.6 | 33.9 | 11.4 |
| Eating and/or drinking | 31.2 | 11.9 | 31.3 | 9.9 |
| Using/dialing cell phone | 53.0 | 11.1 | 50.8 | 11.7 |
| Smoking related | 88.2 | 0.5 | 53.6 | 9.9 |
| Other distraction | 25.4 | 6.7 | 24.5 | 9.6 |
| Unknown distraction | 19.3 | 14.1 | 30.8 | 9.1 |
| Overall | 34.2 | 15.5 | 31.0 | 10.6 |

1. The reciprocals of the percentages represent the absence of the accident environment characteristics.

SOURCE: U.S. data--AAA Found. for Traffic Safety, The Role of Driver Distraction in Traffic Crashes, 2001. Pennsylvania data--provided by the Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., 2001; Traffic Accident Records Unit, Pa. State Police, 2001.

TABLE 12

PERCENTAGES OF SPECIFIC DRIVER DISTRACTIONS
INVOLVING MORE THAN ONE VEHICLE OCCUPANT[1]
PENNSYLVANIA V. THE UNITED STATES

| Driver distraction | United States 1995-99 | Pennsylvania 1999-2000 |
|---|---|---|
| Outside object, person, or event | 27.5% | 26.5% |
| Adjusting radio/cassette/CD | 63.6 | 25.4 |
| Other occupant | 99.8 | 100.0 |
| Moving object in vehicle | 5.6 | 18.6 |
| Using other device/object brought into vehicle | 19.1 | 14.6 |
| Adjusting vehicle/climate controls | 51.7 | 21.6 |
| Eating and/or drinking | 11.3 | 21.0 |
| Using/dialing cell phone | 14.0 | 13.8 |
| Smoking related | 27.2 | 20.6 |
| Other distraction | 25.3 | 21.5 |
| Unknown distraction | 37.1 | 19.7 |
| Overall | 38.7 | 29.8 |

1. The reciprocals of the percentages represent the distractions involving only one vehicle occupant.

SOURCE: U.S. data--AAA Found. for Traffic Safety, The Role of Driver Distraction in Traffic Crashes, 2001. Pennsylvania data--provided by the Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., 2001; Traffic Accident Records Unit, Pa. State Police, 2001.

Driver Distractions by Crash Characteristics. Table 13 shows percentages of specific driver distractions related to several selected crash characteristics: multiple vehicles, and serious and fatal driver injuries for the United States and Pennsylvania.

In the United States and Pennsylvania, most driver distraction categories were strongly related to multiple vehicle crashes. At the national level, "using/dialing cell phone" and "unknown distraction" were very strongly related to such crashes. In Pennsylvania, these categories were somewhat less strongly related but are still important. In the Commonwealth, the "outside object, person, or event" category was highly correlated with multiple vehicle crashes.

The relationship between most distraction categories and crashes involving serious and fatal driver injuries was much stronger in the United States than in Pennsylvania. But this finding is related to the nature of the data collected in the two studies: the United States data include both serious and fatal driver injuries, whereas the Pennsylvania data include only fatal injuries.

## DRIVER DISTRACTIONS AND FATALITIES: PENNSYLVANIA V. THE UNITED STATES

From all causes, including driver distractions and other causes, fatal traffic crashes in 2000 totaled 37,409 in the United States and 1,396 in Pennsylvania. Between 1994 and 2000, fatal crashes grew by 3.2 percent in the United States and 5.8 percent in the Commonwealth. In 2000, vehicle crash fatalities numbered 41,821 in the United States and 1,520 in Pennsylvania.[689] Between 1994 and 2000, vehicle crash fatalities grew by 2.7 percent in the United States and 5.5 percent in the Commonwealth. Clearly, the number of fatalities per fatal crash grew faster in Pennsylvania than the national average. (Table 14)

[689] Each fatal crash involves one or more fatalities.

TABLE 13

PERCENTAGES OF SPECIFIC DRIVER DISTRACTIONS
BY CRASH CHARACTERISTICS[1]
PENNSYLVANIA V. THE UNITED STATES

| Driver distraction | Crash characteristics: Two or more vehicles | Crash characteristics: Serious and fatal driver injuries |
|---|---|---|
| United States 1995-99 | | |
| Outside object, person, or event | 66.1% | 5.7% |
| Adjusting radio/cassette/CD | 37.8 | 1.9 |
| Other occupant | 55.9 | 8.3 |
| Moving object in vehicle | 17.0 | 11.3 |
| Using other device/object brought into vehicle | 48.8 | 13.7 |
| Adjusting vehicle/climate controls | 59.6 | 3.4 |
| Eating and/or drinking | 53.4 | 10.3 |
| Using/dialing cell phone | 82.9 | 8.4 |
| Smoking related | 15.6 | 7.8 |
| Other distraction | 53.8 | 12.7 |
| Unknown distraction | 85.3 | 6.5 |
| Overall | 57.0 | 7.9 |

| Driver distraction | Crash characteristics: Two or more vehicles | Crash characteristics: Fatal injuries[2] |
|---|---|---|
| Pennsylvania 1999-2000 | | |
| Outside object, person, or event | 73.2% | 0.2% |
| Adjusting radio/cassette/CD | 40.9 | 0.8 |
| Other occupant | 51.7 | 1.6 |
| Moving object in vehicle | 40.4 | 0.4 |
| Using other device/object brought into vehicle | 53.5 | 0.8 |
| Adjusting vehicle/climate controls | 54.6 | 0.2 |
| Eating and/or drinking | 39.0 | 0.4 |
| Using/dialing cell phone | 48.4 | 0.6 |
| Smoking related | 29.3 | 0.8 |
| Other distraction | 66.1 | 0.1 |
| Unknown distraction | 61.1 | 2.4 |
| Overall | 56.0 | 0.5 |

1. The reciprocals of the percentages represent the absence of the crash characteristics.
2. Includes drivers, passengers or other parties.

SOURCE: U.S. data--AAA Found. for Traffic Safety, The Role of Driver Distraction in Traffic Crashes, 2001. Pennsylvania data--provided by the Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., 2001; Traffic Accident Records Unit, Pa. State Police, 2001

TABLE 14

FATAL CRASHES AND VEHICLE CRASH FATALITES
PENNSYLVANIA V. THE UNITED STATES

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|
| United States | | | | | | | |
| Fatal crashes | 36,254 | 37,241 | 37,494 | 37,324 | 37,107 | 37,140 | 37,409 |
| Vehicle crash fatalities | 40,716 | 41,818 | 42,065 | 42,013 | 41,501 | 41,717 | 41,821 |
| Pennsylvania | | | | | | | |
| Fatal crashes | 1,320 | 1,337 | 1,353 | 1,412 | 1,354 | 1,382 | 1,396 |
| Vehicle crash fatalities | 1,441 | 1,480 | 1,469 | 1,557 | 1,481 | 1,549 | 1,520 |

SOURCE: Nat'l Highway Traffic Safety Admin., U.S. Dep't of Transp., Fatality Analysis Reporting System (FARS), 2001.

Fatalities related to driver distractions are unknown for the United States as a whole.[690] Distracted fatal crashes and vehicle crash fatalities are known for Pennsylvania.

In 1999, there were 22 distractions resulting in 31 fatalities in the Commonwealth. In 2000, these numbers increased to 34 and 34, respectively. (Table 15) In distractions related to fatalities for the two-year period, 23.2 percent of the distractions were primary contributory factors and 76.8 percent nonprimary contributory factors.

In both years, "other occupant" was the driver distraction category most often related to the number of fatal crashes and multiple fatalities per crash. Several other distraction categories, including "adjusting radio/cassette/CD" and "unknown distraction", as well as "outside object, person, or event" and "smoking related" to a lesser degree, were also important in fatal crashes and fatalities.

[690]Fatality Analysis Reporting System links traffic fatalities to driver related factors. In turn, several driver-related factors could be identified as "technological driver distractions": cellular telephone; computer; fax machine; head-up display; on-board navigation system; and two-way radio. An additional factor is inattentive (talking, eating, etc.). In 2000, there were 31 crashes and 37 fatalities related to technological driver distractions, and 2,986 crashes and 3,339 fatalities related to inattentive. These tallies are, however, seriously incomplete. For example, about 60 percent of the data related to cellular phones is gathered from only two states, Oklahoma and Pennsylvania. Forty-one states reported no technological distraction data. The gathering of data on fatalities related to driver distractions is only now beginning.

## TABLE 15

## DISTRACTIONS AND FATALITIES
## PENNSYLVANIA

| Driver distraction | Number of distractions | Fatalities |
|---|---|---|
| 1999 | | |
| Outside object, person, or event | 2 | 2 |
| Adjusting radio/cassette/CD | 4 | 4 |
| Other occupant | 8 | 13 |
| Moving object in vehicle | 2 | 2 |
| Using other device/object brought into vehicle | 3 | 3 |
| Adjusting vehicle/climate controls | 0 | 0 |
| Eating and/or drinking | 1 | 5 |
| Using/dialing cell phone | 1 | 1 |
| Smoking related | 1 | 1 |
| Other distraction | 0 | 0 |
| Unknown distraction | 0 | 0 |
| Total | 22 | 31 |
| 2000 | | |
| Outside object, person, or event | 3 | 3 |
| Adjusting radio/cassette/CD | 5 | 5 |
| Other occupant | 9 | 9 |
| Moving object in vehicle | 1 | 1 |
| Using other device/object brought into vehicle | 2 | 2 |
| Adjusting vehicle/climate controls | 1 | 1 |
| Eating and/or drinking | 1 | 1 |
| Using/dialing cell phone | 2 | 2 |
| Smoking related | 3 | 3 |
| Other distraction | 2 | 2 |
| Unknown distraction | 5 | 5 |
| Total[1] | 34 | 34 |

1. The total of 34 fatalities includes two cases in which there was more than one distraction. This results in double counting; the total fatalities are actually 32.

SOURCE: Data provided by the Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., 2001; Traffic Accident Records Unit, Pa. State Police, 2001.

# INNOVATIVE COMMUNICATIONS SYSTEMS

Communication systems are being developed to increase safety. Some of these systems are intended to mitigate the potential distraction from new automotive technology that introduces new secondary tasks to drivers. This section addresses the testing of technology intended to mitigate distraction as well as the integration of new systems and how they can be designed to minimize distractions. This section also provides some examples of current and future technologies that typify the direction of motoring.

## CAN COLLISION WARNING SYSTEMS MITIGATE DISTRACTION DUE TO IN-VEHICLE DEVICES?

Experiments were done in "a high-fidelity driving simulator to compare how well drivers can avoid crashes with and without the aid of a" rear-end collision avoidance system.[691] "Rear-end collisions are a particularly prevalent crash type for distracted drivers."[692] In-vehicle systems are valuable but may cognitively or structurally distract drivers.[693] A distraction is structural if a display causes a driver to look away from the road or a device causes him to take his hand off the steering wheel.[694] Of course, a cognitive distraction interferes with thinking about driving.[695]

> [R]eviews of voice communications and driving suggest that speech-based interaction may distract drivers and degrade safety just as visual displays and manual controls can. . . . Collision warnings may mitigate both the structural and cognitive distraction posed by in-vehicle devices. . . . [R]ear-end collision warning systems . . . use electronic sensors . . . to detect the motion of a lead vehicle, compute whether a collision is likely, and trigger warning to alert the driver of the possible collision situation. . . .

[691] John D. Lee et al., Can Collision Warning Systems Mitigate Distraction Due to In-vehicle Devices? 1 *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/31.PDF (last visited Nov. 1, 2001).
[692] *Id.*
[693] *Id.* at 1, 2.
[694] *Id.* at 2.
[695] *Id.*

> These experiments identify how well a warning can mitigate the distraction caused by a demanding visual task and whether or not the warning can benefit drivers who are not distracted by an in-vehicle device.[696]

Participants were told "to evaluate the fidelity of the simulator and drive" normally so that they wouldn't unduly anticipate rear-end crashes.[697] One drive was on a simulated, rural highway initially travelling at 35 miles per hour; the other drive began on a simulated, rural highway initially travelling at 55 miles per hour and concluded on a freeway.[698] The secondary task was to periodically look at a series of one digit numbers displayed above the rear view mirror and report the number of appearances of a specified number.[699] There was no visual distraction task during the second experiment.[700] Both "the percentage of imminent collision situations that ended in a collision and the collision velocity" decreased with the rear-end collision avoidance system.[701] An early warning was more effective than a late warning and both were more effective than no warning.[702] "These results show that . . . a collision warning system can help mitigate the effects of some distractions."[703] Whether distracted or not, drivers avoided almost all collisions with an early warning.[704] For collision velocity, the early "warning benefits undistracted and distracted drivers equally."[705] Drivers receiving an early warning reacted most quickly, those receiving no warning reacted least quickly and those receiving a late warning reacted in between those times.[706] Distracted drivers took longer to respond than undistracted drivers, but "the warning enhances the driver's response" whether he is distracted or not.[707]

Citing the consistent degree of distraction across several studies, the authors assert "that *cognitive distractions* may be as important as the more obvious *structural distractions*."[708] They conclude that "a collision warning system is likely to mitigate the distraction associated with speech-based interactions with in-vehicle computers and cellular telephone conversations, as well as the *structural distractions* associated with visually demanding tasks."[709] However, the "benefit depends on how the system is designed and how drivers respond and adapt to the combination of the collision warning system, the in-vehicle information systems, and the driving environment. Design strategies

[696] *Id.* at 2 (citation omitted).
[697] *Id.* at 3.
[698] *Id.*
[699] *Id.* at 3-4.
[700] *Id.* at 4.
[701] *Id.*
[702] *Id.*
[703] *Id.*
[704] *Id.* at 5.
[705] *Id.*
[706] *Id.* at 6.
[707] *Id.*
[708] *Id.*
[709] *Id.* at 7.

could enhance the benefit of the warning, but driver adaptation could undermine the benefit."[710] A collision warning system could be enhanced by a design integrating it with other in-vehicle functions so that its warning threshold is dynamically adjusted "according to whether the driver is engaged with a potentially distracting device. . . . [H]owever, behavioral adaptation may increase drivers' reliance on the warning system, undermining the joint performance of human and the collision warning system."[711] Overreliance on a rear-end collision avoidance system's capability can cause excessively reduced attention.[712]

> It is possible that the demands of in-vehicle information systems could encourage drivers to rely on the collision warning system as their primary alert to collision situations, rather than as a backup to their ability to detect collision situations. . . . If such adaptation occurs, the warning system could have the unintended consequence of encouraging greater use of potentially distracting systems and ultimately degrading driving safety.[713]

## IN-VEHICLE COMMUNICATION AND DRIVING: AN ATTEMPT TO OVERCOME THEIR INTERFERENCE

> Effects of communication tasks were examined via simulated driving in which one half of the participants had to maintain their driving speed without and with a preceding car on a straight road while the other half . . . had to control their lateral position on a curvy road while driving at a recommended speed. Results from epidemiological studies as well as from experimental studies indicate that using a phone while driving may increase accident risk and change driving behavior. . . . As some of the results of the experimental studies . . . indicate that the negative effect of using a phone may not result from handling the phone but mainly from talking on the phone, . . . completely banning the phone from the car in order to stop drivers from talking to someone on the phone will hardly be possible as in this case talking to passengers should also be prevented.[714]

New communications devices being developed for use in-vehicle might change drivers' behavior; if the effects of using these devices is known, these

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[710] *Id.*
[711] *Id.*
[712] *Id.*
[713] *Id.*
[714] Mark Vollrath & Ingo Totzke, In-vehicle Communication and Driving: An Attempt to Overcome their Interference 1-2 (citations omitted) *at* http://www-nrd.nhtsa.dot.gov/departments/nrd-13/driver-distraction/PDF/33.PDF (last visited Nov. 1, 2001).

changes may be counteracted by a system that detects changes in driving or on-going communication and prophylactically reacts.[715]

In this experimental simulation, driving performance was measured by deviation in speed, headway, lateral position, steering wheel velocity and heading.[716] Three communication tasks were done during the whole drive:

> (1) a manual operation task that focuses on manual output and requires only some visual input and memory, (2) a visual information processing task which requires only basic vocal output, and (3) an auditory information processing task which also requires minimal vocal output. . . . To summarize these results:
>
> ✍ Manual operation deteriorates the longitudinal and lateral control of the car on straight and curvy roads.
>
> ✍ Visual information processing mainly influences driving behavior on the curvy road where longitudinal and lateral control deteriorates.
>
> ✍ In the acoustic information processing condition only the variation of speed was increased but no other significant negative effect on driving was found.[717]

The communication tasks changed the driving, but the latter also influenced the former.[718] The effect on driving was significant for manual operation and visual informational processing but not for acoustically processing information.[719] "The results presented show that not all communication tasks interfere with driving. Thus, it is preferable to present information acoustically and avoid visual output. . . . The results from the communication tasks show that interference is not restricted to driving behavior but also found in the performance of the communication tasks."[720]

## INTEGRATION

<u>Crashes Induced by Driver Information Systems and What Can be Done to Reduce Them</u>. "As systems such as adaptive cruise control . . ., navigation, . . . and automatic lane control . . . see expanded use . . ., driving will change from a

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[715] *Id.* at 2.
[716] *Id.*
[717] *Id.* at 3, 5.
[718] *Id.* at 5, 6.
[719] *Id.* at 6.
[720] *Id.*

real-time control task to telematics management. The implications of these changes for vehicle safety and usability, and . . ., the driving process, have received insufficient attention . . .."[721] From crash data, the author of this paper characterized the risk of crash associated with using mobile phones in moving vehicles as increasing "on the order of 3 or so."[722] So that future systems don't overload drivers, designers need to consider eyes and mind off the road.[723] When drivers were tested operating commercial navigation systems on an oval track with traffic, it took them three times longer to enter a destination than dial an 11 digit number on a cell phone.[724] The author, Paul Green, recognizes the "enormous benefits to driving safety and convenience" that high technology in-vehicle devices offer, but, when used at particular times for certain things, they pose an "unacceptable risk to the motoring public by overloading drivers."[725] To reduce this risk to a minimum, he proposes:[726]

1. Applying and extending regulations and guidelines to design interfaces.

2. Developing interfaces via human factors.

3. Developing a workload manager.

If rules are developed for interfaces on navigational systems forbidding a combination of reading and operating those systems because that would be too demanding on drivers, that combination could also be a combination on other systems, such as e-mail.[727] A workload manager technologically controls what a driver can do depending on the driving situation and his capabilities.[728] The workload would be affected by a driver's age and expertise along with "road geometry, traffic, speed, signs, weather, time of day, and in-vehicle system tasks."[729] Green says that restrictions on the use of new devices in cars "while driving are warranted, but not a blanket ban."[730] Improved design will be "the most effective means of minimizing risk to drivers."[731]

Effective Utilization of In-vehicle Information Integrating Attractions and Distractions. Safety of motorists will be affected by sub-systems blended or proposed to be blended into driving. These systems are technologies that

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[721] Paul Green, *Crashes Induced by Driver Information Systems and What Can Be Done to Reduce Them*, SAE Technical Paper Series 2000-01-C008, reprinted from Automotive Electronics: delivering technology's promise (P-360) (2000).
[722] *Id.*
[723] *Id.*
[724] *Id.* (citation omitted).
[725] *Id.*
[726] *Id.*
[727] *Id.*
[728] *Id.*
[729] *Id.*
[730] *Id.*
[731] *Id.*

provide advanced traveler information,[732] safety and collision avoidance[733] as well as convenience[734] and entertainment.[735] Because interactive systems can complicate driving, "[g]reat care must be exercised to combine these sources of in-vehicle information in a manner that . . . makes driving safe rather than dangerous." [736] Speech operated systems reduce non-roadway visual demands, but interactive speech can still overload drivers.[737] Systems can be engineered to create priorities and values so that only important messages will be displayed, thereby reducing potentially unnecessary dstractions.[738] Technology can also entirely prevent information from being related when relating it might be dangerous.[739]

Attention and related mental processes are perception, cognition and motor action.[740] Perception, the "ability to detect and recognize external stimuli[,]" requires the least amount of attention among these stages.[741] Cognition, the ability to understand perception and calculate, "requires somewhat more attention."[742] Motor action, the "ability to select and enervate appropriate muscle groups[,] . . . requires large amounts of attention."[743]

People can be distracted when information flow is being processed serially and they cannot or do not switch to the new task.[744] Another manner of distraction occurs when people simultaneously process parallel information so that their attention is divided or starved between competing tasks and processes.[745] "Mental processes such as switching and attention starvation are directly linked to automotive safety."[746]

In-vehicle distractions may be statutorily prohibited or technologically omitted via design.[747] Up to now, engineering has mostly provided kinds and quantities of in-vehicle infotronics integration, partially due to "an insufficient

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[732]Automated tolls; route guidance, navigation and selection; regulatory information; road conditions; etc..

[733]Road departure; motorist, emergency and roadside services; vehicle location and status; intersection; rail crossing; drowsy driver; automatic cruise control; etc..

[734]Telefacsimile; mobile pc; retrievable settings for mirrors and seats; cellular phone; etc..

[735]Barry H. Kantowitz, *Effective Utilization of In-Vehicle Information: Integrating Attractions and Distractions, in* Automotive Electronics: Delivering Technology's Promise 43, 44 (2000) (citation omitted).

[736]*Id.*

[737]*Id.* at 44.

[738]*Id.* at 45.

[739]*Id.*

[740]*Id.*

[741]*Id.*

[742]*Id.*

[743]*Id.*

[744]*Id.* at 46.

[745]*Id.*

[746]*Id.* at 48.

[747]*Id.* at 46.

corpus of human factors research."[748] This problem is compounded by the challenge of integrating nonexistent devices.[749] The result is that devices and systems are developed in isolation.[750] The author of this paper, Barry Kantowitz, proposed constraints produced by drivers' information-processing limitations as a source for guidelines and standards for compatibly safe, infotronic devices.[751]

Integration of Driver In-vehicle ITS Information. "There is a strong need to integrate three classes of driver information inside the vehicle: (1) safety and collision avoidance, (2) advanced traveler information systems, and (3) convenience and entertainment systems. As more information is added inside the vehicle, cars and trucks start to take on some of the interface characteristics of airplanes."[752] The two great challenges to developing these systems are reliably blending technologies while making them easy to learn and use so that they do not complicate the basics of operating vehicles.[753] The countervailing goals are to allow a driver to obtain desired information while preventing excessive information that could dangerously distract him.[754] Spoken commands and displays are increasingly being designed to prevent a driver from being overloaded by visual information, but cognition loads a driver's "motor programming capabilities."[755]

There is potential intelligent transportation systems in-vehicle information[756] for safety and avoidance of collisions,[757] advanced traveler services,[758] and convenience and entertainment.[759] Engineers must design an interface so that a driver can safely and conveniently use the service and safely and conveniently use the other in-vehicle systems. Partially confounding the design of the several systems is the knowledge that the workload imposed on a driver "is a function of driver age and experience."[760] To solve this, the authors of this paper contend that a smart chip embedded on an ignition key could allow systematic responses tailored to individual drivers' abilities and preferences.[761] "Many luxury cars on the road today can remember physical preferences of the

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[748]*Id.*
[749]*Id.*
[750]*Id.*
[751]*Id.* at 47.
[752]Barry H. Kantowitz & M. Joseph Moyer, Integration of Driver In-vehicle ITS Information 1 (manuscript on file with J. St. Gov't Comm'n).
[753]*Id.*
[754]*See id*. at 2.
[755]*Id.* at 2.
[756]*Id.* at 3.
[757]Road departure, intersection, drowsy driver, automatic cruise control, location of vehicle and theft detection.
[758]Route guidance and selection, yellow pages, automated tolls and information on regulations and road conditions.
[759]Pager, cellular phone, mobile personal computer and retrievable settings for mirrors and seats.
[760]Kantowitz & Moyer, *supra* note 752, at 5.
[761]*Id.*

driver, such as seat position and mirror angles."[762] Obviously, "[i]ntegrated displays should be designed based upon guidelines generated from research on the relevant perceptual and cognitive issues that bear on human-centered automation."[763] The unique requirements of in-vehicle intelligent transportation systems' "information demand dedicated empirical research to ensure that" systematic "workload does not interfere with safe and convenient vehicle operation."[764] Alliance of Automobile Manufacturers is creating such guidelines now.

The Challenges for Safe and Usable Internet Services in Vehicles. In-vehicle internet "services should not be available if they are dangerous to road users."[765] In-vehicle internet information can support drivers and their passengers, who "do not have any of the potential considerations of task interference that a driver" does.[766] "This paper primarily considers the usability challenges to be overcome for the safe in-vehicle use of built-in and docking of existing . . . systems that integrate with in-vehicle systems. . . . Inattention is the most prevalent proximate cause of crashes . . . in the United States."[767] Along with visual and manual components of driver distraction, "[c]ognitive distraction is a profound concern for road safety. There is clear evidence that you have to keep your mind on the road and not just your eyes."[768] To avoid distracting and frustrating a driver, information presented via internet should be instantly loaded rather than the "long and unpredictable" loading presently experienced.[769] Graphical internet presentations are cognitively "incompatible with driving" because appearance and structure are too variable among sites.[770] A large complication of displaying information to a driver and applying a safe interface therefor is the major reliance drivers have on visually processed information.[771] Further complicating the design of safe systems for drivers is the fact that "[i]ndividual differences such as age and experience have been shown to radically affect the ability to interface with in-vehicle systems."[772] Introducing in-vehicle internet functions poses the principal ergonomic challenges of "primary task conflict, physically constrained workspace, unfamiliar interface methods and poor control location."[773] Obviously the placement of these controls is secondary to placement of controls related to driving, yet if they are too far off a driver's normal sight line they could unnecessarily distract him from the forward view.[774]

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[762]*Id.*

[763]*Id.* at 6.

[764]*Id.* at 7 (citation omitted).

[765]P. C. Burns & T. C. Lansdown, E-Distraction: The Challenges for Safe and Usable Internet Services in Vehicles 1 (manuscript on file with J. St. Gov't Comm'n).

[766]*Id*. at 2.

[767]*Id*. at 3 (citation omitted).

[768]*Id.*

[769]*Id*. at 4.

[770]*Id.*

[771]*Id.* (citations omitted).

[772]*Id.* (citations omitted).

[773]*Id*. at 5.

[774]*Id.*

Tasks that are too distractive probably should be redesigned or removed.[775] Recommended guidelines cover considerations such as:[776]

- Glance duration and task time
- Instantaneous feedback
- Minimal visual clutter
- Logical presentation of information
- User determination of initiation and pace of interaction
- Accommodation for experience

A technique to distinguish between driver and passenger could grant the latter

> access to services that are too distracting for the driver. . . . Dialogue managers can assist in preventing the presentation of information at inappropriate times to reduce driver distraction and overload. . . . The dialogue manager should block information when it detects that the driver is too busy or will be occupied with more important tasks. . . . Vehicle users should be able to access the Internet using conventional interfaces while the vehicle is stationary. However, the vehicle systems must lock out some functionality during driver in-transit use.[777]

The key challenge is to meet the desire for in-vehicle internet services without compromising safety by imposing unreasonable distraction to drivers.[778]

<u>The Development of a Design Evaluation Tool and Model of Attention Demand</u>. Goals of in-vehicle information systems are to increase mobility, efficiency, safety and convenience.[779] These systems should minimally adversely impact driving and improve driver performance whenever possible.[780] Because these complex systems can overload a driver's limited attention, engineers need to evaluate designs' safe usability.[781] A driver's primary task is driving and decreased resources therefor "may lead to decreased driving performance, thereby affecting the safety of the driver and those nearby."[782] Most in-vehicle systems demand one or more of these driver resources: vision, audition, supplemental informational processing, manipulation and speech.[783]

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[775] *Id.* at 6.
[776] *Id.* (citations omitted).
[777] *Id.* at 7.
[778] *Id.* at 8.
[779] Jonathan M. Hankey et al., The Development of a Design Evaluation Tool and Model of Attention Demand 1 (manuscript on file with J. St. Gov't Comm'n).
[780] *Id.*
[781] *Id.*
[782] *Id.* at 2.
[783] *Id.*

This paper proposes a prototype to calculate the demands on driver resources from a task or set if tasks. Such a model could assist in comparing designs, evaluating improved and upgraded designs and comparing a design or task against benchmark criteria.[784] It is also important to understand additional loads on drivers from factors such as age, driving environment, displays and subtasks.[785]

## CURRENT AND FUTURE TECHNOLOGIES

According to a recent survey of scores of senior executives in the automotive industry, within the next four years we can expect approximately 10 percent of luxury vehicles to have a phone interface, navigation, automatic collision notification, satellite radio, removable media, e-mail and internet, a built-in personal data assistant and adaptive cruise control.[786] According to the same survey, within the next five years we can expect a similar percentage of luxury vehicles to have assisted rear parking, MP3 and Bluetooth[787] support, automatically download traffic information, blind spot detection and warning, vocally operated controls, downloadable software, forward collision warning, assisted forward parking and lane departure warning.[788]

Based on crash statistics, the risk of death caused by drivers using cell phones remains unknown because too few jurisdictions formally collect this data.[789] A senior research scientist and expert on human factors at University of Michigan's Transportation Research Institute, Paul Green, estimated that 219 people will die this year from a cell-phone related crash.[790] He said that this is a greater number than the number of women and children killed by deployment of air bags and the number of deaths from Firestone tired Ford Motor Explorer rollovers.[791]

He has presented potential solutions to problems encountered by drivers using a cell phone.[792] Hands-free mounting eliminates searching for a handset, vocal dialing eliminates manual dialing and auditory feedback can alert remote

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[784] *Id.* at 6-7.

[785] *Id.* at 7.

[786] Paul Green, Remarks at Nat'l Conf. of State Leg's Driver Focus and Tech. Forum (Sept. 11, 2001).

[787] "Bluetooth technology uses short-range radio waves to connect devices without the need for a physical connection." Ananova, Sony Ericsson Unveils Tiny Bluetooth Hands-free *at* http://www.ananova.com/business/story/sm_426995.html (last visited Oct. 18, 2001).

[788] Green, *supra* note 786.

[789] *Id.*

[790] *Id.*

[791] *Id.*

[792] *Id.*

conversers to driving situations such as turning and stopping. Green regards education and hands-free operability to be solutions of limited value because habit can be too strong for the former to counter and the latter ignores cognitive demands of conversing.[793] Banning the use of cell phones while driving except in an emergency is only possibly a short term solution to distracted driving because of developing telematics.[794] "As any engineer knows, the best way to eliminate hazards is to design them out."[795] As an ultimate solution, he proposes a technological workload manager to detect driving demands and control presentation of information along with operability of equipment.[796] "[F]or example, incoming cell phone calls might be automatically routed to an answering machine in heavy traffic, but permitted when no traffic is present on a straight road."[797]

Wingcast. Ford Motor and QUALCOMM formed Wingcast to develop and deliver wireless and mobility informational services to bring voice, entertainment, internet, and safety services into motor vehicles. Wingcast works with at least seven brand name, original equipment manufacturers to supply reference designs and systematic integration. QUALCOMM's wireless technology is being combined with Ford Motor's telematics so that information and services will be seemlessly accessible from motor vehicles, phones, personal computers and digital assistants or any other compatible device.[798] The user interface will be primarily vocal. Passengers might be able to access additional applications unavailable to a driver. The key categories of services are for safety and security, navigation, communications, convenience, entertainment and information. Specifically, they include:

- Roadside assistance
- Remotely unlocking doors
- Tracking a vehicle
- Diagnosing a vehicle
- Hands-free services
- Driving directions
- Route selection
- Traffic reports
- Personal phone calls
- E-mail
- Locating ATM's, etc.
- Concierge for tickets, etc.
- Customized information

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[793] *Id.*

[794] *Id.*

[795] Paul Green, Safeguards for On-board Wireless Communications 5 (presented at 2d Ann. Plastics in Auto. Safety Conf., Troy, Mich. 2001) (manuscript on file with J. St. Gov't Comm'n).

[796] Green, *supra* note 786.

[797] Green, *supra* note 795, at 10.

[798] WingCast Mobility: Technology, *at* http://www.wingcast.com/products/technology.htm (last visited Sep. 24, 2001).

> "Telematics refers to systems that combine the functionality of internal vehicle electronics, wireless communications, and information technology such as the Internet and Global Positioning Systems" to deliver "information, services, communications and applications."[799] It is estimated that there will be more than 11,000,000 telematics subscribers domestically within three years paying substantially more than $1 billion.[800] "Numerous . . . studies confirm that consumers place the highest value on safety and security features, followed by navigation."[801]

VW Project. Next year at a European motor show, Volkswagen will reportedly display a luxury model with an info-tainment center.[802] This center will have "a seven-inch colour screen, housing all controls for a six-disc CD changer, satellite navigation, TV, on-board computer, telephone and" air conditioning system.[803]

Navlab/AHS. Over approximately 16 years, Carnegie Mellon University developed a fleet of robotic vehicles for Automated Highway Systems Project.[804] A Pontiac Minivan was computer driven for 98 percent of the 5000 kilometers from Pittsburgh to California.[805] Areas of investigation included integrated computerized maps and satellite positional information as well as "a collision warning system and system that warns the driver if he or she is drifting off the road."[806] Once in California, fully automatic vehicles were demonstrated on a freeway by a consortium for Autonomous Highway Systems.[807] The goal of this consortium was "to develop technology to alleviate congestion and improve safety through automation."[808]

SafeTRAC. SafeTRAC is a trademarked brand name for a drowsy driver warning system from AssistWare Technology.[809] It monitors the road via video and audibly warns the driver if the vehicles drifts or weaves excessively.[810] The aftermarket version plugs into a cigarette lighter, can be installed in fewer than 10 minutes and costs $1975.[811]

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[799] WingCast Mobility: Product Overview, *at* http://www.wingcast.com/products/index.htm (last visited Sep. 24, 2001).

[800] WingCast Mobility: Our Markets, *at* http://www.wingcast.com/company/market.htm (last visited Sep. 24, 2001).

[801] *Id.*

[802] Ananova, VW takes on Mercedes with Large Luxury *at* http://www.ananova.com/news/story/sm_427874.html (last visited Oct. 19, 2001).

[803] *Id.*

[804] *See* Navlab/AHS, *Navlab/AHS, at* http://www.cs.cmu.edu/afs/cs.cmu.edu/user/hws/www/tours/Navlab-AHS.html (created June 1997).

[805] *Id.*

[806] *Id.*

[807] *Id.*

[808] *Id.*

[809] SafeTRAC, http://www.assistware.com/page2.html (last visited June 21, 2001).

[810] *Id.*

[811] *Id.*

AssistWare Technology is a partner with U.S. Department of Transportation's Federal Highway Administration testing a system to "prevent run-off-the-road crashes caused by driver inattention, distraction, drowsiness, and excessive speed."[812]

The PERCLOS Monitor. By continuously measuring eye position and eyelid closure, this device gauges a driver's drowsiness and audibly warns him when a preset threshold is met.[813] It is the first monitor to automatically detect fatigue and was developed at Carnegie Mellon Research Institute.[814]

Suzuki Concept Car. The Covie, Suzuki's electric vehicle, can link to electronic machines at home via a Global Positioning Satellite receiver so that a driver can monitor and operate household appliances.[815]

Sprint PCS Voice Command[sm.] With Sprint PCS Voice Command,[816] one dials * TALK and then just says whom to call. Up to 500 names, each with up to five phone numbers may be stored. For example, one can say

> Call 5551234.
> Call John Smith at Home.
> Call John Smith at Work.
> Call John Smith on his mobile phone.

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[812]News Release, Fed. Highway Admin., U.S. Dep't of Transp., DOT Announces Test to Prevent Run-off-the-Road Crashes (Oct. 31, 2001) *at* http://www.fhwa.dot.gov/pressroom/fhwa0136.htm.

[813]About DRC, *Tech Innovation: Driving Safety at* http://www.cmu.edu/cmri/drc/drcperclosfr.html (last visited May 29, 2001).

[814]*Id. at* http://www.cmu.edu/cmri/drc/drcaboutfr/html.

[815]Ananova, Suzuki Concept Car Can Control Home Appliances *at* http://www.ananova.com/business/story/sm_430951.html (last visited Oct. 23, 2001).

[816]*See* Sprint, https://m22.sprintpcs.com/manage/vad_manage_login.asp (last visited Oct. 22, 2001).

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# OVERVIEW

Traffic safety is highly affected by the interaction of numerous variables. It may be too simplistic to isolate one variable and ignore confounding variables. For example, traffic safety aggregately depends upon the exposure to risk, the frequency of misfortune or accidents and the severity thereof. The severity in turn depends upon traffic, type of accident, speed, mass of the involved vehicles, age of the injured and rapidity of competent medical treatment. This section provides a brief overview of some of the more prominent variables.

If one is persuaded by the material herein, one will conclude that traffic safety is at historically high levels and that numerous factors interact complexly to affect and determine safety. Of any single factor, the road user has the biggest impact on safety and his behavior is influenced by direct feedback and his subjective perception of risk. Counterintuitively, education can be surprisingly ineffective but is necessary to teach knowledge unacquired by direct experience. While laws are important, social norms are of paramount importance.

How does this affect driver distractions and safety? Drivers individually react to both the road environment and automotive technology. Automotive technology that is intended to increase safety may instead be consumed to increase mobility. The same can be true of better designed roads. Although designed to increase safety, users may drive on those roads to increase mobility instead. In other words, drivers adapt in response to their perceptions. Misunderstanding psychology can even reverse putative benefits of safety measures leading to a resultant decrement in safety. For example, if drivers are forbidden from holding a phone while driving but permitted to phone via hands-free equipment, they might be willing to phone more frequently, engage in lengthier and more complex conversations and converse in all traffic patterns.[817] This could result in greater risk because the exposure to cognitive tunneling from interactive conversation would be higher than the risk from more limited exposure one might experience if he phoned less, engaged in shorter and more simple conversations and conversed in selected traffic patterns because he was holding a phone to his face.

Some background material that provides a broader context for traffic safety follows.

[817] The same could be true from an engineering aspect. In other words, aside from a question of law, a system that is designed to be operated audiovocally instead of manually could also lead to a perverse result.

## STATUS QUO

Stuck in Traffic. Congestion levels on major road systems in scores of United States urban areas have more than tripled from 1982 to 1999.[818] "The total congestion 'bill' for the 68 areas in 1999 came to $78 billion, which was the value of 4.5 billion hours of delay and 6.8 billion gallons of excess fuel consumed."[819] Travel time grew even "[i]n areas where the rate of roadway additions were approximately equal to travel growth."[820] This may be because more delay can be caused by incidents rather than heavy traffic demand.[821] "Overall, in the 68 urban areas, 33 percent of the daily traffic is congested."[822] This percentage nearly doubled from 1982 to 1999.[823]

Traffic congestion is increasing in our Commonwealth but not as rapidly as elsewhere in United States.[824] Statewide, the number of congested roads increased by 15 percent from 1995-99.[825] Increasing vehicle miles traveled within Pennsylvania show no signs of abating and far exceed our ability to expand highway capacity.[826] "Congestion leads to unsafe roads and increases [in] crashes."[827] In evaluating travel, prospective travelers ask:[828]

- Can I get there?
- How long is the trip?
- What are my travel mode options?
- What route do I take?
- When do I leave?
- Will I be comfortable and safe?
- Is the trip convenient?
- How much will it cost?
- Do I need to make this trip?

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818 David Schrank & Tim Lomax, Tex. Transp. Inst., *The 2001 Urban Mobility Report* iii (2001).

819 *Id.* "The average annual delay per person in the 68 urban areas is 36 hours (or the equivalent of about one work week of lost time)." *Id.* at 10. Two of these 68 urban areas are in our Commonwealth, Philadelphia and Pittsburgh. *Id.* at 37. "The average cost per person in the 68 urban areas was $620 in 1999." *Id.* at 29.

820 *Id.*

821 *See id.* at 8. "Road congestion is slow speeds caused by heavy traffic and/or narrow roadways due to construction, incidents, or too few lanes for the demand." *Id.* at 31.

822 *Id.* at 11. "In other words, one-third of the daily traffic is moving at less than freeflow speeds." *Id.*

823 *Id.* at 15.

824 Leg's Budget & Fin. Comm., Pa. Gen. Assem., A Review of Traffic Congestion Trends and Related Mitigation Efforts S-1, 5, 14 (2001).

825 *Id.* at 9.

826 *Id.* at S-6.

827 *Id.* at 4. *See also id.* at 17-19.

828 Schrank & Lomax, *supra* note 818, at 3.

The availability of telecommunications before, during and after a trip can affect a prospective traveler's evaluation of a transportation system and even determine whether to travel at all. Also, congested traffic can affect a motorist's desire and willingness to add potentially distractive secondary tasks to his primary task, driving. A motorist might be able to optimize his time in transit by concurrently performing secondary tasks. Presumably, the feedback from traffic would encourage a motorist to engage in secondary tasks when it is so congested that traffic is stop and go or crawling and when traffic is light and moving at free flow speeds. Conversely, one presumes that the feedback from heavy or dense traffic that is moving at nearly free flow or free flow speeds would discourage a motorist to engage in secondary tasks because he must be more vigilant of other motorists. In the former example, a motorist has relatively more time to react because traffic is dense but speed is low or speed is high but traffic is sparse; in the latter example, neither the density of traffic nor the speed thereof provide a reassuringly adequate margin during which to react.

Traffic congestion impedes mobility but increases safety, as measured by serious injuries and fatalities.[829] The expectation that increasing motorization would increase traffic fatalities led National Highway Traffic Safety Administration in 1975 to estimate that fatalities would increase 62 percent in United States over the succeeding decade; even though motorization increased, a 2 percent decline actually occurred over the succeeding decade.[830]

Assessment. Nationally, an estimated 6,394,000 crashes were reported to police in 2000.[831] In our Commonwealth, 147,253 crashes were reported to police the same year.[832] These numbers represent a decrease of 1.2 percent and an increase of 4.2 percent respectively from 1990.[833] The estimated mileage traveled in vehicles was 2.7 trillion nationally in 2000 and 102.5 billion in Pennsylvania during the same year.[834] In 2000**,** the rate of crashes per 100 million vehicle miles nationally was 237 and in our Commonwealth 144 and represent declines of 21.5 percent and 12.7 percent respectively from 1990.[835] Although crashes reported to police throughout our Commonwealth increased during the last decade, we can be encouraged by a significant reduction per mileage traveled albeit not as dramatic as the national reduction per mileage.

[829]Evans, *supra* note 54, at ch. 14.

[830]*Id.*

[831]Nat'l Highway Traffic Safety Admin., U.S Dep't of Transp., Traffic Safety Facts 2000 Overview 1 (2001).

[832]Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., Pa. Crash Facts & Statistics 11 (2000).

[833]*See* Nat'l Highway Traffic Safety Admin., *supra* note 831; Bureau of Highway Safety & Traffic Eng'g, *supra* note 832.

[834]Nat'l Highway Traffic Safety Admin., *supra* note 831, at 3; Bureau of Highway Safety & Traffic Eng'g, *supra* note 832, at 11.

[835]*See id.*

Nationally, an estimated 3,189,000 persons were injured in traffic accidents in 2000.[836] In our Commonwealth, 131,471 persons were injured the same year.[837] These numbers represent a decrease of 13 percent and 8 percent respectively from 1990.[838] In 2000, the rate of persons injured per 100 million vehicle miles nationally was 118 and in our Commonwealth 128 and represent declines of 21.9 percent and 23.4 percent respectively from 1990.[839]

Nationally, 41,821 persons died from traffic accidents in 2000.[840] In our Commonwealth, 1,520 persons died from traffic accidents the same year.[841] These numbers represent a decrease of 6.2 percent and 7.7 percent respectively from 1990.[842] In 2000, the rate of fatalities per 100 million vehicle miles nationally was 1.6 and in our Commonwealth 1.5 and represent declines of 23.8 percent and 21.1 percent respectively from 1990.[843]

These levels are historical lows or near the historical lows. Exposure to risk has risen while the frequency of misfortune or accidents has decreased relatively. Why is that and can this trend continue? There are basically three components that primarily contribute to this: the road environment, automotive technology that increases safety and the user.

## USERS

Mix of Vehicles. There is quite a mix of motor vehicles by type on the road. At least a third of vehicles are buses and trucks. The remaining motor vehicles are everything else from motorcycles to subcompact cars to compact cars to full size sedans to station wagons and minivans.[844] The mix of vehicles places the safety of those in smaller vehicles at a relative disadvantage. Differences dependent on car size "suggest large increases in injury risk with decreasing car size" because increased mass "will always reduce the deceleration forces experienced within the vehicle."[845] Fatality risk in a car decreases as a car's mass increases, but the fatality risk in the other involved car then increases.[846] Some scholars think that the net effect of safety standards on

[836] Nat'l Highway Traffic Safety Admin., *supra* note 831, at 3.
[837] Bureau of Highway Safety & Traffic Eng'g, *supra* note 832, at 11.
[838] *See* Nat'l Highway Traffic Safety Admin., *supra* note 831, at 3; Bureau of Highway Safety & Traffic Eng'g, *supra* note 832, at 11.
[839] *Id.*
[840] Nat'l Highway Traffic Safety Admin., *supra* note 831, at 3.
[841] Bureau of Highway Safety & Traffic Eng'g, *supra* note 832, at 11.
[842] *See* Nat'l Highway Traffic Safety Admin., *supra* note 831, at 3; Bureau of Highway Safety & Traffic Eng'g, *supra* note 832, at 11.
[843] *Id.*
[844] *See* table 3, *supra* p. 88.
[845] Evans, *supra* note 54, at ch. 4.
[846] *Id.*

traffic fatalities is essentially zero because "safer vehicles increase driver risk-taking, thereby reducing . . . the benefits to car occupants, but increasing the risk to non-occupants."[847] For instance, fatality risk decreases in larger cars for occupants of those cars, and "[t]here is direct observational evidence that larger cars are associated with higher levels of driver risk-taking, as indicated by higher travel speeds and closer following headways."[848]

From 1996 through 2000, crashes involving heavy trucks in Pennsylvania increased from 7,709 to 8,145, but fatal crashes thereof decreased from 175 to 161 during those same years.[849] For fatal crashes in the United States, large trucks have a higher involvement per 100 million vehicle miles than light trucks and passenger cars but substantially lower than motorcycles.[850] The converse is true for crashes causing injury and crashes resulting only in property damage; passenger cars and light trucks have a higher involvement per 100 million vehicle miles than large trucks and motorcycles.[851]

Harvard Center for Risk Analysis calculated that driving a small car instead of a large car is more than twice as risky as driving while using a cellular phone and produces almost half as many fatalities per million drivers annually as does driving six hours over the course of a year with a blood alcohol concentration of 0.1 percent.[852]

Demographic Mix. More than 3/4 of those over age 65 are licensed drivers. Approximately 5 percent of licensed drivers are less than 20 years old and approximately 14.3 percent of licensed drivers nationally and 17.4 percent of licensed drivers in Pennsylvania are over age 65.[853]

"Most road-user factors important in traffic safety depend strongly on the sex and age of the road-user."[854] In severe and fatal traffic crashes,

> [t]he overinvolvement of young, and male, road users is one of the largest and most consistently observed phenomena in traffic throughout the world. It is so robust and repeatable that it is almost like a law of nature. Its magnitude suggests that it must involve much more than a mere lack of driving . . . experience.[855]

Though youthful, novice drivers have posed a longstanding hazard to themselves and others, aging drivers whose mental and sensory abilities are

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[847] *Id.* (citation omitted).
[848] *Id.* (citation omitted).
[849] Bureau of Highway Safety and Traffic Eng'g, *supra* note 832, at 54.
[850] Nat'l Highway Traffic Safety Admin., U.S. Dep't of Transp., Traffic Safety Facts 1999, at 17 (2000).
[851] *Id.*
[852] Lissy et al., *supra* note 612, at 37.
[853] *See* tables 1 & 1A, *supra* p. 86.
[854] Evans, *supra* note 54, at ch. 2.
[855] *Id.*

declining are frequently compelled to drive to acquire necessary and desirable goods and services because of longer life spans and commercial and residential developmental patterns that foreclose the availability of affordably efficient public transportation. The problem with youthful drivers is likely more a problem of how they choose to drive rather than a question of skill.[856] They exhibit a higher propensity to take risks. The problem with older drivers is more a problem of skill due to declining mental and sensory abilities.

Condition of Drivers. Since safe driving requires alertness and consumption of alcohol as well as fatigue decrease alertness, tired drivers and drunk drivers are hazardous. Considering death to be the worst hazard a motorist faces and realizing that approximately 40 percent of national traffic fatalities in 2000 involved impairment from alcohol,[857] one quickly senses how dangerous someone's condition can be. This is even more striking because the lowest percentage of traffic fatalities nationally that involved impairment from alcohol since 1975, when records began being kept, is 38 percent during 1999.[858] This percentage used to be about half of traffic fatalities so that progress is being made, but 40 percent remains substantial.

## CONFOUNDING FACTORS

Complexity of Crashes. Too often, a single factor may be misperceived as having caused an accident.

> Many factors are associated with every traffic crash. The word "cause" has largely disappeared from the technical literature on safety, and for good reasons. Suppose on a dark rainy morning a young man argues with his wife about the purchase of a sofa, leaves the house late for work in a rage, drives his poorly-maintained car too fast on a badly-designed poorly-lit curve, skids, and is killed in a crash with a truck driven by an older driver. It is of little value to say that the death was "caused" by the car driver's youth or maleness, the truck driver's old age, the car's bald tires, the high cost of sofas, emotional stress, the non-use of a safety belt, inadequate police enforcement, rain, or any other of the many factors which, if different on this particular occasion, would have prevented the death.

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[856] *Id.* at ch. 6.

[857] New Release, U.S. Dep't of Transp., Secretary Mineta Announces Progress, Setbacks for Highway Safety in 2000 (Sept. 24, 2001), *available at* http://www.nhtsa.dot.gov/nhtsa/announce/press/pressdisplay.cfm?year=2001&filename=pr49-01.html (last visited Nov. 19, 2001).

[858] *Id.*

> All too often the term "cause" conveys the notion of a single cause, in the deterministic sense in which it is used in the physical sciences or engineering. . . . One recurrent complexity in attempting to understand traffic safety is that factors interact with each other—every piece of the traffic system is in some way connected to every other piece. If drivers know their vehicles are in poor safety condition, they may exercise increased caution. If a hazardous section of roadway is rebuilt to higher safety standards, it is likely that drivers will travel this section faster than before the improvement, or with reduced care. Differences in crash rates on different types of roadways reflect not only effects due to the roadways as such, but also that different speed limits, driver speed choices, and driver vigilance levels are associated with different types of roadways.
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> Suppose a head-on collision resulting from improper overtaking at too high speed occurred on a dry, well-lit roadway. It is unlikely that any factors other than road-user factors would be associated with this crash; yet such a crash would not occur on a divided highway. If a driver's neglect of vehicle upkeep culminated in a tire failure that preceded a crash, it is unlikely that any factors other than vehicle factors would be associated with this crash.[859]

An expert on traffic safety and the individual quoted above, Leonard Evans, suggests examining traffic crashes "in terms of factors, which, if different, would have altered the probability of occurrence or severity of outcome of the crash" rather than focusing on causes, especially single causes.[860] Identifying specific engineering and environmental factors as influential is confounded by influential road-user factors.[861]

Notwithstanding the preceding explanations, two independent, major studies during the 1970's reached consistent results in identifying road user factors associated with a large sample of crashes. "Multi-disciplinary post-crash investigations in the US and UK identify road-user characteristics as factors in 94% and 95% of crashes, respectively . . .. Nearly all attempts to examine engineering and environmental factors encounter larger driver behavior influences."[862]

Behavior. Although factors interact and vary concurrently in traffic, "the most important factor influencing traffic safety is individual human behavior."[863] Dr. Leonard Evans, an author and president of Science Serving Society, attributes changes in human behavior to contributing more than engineering and

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[859]Evans, *supra* note 54, at ch. 4.
[860]*Id.*
[861]*Id.*
[862]*Id.*
[863]*Id.* at ch. 13.

medical advances in decreasing traffic fatalities per unit distance of travel in United States by over 90 percent from 1921 to 1988,

> especially as some of the safety benefits of engineering are consumed in mobility increases and increased driver risk taking. . . . While drivers increase their safety by reacting to traffic laws, and to their own perceptions of risk, the human behavior component judged to have had the largest effect is a general evolution in social norms pertaining to driving. Societies react to the total number of fatalities, whereas individual drivers cannot because they have no direct experience of it. Safety cannot be learned from direct experience alone because useful feedback is too infrequent. Many safety behaviors are eventually performed by habit . . . . Safe driving habits are acquired by a social process not all that different from that generating hygienic habits.[864]

Citing clearly large improvements in public health from collective changes in human behavior relating to diet, exercise, smoking and consumption of alcohol, Evans concluded "that the largest potential gains in traffic safety can be achieved by encouraging and stimulating changes in the social norms relating to driving towards practices more conducive to safety, and away from practices . . . inimical to safety."[865] The factors that he characterized as likely to importantly influence social norms related to driving are fictional, media portrayals of life-threatening driving, encouragement of increased driver courtesy and public policy towards and taxation of consumption of alcohol.[866]

Experience reinforces drivers' systematic bias that they are more skillful than other drivers because most motorists are neither killed nor injured.[867] "The longer one drives, the greater is the accumulation of evidence that all the really bad things happen to others."[868]

Two approaches to understanding a driver are human factors and motivation.[869] The former considers a driver to be adequately motivated to avoid crashes and attributes crashes to failure of perception and judgment; the latter considers driving to be essentially self-paced making a driver's actions mostly determinative of how difficult driving is.[870]

> [T]he largest potential for increases in traffic safety is in the realm of stimulating changes in social norms relating to driving . . .. . . .

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[864] *Id.*
[865] *Id.*
[866] *Id.*
[867] *Id.* at ch. 12.
[868] *Id.*
[869] Pierro Hirsch, *Is Legal Driving Safe Driving?* (Sept. 9, 1997), *at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000327&static=1 (last visited Aug. 31, 2000).
[870] *Id.*

> While efforts to improve vehicles, roadways, regulation, legislation, and law enforcement will continue to reduce harm from traffic crashes, the main opportunity for substantial reductions is through people taking steps to protect themselves from this large source of harm.[871]

"In road safety we have passive safety strategies, which try to engineer safer environments, and active or behavioral strategies, which try to influence people to act more safely."[872] Because it was asserted that vehicular deficiencies are easier to analyze and remedy, the passive approach became dominant in the 1960's.[873] Major improvements in public health are again being sought from individuals through advocating health lifestyles.[874] In designing safety programs and allocating resources, it is important to understand how and why motorists behave.[875] "If we are unclear or wrong about how drivers think and what their motives are, our attempts to educate or influence them will be ineffective."[876] Individuals take acceptable risks and risks of which they are unaware.[877] The latter case is where driving demands exceed a motorist's capability to process information and perform his skills.[878] This is known as human factors whereby engineers attempt to modify vehicular and roadway environments to reduce demands on humans' limited perceptual and mental capacities.[879] The former case depends upon a motorist's motivations; driving is self-paced whereby a driver's actions dictate how demanding driving is.[880] The concept of risk homeostasis asserts that ergonomic advances by human factors experts motivate motorists to take more risk to compensate for the vehicular and roadway improvements.[881] Both approaches are valid.[882] The elderly, who are highly motivated to be safe, wreck a lot because of their deteriorating capacities; beginning drivers wreck a lot because their abilities are limited and they are insufficiently motivated to avoid risks.[883]

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[871] Evans, *supra* note 54, at ch. 15.
[872] Lawrence P. Lonero, *Risk Mentality: Why Drivers Take the Risk They Do* (Apr. 2, 2000), *available at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000182&static=1 (last visited Aug. 30, 2000).
[873] *Id.*
[874] *Id.*
[875] *Id.*
[876] *Id.*
[877] *Id.*
[878] *Id.*
[879] *Id.*
[880] *Id.*
[881] *Id.*
[882] *Id.*
[883] *Id.*

Whatever perspective on the driver we choose, it is clear that the vast majority of deaths and injuries on the roads are caused by the actions of "normal" drivers, as opposed to those who can be identified as deviant . . . drivers. Certainly there are all too many chronic bad risks, but they are only a small part of the total problem. . . . Surprisingly little is known about the details of normal driver behaviors that lead to the vast majority of collisions. If we look at individual cases, we can see specific errors, but we can rarely see why this error, which is probably very common, perhaps even "normal", led to a crash this time and not the other gazillion times it was committed. This limits the current choice of priority behaviors targeted for change to obvious general categories of behavior—such as impaired driving, speeding . . .. Routine collision reports are not specific or precise enough to be of much help. Better report forms and training of police crash investigators could help a lot. Special, in-depth collision studies have pointed strongly to failures in attentiveness and hazard detection as leading causes of crashes, but even these findings have limits. If a driver failed to perceive a hazard, was it because of some limit to perceptual skills or because attention was directed elsewhere? If the driver was not paying adequate attention, what was he/she doing? Did failure of attention occur from carelessness, or did the driving situation place too much demand on the drivers' attention switching capabilities? Could it be some of both? . . .

Normal drivers are motivated to behave in ways that they think are useful to their best interests. . . . They respond to changes in the environment to achieve certain outcomes . . .. Normally, nobody wants to be injured, so a safe trip is an important priority. But . . . there are always other priorities to be traded off against safety. . . . It is clear that we are willing to accept a certain amount of risk in return for the benefits of mobility. . . . Once we are on the road, we can choose between cautious behavior and risky behavior in most any situation. Each choice has certain benefits and costs.
. . . .
[M]any costs and benefits that motivate our decisions are not certain, and some of them are much less certain than others. For instance, speeding is likely to get us to our appointment earlier, more likely than it is to get us a speeding ticket. What's more, we don't usually know what the real odds are. . . . We make our decisions based on what we think the odds are (subjective risk), and this is likely to be pretty loosely connected to the real odds, especially when these are very small. On any given trip, the odds of anything bad happening are low . . ..[884]

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[884] *Id.*

Normal, optimistic bias discounts the risk of coming to harm.[885] This combines with control illusion,

> which means we think we have more control than we really do have. Every time we get away with a risky action, we learn that we can control things even when we're doing what we have been told is dangerous—for example, "speed kills", but we get away with speeding on a regular basis. Our roadway system is pretty forgiving, and it teaches us through our own experience that the chances of serious injury, for us, are pretty close to zero. We must be special. As drivers we almost all think we are better than average, and our feelings of being in control help us discount the real risks we face. Our optimistic illusions have an interesting side effect that makes safety education tougher. . . . There is a strong tendency to depersonalize big societal problems like road safety because, . . . ". . . I'm going to be OK." . . . To help us behave in ways that treat risks more realistically, we have to find some effective motivational handles.[886]
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> Both individuals and society choose risk.
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> As a society we decide how much loss we are willing to accept in exchange for how much freedom and mobility. The overall level of road crash risk . . . is the balance of what is decided about all the factors that could help or hurt road safety. . . . To change the level of road safety, we have to disturb the current balance. Even before we get started, natural, unplanned trends in society may disturb the balance for us. For instance, current demographic trends mean larger numbers of both elderly and young drivers are entering the driving population, and both groups crash a lot. . . .
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> A large number of factors influence what drivers choose to do, ranging from behavior genetics to visual perception to the economy. We can only do something about a small proportion of these. . . . Most of us are content with our own behavior, so it is difficult to impose influences that are perceived to be onerous for us normal drivers. We are all in favor of safety, but not if it is too inconvenient, especially since we don't think the overall risk really applies to us anyway. Punitive or inconvenient influences that are strong enough to produce behavioral change will be seen as onerous, unless they are directed to groups that are perceived to be deviant. While popular and expedient, the impact of addressing only deviant drivers is limited, even if it is effective, because of the small numbers involved.

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[885] *Id.*
[886] *Id.*

> . . . .
> There are four main tools for influencing driver behavior: 1) Legislation . . . 2) Enforcement . . . 3) Education . . . and 4) Reinforcement . . ..[887]

Until the 1960's, the approach to traffic safety in this country was largely an effort to reduce accidents by educating and training drivers.[888] A medical doctor, William Haddon, applied epidemiology to traffic safety and his approach attracted influential policy makers, Daniel Moynihan, Ralph Nader and Joan Claybrook, *inter alia*.[889] Their and others' advocacy led to the creation of U.S. Department of Transportation's National Highway Traffic Safety Administration to regulate traffic safety.[890] Resultant regulations were safety measures to reduce injuries more typically regulating the vehicle rather than regulating the driver to reduce accidents.[891] An expert in traffic safety, Leonard Evans, explained the passive approach to safety by presenting a typhoid epidemic that can be countered by adding chlorine to water or persuading consumers to boil water.[892] He said that the passive approach, chlorination, is preferred because one can't depend upon everybody to act prudently and boil the water, but "*there isn't any chlorine for traffic crashes.*"[893]

Focusing upon an object while being oblivious to a second object directly in one's field of vision is called inattentional blindness.[894] David Strayer, a professor of psychology at University of Utah said, "There is a part of driving that is automatic and routine. There is a second part of driving that is completely unpredictable, and that is the part that requires attention."[895]

> Most of the time, driving does not take up the full attention of an experienced driver. We humans have a very strong tendency to 'multi-task' . . .. In easy driving conditions, absent-mindedness is probably the greatest danger. . . . Apart from simple knowledge and vision tests for beginners, there is no diagnosis of drivers' different abilities such as attention-dividing skills and visual capabilities. A person could go through a lifetime with the driving equivalent of dyslexia and never realize it . . ..[896]

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[887] *Id.*

[888] Malcolm Gladwell, *A Reporter at Large: Wrong Turn*, The New Yorker, June 11, 2001, at 50, 52.

[889] *Id.* at 52-53.

[890] *Id.* at 53.

[891] *Id.,* an example of the former regulation is manditorily glazed windshields.

[892] *Id.* at 54. The passive approach is also sometimes identified as a human factors approach.

[893] *Id.*

[894] *Id.*

[895] *Id.* at 55.

[896] Drivers.com, *Cell Phones and Other Distractions* (Apr. 8, 2000), *at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000278&static=1 (last visited Aug. 30, 2000).

"People allow themselves to be distracted while driving because they think that they will still be able to pay attention to anomalies. But it is precisely those anomalous things . . ., which they won't see" as a result of inattentional blindness.[897] Malcolm Gladwell, a journalist, asserts that Haddon focused on what happened during and after an accident rather than what happened before because people do stupid things they can help and stupid things they can't help.[898] It is such a perception that led to the air bag.[899] But note that

> [w]earing a seat belt cuts your chances of dying in an accident by forty-three per cent. If you add the protection of an air bag, your fatality risk is cut by forty-seven per cent. But an air bag by itself reduces the risk of dying in an accident by just thirteen per cent.[900]

The passive protection is the air bag because it is automatic. The active[901] protection is the seat belt because the driver must fasten it. While both devices are protective, the former is vehicular oriented; the latter is behaviorally oriented. Gladwell suggests the latter approach should be reemphasized because active protection can be more successful than those who favored the former approach anticipated. An example of this is increasing belt-wearing rates to rates unexpected by Nader *et alia.*

> Drivers have always done other things while driving. . . . Dividing attention effectively is what good driving is all about. . . . [T]he task is not demanding enough for full-time attention. . . . But distractions have always been a problem and, as far back as the 1970s, a major analysis of traffic crashes . . . identified "driver inattention" and "improper lookout" as the leading causes of crashes.[902]

In order to motivate individuals, one must understand their behavior. In an attempt to explain behavior, Gerald Wilde created risk homeostasis theory. This theory "maintains that . . . people accept a certain level of subjectively estimated risk to their health, safety, and other things they value, in exchange for the benefits they hope to receive" from any activity.[903] Wilde claims that the uniquely controlling variable of loss due to accidents and lifestyle-dependent disease is the accepted level of risk because, "in the long run, the human-made mishap rate essentially depends" on that.[904] "*People alter their behavior in*

[897] Gladwell, *supra* note 888, at 55.
[898] *Id.*
[899] *Id.*
[900] *Id.* at 58.
[901] The active approach is also sometimes identified as a motivational approach.
[902] Drivers.com, *Distracted Drivers: Are Car Phones Guilty?* (July 5, 2000), *at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000313&static=1 (last visited Aug. 30, 2000).
[903] Gerald J. S. Wilde, Target Risk 2 at 5 (2001) (citations omitted).
[904] *Id.* at 6.

*response to the implementation of health and safety measures, but the riskiness of the way they behave will not change, unless those measures are capable of motivating people to alter the amount of risk they are willing to incur.*"[905] Wilde presents motivation as an alternative to enforcement, education and engineering to increase health and safety that depends on human conduct.[906] "[A] sure way to reduce the accident rate on a particular road to zero is to simply close that road . . .. It is almost as obvious that road users will move to other roads and that the accidents will migrate with them to other locations."[907]

Homeostasis refers to a "dynamic process that matches actual output to a target."[908] Homeostatic process controls bodily functions such as temperature and operates in engineered devices such as clothes dryers and centralized heating, venting and air conditioning.[909] "A homeostatic process makes it possible to extract long-term steadiness from short-term fluctuations."[910] Homeostasis uses negative feedback to correct or reduce an error so that it functions from circular causation.[911]

All behavior entails risk be it uncertain performance or consequence; individuals maximize expected benefits from behavior by optimizing their level of risk.[912] By failing and refusing to travel, one reduces his risk in transit to zero, but he then experiences immobility.[913] By traveling, he gains mobility but exposes himself to risk in transit. Anyone who desires to travel likely mobilizes in a manner that maximizes the net benefit of his exposure to risk.[914] In other words, a maximum benefit requires optimal rather than minimal risk.[915] Knowing how and whether factors such as age, fatigue and distraction influence risk taking might be highly valuable in developing additional features for motor vehicles.

Risk is not usually consciously monitored

> just as human beings are usually unaware of their body temperature, . . . level of psycho-physiological arousal, or ambient light conditions . . .. Most of the time, most road users only have pre-attentive, near-conscious awareness of risk.
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> The level of traffic accident risk that is perceived by the individual . . . derives from . . . the person's past experience with traffic, the person's assessment of the accident potential of the immediate

[905] *Id.*
[906] *Id.* at 8.
[907] *Id.*
[908] *Id.* at 9.
[909] *Id.* at 9-10.
[910] *Id.* at 13.
[911] *Id.* at 16.
[912] *Id.* at 151.
[913] *Id.* at 152.
[914] *Id.*
[915] *Id.* at 165.

> situation, and the degree of confidence the person has in possessing the necessary decision-making and vehicle-handling skill to cope with the situation.[916]

When a person notices that the perceived risk exceeds the target risk, corrective action is taken.[917] The level of perceived risk is influenced by past accident rates and everyday experiences.[918] When the perceived risk is lower than the targeted risk (or acceptable risk), motorists drive in a riskier manner or increase their mobility.[919] Of course, when the perceived risk is higher than the targeted (or acceptable) risk, motorists drive in a more cautious manner to increase their safety. This may have happened when Sweden and Iceland "changed from left-hand to right-hand traffic at an early morning hour in the late 1960s . . . the traffic accident rate per head of population dropped immediately and considerably after the change-over, but . . . returned to pre-existing trends[ ]within two years in Sweden and" 10 weeks in Iceland.[920] Apparently, motorists initially drove in a more cautious manner to compensate for a perceived greater risk.

> Human behavior feedback, or user response, to changes in safety systems may greatly alter safety outcomes. In some cases the outcome is even of opposite sign to that expected; changes instigated to increase safety have actually reduced safety, while changes expected to reduce safety, but made for other reasons, have actually increased safety. While no predictive model of how users react to changes is available, some general patterns are apparent. If the safety change affects vehicle performance, it is likely to be used to increase mobility. Thus improved braking or handling characteristics likely lead to increased speeds, closer following, and faster cornering. Safety may also increase, but by less than if there had been no behavior response. When safety changes are largely invisible to the user, such as improvements in vehicle crashworthiness, there is no evidence of any measurable human behavior feedback. Likewise, when measures affect only the outcome of crashes, rather than their probability, no user responses have been measured. In principle, it is almost certain that users respond in some degree to just about everything of which they are aware.[921]

Behavioral adaptations to safety measures can neutralize their expected benefit. Federal Republic of Germany's Ministry of Transport tested some empirical implications of risk homeostasis theory.[922] Anti-lock brake systems

[916] *Id.* at 39-40.
[917] *Id.* at 40.
[918] *Id.* at 41.
[919] *Id.*
[920] *Id.* at 42 (citation omitted).
[921] Evans, supra note 54, at ch. 11.
[922] Wilde, *supra* note 903, at 113.

were equipped on part of a fleet of cabs in Bavaria, which should have made them safer if drivers didn't change their behavior in response thereto.[923] There was no statistical significance in the number of accidents for the cabs equipped with the anti-lock brakes compared to those without.[924] Accelerometers were secretly installed in an equal number of cabs with anti-lock brakes and cabs without.[925] "[E]xtreme deceleration . . . occurred more often in the vehicles with" anti-lock brakes.[926] Drivers were also secretly, systematically observed along the same route.[927] There were significant differences between the drivers with anti-lock brakes and those without; those with had poorer lanekeeping, poorer mergers, created more conflicts, etc..[928] Other than the anti-lock brake equipped cabs having more accidents on slippery roads than those unequipped, there was no major drop or difference in accident rate until drivers became liable for part of repair costs and subject to dismissal for excessive accidents.[929] It seems that the anti-lock brakes didn't reduce exposure to accident, and the accidents didn't decrease until "drivers' target level of risk was reduced by increasing their expected cost of risky behaviour."[930]

> [H]umans change their behavior in response to the perceived probability and severity of harm. . . . Better brakes will reduce the absolute size of the minimum stopping zone, . . . but the driver soon learns this new zone and, since it is his field-zone ratio which remains constant, he allows only the same relative margin between field and zone as before.[931]

Behavioral adaptations to safety measures can also decrease their expected benefit.[932] Commonwealth of Canada's Ministry of Transport tested drivers on a track using both anti-lock and regular brakes.[933] The drivers used the better brakes to drive faster and brake harder rather than to decrease stopping distance.[934] These results comport with a prediction in 1938 that more efficient brakes don't increase safety because the stopping zone becomes learned and drivers adapt accordingly.[935] Wilde notes that people exchange improved braking for greater speed thereby increasing mobility rather than safety.[936] It is easier to disobey law than psychology.[937]

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[923] *Id.* at 113-14.
[924] *Id.* at 114.
[925] *Id.*
[926] *Id.*
[927] *Id.*
[928] *Id.* at 115.
[929] *Id.*
[930] *Id.*
[931] Evans, *supra* note 54, at ch. 11.
[932] Wilde, *supra* note 903, at 116.
[933] *Id.*
[934] *Id.* at 116-17.
[935] *Id.* at 117 (citation omitted).
[936] *Id.* at 118.
[937] *Id.*

By this same thinking, some think that better roads allow motorists to driver faster so that the number of accidents thereon do not decrease as a result of the improved road.[938] Evans prefers to identify this response as human behavior feedback rather than another term, such as risk compensation.[939] He mentioned that German insurers' data showed higher crash rates for cars with anti-lock braking than vehicles without it even though this electronic technology stabilizes and shortens stopping distance.[940] This study was published in 1990 and speculated that riskier drivers might have chosen to purchase anti-lock braking.[941] A more clearly perverse effect of a safety measure that reduced safety was evinced by a large-scale, well-executed study over five years that showed that pedestrians in marked crosswalks were struck approximately twice as often as those in unmarked crosswalks.[942] When braking capabilities are compromised because roadways are slippery, drivers take care to drive slower resulting in lower fatality rates albeit higher crash rates in winter than in summer.[943] Two Scandanavian nations changed from driving on the left to the right side with the expectation that safety would decrease in the near term yet experienced the contrary, substantial drops in traffic fatalities.[944] From observational data associating lower risk taking with smaller cars and relatively lower involvement rates of smaller cars in fatal crashes, Evans inferred that drivers reduced their putatively higher risk of death from decreased mass of their vehicle by driving more safely.[945] Other studies showed army drivers compensating for fatigue by systematically increasing time headways and accompanied drivers driving more cautiously than solo motorists presumably compensating for potentially deteriorated driving from being distracted by passengers

> as reflected in longer headways and slower speeds. . . . [T]he overall finding that behavior feedback effects are widespread in traffic safety systems seems beyond reasonable dispute. . . . Because of the self-paced nature of the driving task, technical changes that are readily apparent to the driver are very likely to induce user responses. Thus improved braking, handling, tire-road friction, headlights, and so on, are likely to induce increases in speed, enjoyment, relaxation, etc. One can anticipate with considerable confidence that safety increases from such measures will be lower than expected. . . . There is no case of a safety change invisible to road users which has generated a measurable user response. . . . For highly visible safety changes which influence only the probability of death or serious injury, but

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[938] Evans, *supra* note 54, at ch. 11.
[939] *Id.*
[940] *Id.*
[941] *Id.* (citation omitted).
[942] *Id.*
[943] *Id.*
[944] *Id.* (citations omitted).
[945] *Id.* (citations omitted).

> not the probability of crashing, there is little evidence of important behavior response. . . . In the traffic safety context, the view that probability of detection is more important than severity of punishment in deterring undesired behavior has been persuasively presented . . .. A high probability of a minor adverse consequence exercises a much larger influence on driver behavior than, say, the factors influencing the probability of being killed or injured. The prospect of a . . . fine . . . controls traffic speeds more than does the relationship between fatality risk and speed. The probability of death is so improbable and abstract that its reduction through the use of a device such as a safety belt or airbag is unlikely to exert much influence . . . on behavior. The empirical evidence shows little indication of changes in driver behavior with the introduction of mandatory safety belt wearing laws . . .. . . . For the case of car mass effects, the cars with the higher fatality risk have lower crash rates. This more likely flows from directly observed differences in performance, handling properties, stability, and noise levels than in the expectations of outcome, given that a crash occurs.[946]

The distinction between behavior and performance is central to traffic safety because insofar as driving is largely self-paced, a driver chooses his own level of task difficulty.[947] Just because a driver's performance skills are high doesn't mean that he behaves more safely. For example, the more skillful a driver is, the more willing he might be to engage in secondary tasks.[948]

> As driver performance focuses on capabilities and skills, it can be investigated by many methods, including laboratory tests, simulator experiments, tests using instrumented vehicles and observations of actual traffic. As driver behavior indicates what the driver actually does, it cannot be investigated in laboratory, simulator or instrumented vehicle studies. As a consequence, information on driver behavior tends to be more uncertain than that about driver performance.
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> The crash rate at age 40 is about one sixth what it is at age 20. Although some increase in skill, especially higher level information processing, may contribute to a decreased crash rate with age, it seems implausible that it could generate more than a small fraction of this large effect. In terms of such performance measures as visual acuity and reaction time, the performance of younger drivers is markedly superior to that of older drivers. The higher involvement rates of younger, and male, drivers seem more related to how they are choosing to drive, particularly their

[946] *Id.* (citations omitted).
[947] *Id.* at ch. 6.
[948] *Id.*

propensity to take driving risks, than to their abilities at the driving task.[949]

Evans noted some papers finding higher levels of risk taking among male drivers. He also mentioned a British study examining factors in urban crashes that found that male drivers drove too fast more commonly than female drivers and younger drivers drove too fast more commonly than older drivers.[950] "The problem of traffic crashes is much more one of drivers doing things that they know they ought not to do, than of not knowing what to do. . . . Reducing traffic crashes requires a change . . . in behavior."[951]

Copious, direct feedback teaches us that average driving is safe.[952] Because crashes are rare, "[e]xperience teaches us to adopt inadequate safety margins. To avoid crashes over long periods . . . requires adopting safety margins that incorporate the possibility of event of much greater rarity than are encountered in everyday driving."[953]

Most people can drive and learn to do so "without expending large amounts of time or energy. . . . In 1901 Carl Benz thought that the global market for the automobile was limited" because he didn't think more than 1,000,000 people could be trained as chauffeurs.[954] As with other skills, one can divide the acquisition of driving skills into an early, intermediate and final phase.[955] In the final phase, the skill is performed at a high level with minimal effort and can be characterized as an autonomous phase because "the task can be performed using a small fraction of the driver's attention."[956] In this stage, the small amount of mental capacity assigned to driving can be quickly increased in response to traffic. This is precisely what happens when a motorist is listening to the radio for specific information yet fails to perceive it when broadcast should traffic distract him from listening attentively.[957] Drivers can do other things while driving precisely because driving is not demanding enough for full-time attention, and for this reason, "[d]ividing attention effectively is what good driving is all about."[958]

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[949]*Id.*
[950]*Id.*
[951]*Id.*
[952]Id. at ch. 11.
[953]Id. at ch. 12.
[954]*Id.* at ch. 5.
[955]*Id.*
[956]*Id.*
[957]*Id.*
[958]Drivers.com, Distracted Drivers: Are Car Phones Guilty? (July 5, 2000), *at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000313&static=1 (last visited Aug. 30, 2000).

## CORRECTIONS

Education. The effectiveness of driver education programs on traffic safety is questionable.

> [W]e find no convincing evidence that driver education, or increased driving skill and knowledge, increase safety. Although driver education speeds up the process of learning driving skills, the main way such skills are acquired and honed is through direct feedback. . . . With minimal instruction most people could probably learn to drive by trial and error.
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> In contrast, safety cannot be learned by direct feedback, but requires absorption of accumulated knowledge and experience of others. The main reasons people buy smoke-detector fire alarms is not that their last house burned down; similarly, experiencing crashes is an ineffective way to learn how to avoid them. . . . If drivers adopted safer driving practices, and allowed larger margins of safety, by the end of their driving careers it would not have made much difference in most cases; this follows from the statistical nature of crashes, which are rare events. . . . Drivers who take extra care when in the proximity of pedestrians, bicyclists and motorcyclists, greatly reduce the probability that they will be the legally innocent and physically unharmed agent of some fellow human's death or permanent injury.[959]

Education is important to teach knowledge unaquired via direct experience and raise awareness of rare albeit potential harm. Safety measures have to objectively reduce danger more than they subjectively reduce it because if people feel safer than they really are, they may modify their behavior thereby increasing their exposure to danger.[960] To be effective, messages have to be perceived as personally relevant to the audience and motivate individuals to achieve or avoid something.[961] When addressing safety, it is ultimately more important to be successful than responsive.[962] "[A]s a means to reduce accidents[,]" Wilde is unconvinced that education has been proven effective.[963]

> To expect drivers to learn safety by driving is somewhat like expecting people to learn the value of smoke-detectors by having their houses burn down. Despite the enormous reinforcement that houses do not generally burn down, that child pedestrians do not normally dart into the road, and that bicyclists do not normally fall

[959] Evans, *supra* note 54, at ch. 6.
[960] Wilde, *supra* note 903, at 101 (citation omitted).
[961] *Id.* at 105.
[962] *See id.* at 109 (citation omitted).
[963] *Id.* at 110.

> off their bicycles, safety requires that people behave as if such events may in fact occur.[964]

Better training is often reflexively offered to improve traffic safety but can decrease safety, especially when it comes to distractions. The more skillful the driver, the more he can perform harder tasks and accept secondary tasks such as listening to a radio.[965] Because normal driving is largely self-paced, increased skill, knowledge and performance might not increase safety.[966]

> As driving skill increases from the first time behind the wheel, both the ability to project the present state of a vehicle into the near future, and the ability to judge the future effects of control inputs increase. The amount of mental capacity that must be assigned to the driving task decreases, although in emergency situations, the driver re-directs full attention to the driving task. Many studies have failed to show that crash rates are influenced by car driver education, training, or knowledge . . .. . . . Although vision is central to driving, those with the best vision do not have the lowest crash rates. . . . While violations of expectancy play an important role in many crashes rather than limitations of drivers ability to judge such stimuli as relative speed, small reductions in reaction time can still reduce the probability and severity of crashes in many cases.[967]

Even though the youngest drivers have the highest crash rates, their overinvolvement can be attributed to reasons other than a lack of skill: exposure to more risky conditions, likelihood of experiencing risk as rewarding and inexperience.[968] "If increased rates of crashing were due to lack of skill, then training and education would appear to be a natural countermeasure[;]" however, by 1991 no study with acceptable methodology on the influence of driver education on crash rates "has shown that those who receive driver education have lower crash rates than those who do not."[969] A famous evaluation in Georgia during the 1980's concluded that those receiving driver education were able to acquire licenses at an earlier age yet experienced crash rates typical for their age, consequentially increasing crashes because they started driving sooner.[970]

In 1983, Quebéc expanded its mandate of driving training to everybody seeking a driver's license rather than just 16- and 17-year olds.[971] Researchers at Université of Montréal concluded that the expanded "requirement had no

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[964]Evans, *supra* note 54, at ch. 13.
[965]*Id.* at ch. 6.
[966]*Id.*
[967]*Id.* at ch. 5.
[968]*Id.*(citation omitted).
[969]*Id.*
[970]*Id.*
[971]Wilde, *supra* note 903, at 89.

appreciable effect on the frequency or severity of accidents amongst newly licensed drivers who were 18 or older."[972] Perversely, "[t]he risk of accident actually *increased* for 16- and 17-year olds. This was attributed to the fact that the new legislation resulted in an increase in the number of young people obtaining a licence before age 18."[973] Previously, teenagers could avoid the cost of mandatory training at a registered driver school by waiting until age 18 to be licensed.[974] Expanding the requirement to anybody seeking a license eliminated this economic incentive to wait.[975]

> Post-licensure training programs have not been shown to reduce crash rates. . . . A possible reason why training and education do not lead to clear changes in safety is that so much of the skill and knowledge they aim to impart will be learned by trial and error, and by experience. Without instruction, drivers will learn . . . based on experimentation and feedback. . . . The absence of proven safety benefits from driver education does not prove that training cannot increase safety, but merely that none of the methods so far applied have been demonstrated to be successful. The importance of traffic safety justifies continuing searching aimed at discovering more effective training techniques.[976]

Lawrence P. Lonero, an author whose remarks are extensively quoted throughout this overview, observed that traditional safety education that informs a passive audience

> has proven to be ineffective in changing behavior. . . . . Keep in mind that ineffective safety measures make the world safer for bureaucracy, but they are actually harmful for the rest of us. They trick us into thinking that something useful is being done, preventing other actions which could actually be effective. We have limited mental and financial resources. Ineffective programs use up those resources just as fast as good programs, without producing any offsetting savings from loss reduction.[977]

Lonero contends that we know how to influence and change behavior, but we don't know how to change the behavior of organizations that could be influential enough to make a difference.[978] Hard data is required to prove that behavioral programs work, and hard data is obtained from evaluation.[979] Coordination and accountability are the other critical issues that the author

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[972] *Id.*
[973] *Id.*
[974] *Id.*
[975] *Id.* (citation omitted).
[976] Evans, *supra* note 54, at ch. 5.
[977] Lonero, *supra* note 872.
[978] *Id.*
[979] *Id.*

identifies.[980] The former is critical because driver behavior has multiple causes that require multifaceted programs to be effective; the latter is critical because organizations respond to incentives and disincentives.[981] The author lays blames on government for going easy on the average driver, diffuse responsibility among governmental agencies and levels of government that result in "little meaningful coordination or accountability" and media that is "seriously ignorant of technical aspects of driver safety and incompetently uncritical of poor information and lame programs."[982] The rest of the blame lies with us who don't want to be bothered too much and are optimistic that misfortunate wrecks won't happen to us.[983]

> There is little doubt that using a mobile phone while driving can distract the driver from the task of driving safely. This potential problem will have an increasing impact on road safety as more mobile communications devices appear in vehicles . . ..
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> . . . .
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> [R]esearch and statistics from around the world have shown that drivers who use mobile phones while driving have impaired driving performance, an increased risk of a crash, and an increased risk of a fatal crash. While mobile phones have been implicated in the causes of a few fatal crashes in the United States, their impact on road safety is unlikely ever to be as great as the impact of speed, alcohol, fatigue and seat-belt use. So in considering future activities on the issue of mobile phones and driving, it is important to remember the cost effectiveness to road safety in general, of such activities.
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> [I]t is obvious that the highest priority should be given to educating the public about the possible risks associated with using a mobile phone while driving, both hand-held and hands-free models. Such education should focus on the fact that mobile phones are just one of many in-car distractions that should be avoided to reduce the risk of having a crash.[984]

Counterintuitively, advanced driver training programs may not reduce crashes even though they raise levels of driving skill. Higher crash risk results from those better trained motorists being motivated to implement their increased skills thereby leaving smaller margins of safety than previously.[985] Evans

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[980] *Id.*

[981] *Id.*

[982] *Id.*

[983] *Id.*

[984] Dave Lamble & Laurence Hartley, *Report on the Feasibility of Studies to Investigate the Involvement of Mobile Phones in Road Crashes* (Nov. 15, 1998), *available at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000276&static=1 (last visited Aug. 30, 2000).

[985] Lawrence P. Lonero & Kathryn M. Clinton, *Driver Education: How to Get the Results We Are Looking for* (Sept. 9, 1997), *available at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000300&static=1 (last visited Aug. 31, 2000).

suggests that crash risk can be reduced by habitually "adopting more generous following headways than experience teaches" and maximizing attention when circumstances merit.[986]

"Depending upon the circumstances, legal driving can be either safe or risky, and safe driving can be either legal or illegal."[987] Aside from insurance and legal liability, factors causing motorists' behavior include how they learned to drive, licensing standards and rarity of traffic crashes.[988]

> [S]afe driving is precisely the act of maintaining adequate margins of safety around the car at all times and in all circumstances. This goal is achieved through the habitual use of safety protocols, or . . . associated driving rules . . .. . . . Many research directions in traffic safety are difficult to investigate because of the multifactorial nature of the concepts, the lack of precision and control over relevant variables, and the everpresent difficulty of collecting reliable data. . . . If properly and consistently implemented in all relevant areas, ranging from educational curricula and licence testing to driver improvement programs, safety protocols could influence the way people think about the role of the driver in collision avoidance. And that might be the necessary first step towards improving the way people drive.[989]

Notwithstanding scholarly views expressing disappointment with past educational programs intended to increase traffic safety, an educational campaign specifically designed to publicize the dangers of distracted driving in this Commonwealth should be attempted because the direct feedback experienced by drivers is inadequate to make a lasting correction.

> [T]he largest potential for increases in traffic safety is in the realm of stimulating changes in social norms pertaining to road-user behavior. . . . While efforts to improve vehicles, roadways, regulation, legislation, and law enforcement will continue to reduce harm from traffic crashes, the main opportunity for substantial reductions is through people taking steps to protect themselves from this large source of harm.[990]

<u>Legislation</u>. In shaping driver behavior, the chances of getting caught are much more important than the size of the penalty.[991]

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[986] Evans, *supra* note 54, at ch. 12.

[987] Hirsch, *supra* note 869.

[988] *Id.*

[989] *Id.*

[990] Evans, *supra* note 54, at ch. 15 .

[991] Lawrence P. Lonero, *Have the Wheels Fallen off Traffic Enforcement?* (Sept. 9, 1999), *available at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000138&static=1 (last visited Aug. 31, 2000).

> When drivers don't perform well enough and public safety is seen to be at stake, pressure is put on policymakers and politicians to do something. The easy way out, as in the case of mobile phone use in cars, is to pass laws. . . . It will likely be easier to enforce a law against hand-held mobile phones than one against hands-free. But research evidence so far shows little difference between the distraction effect of hand-held and hands-free phone use by drivers. And research into the effectiveness of enforcement programs indicate that a big increase in enforcement levels is required to create a significant reduction in violations. In other words, a high probability of being caught is a greater deterrent than tough penalties by themselves.
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> Selective Traffic Enforcement Programs . . . are a commonly used strategy in which certain violations are targeted and a blitz of enforcement action, backed up by several announcements in the media, ensures that the general public knows there is something going on. These programs have been shown to be effective and they are widely used. However, once the . . . program is over, things tend to drift back to normal. . . . The difficulties of achieving results with enforcement surely points to a need for education and training as a means of changing the way drivers relate to potential distractions . . .. However, something will have to change before policymakers place much faith in training. Researchers have looked at driver education programs . . . in the past and found them wanting. . . .
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> What keeps drivers alert . . . is reinforcement from the traffic environment. At street intersections, . . . drivers will normally check fairly thoroughly for traffic because if they don't, there's a good chance they will be punished . . .. On the other hand, maintaining good checking habits at railway grade crossing will be difficult because the chance of meeting a train is rare. Complacency, in other words, is what allows drivers to be seduced by distractions. . . . [I]t's quite possible that a well-trained driver, feeling mastery over the task, might even be more susceptible to distractions than an untrained one.[992]

[992] Drivers.com, *An Educator's Standpoint on Distractions* (Sept. 22, 2000), *at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000350&static=1 (last visited Oct. 27, 2000).

Legislation influences behavior by deterrence and education.[993] When enforced, the former threatens with punishment for misbehavior.[994] The latter reflects and partly influences or reinfluences social norms.[995]

> Legislation by itself has limited effect on road users' behavior, probably less effect than most people think. Typically, new legislation has an initial impact, because people overestimate the deterrent threat. . . . There may, however, be subtle long-term or cumulative effects on social norms, at least for some types of legislation. It is conceivable that a lot of rules and publicity efforts, each of which is ineffective on its own, adds to some mysterious effect on social norms. This may have happened with DWI.
>
> Legislative interventions need . . . enforcement, reinforcement, and education. . . . Enforcement . . . threatens penalties, and with some probability, delivers them. . . . Enforcement presence has dramatic short-range effects. Even an empty threat can have a big effect, for a while. . . . Unfortunately, there is rarely enough surveillance for this effect to make a significant contribution to road safety on its own. The "halo effects" of visible surveillance can extend the perceived threat, and this may contribute to general deterrence. Specific deterrence is restricted by the weakness of punishment as a behavioral influence and by the low chances of repeat violators being detected. Competing priorities for police resources may lock routine surveillance into a game-theory equilibrium with offenders: more enforcement leads to less violations, which leads to less enforcement, and so on.[996]

Nationally, "[i]n 1999 an estimated 10.3% of licensed drivers were pulled over by police one or more times in a traffic stop. . . . An estimated 2.1% of all licensed drivers were stopped two or more times."[997] "Police issued a traffic ticket to just over half (54.2%) of the drivers they stopped . . .. Another 26.4% received a warning, and the remaining 19.4% received neither ticket nor warning."[998]

Evans also noted that a sharp change resulting from intervening enforcement is often followed by a reversion to prior levels but still considers intervening enforcement to be considerably beneficial because harm is prevented at least between the change lower and the drift back.[999]

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[993]Lonero, *supra* note 872.
[994]*Id.*
[995]*Id.*
[996]*Id.*
[997]Bureau of Justice Statistics, U.S. Dep't of Justice, Contacts between Police and the Public: Findings from the 1999 National Survey 2 (2001).
[998]*Id.* at 17.
[999]Evans, *supra* note 54, at ch. 8.

> One main reason why crash rates tend to drift back to prior levels after the introduction of interventions is that the objective risk of detection is small. The intervention is introduced with much publicity, convincing motorists that if they transgress, they will be subject to well advertised penalties. Later, people observe . . . that there is not a policeman at every corner . . ..[1000]

Evans emphasizes the influence of social norms on behavior and the role that public policy contributes to that influence.[1001] He identified the dramatic change in social norms on smoking in United States during recent decades and believes that the relative disappearance of smoking on television greatly contributed to declining consumption of tobacco.[1002] Evans said that drunk driving has become less acceptable because mass media changed attitudes via coverage of potential negative factors resulting therefrom.[1003] Activists reduced the harm from drunk driving by successfully stimulating amendments to transportation codes thereby educating society and statutorily defining acceptable behavior.[1004] He largely credits activists and mass media for changing social norms rather than more severe punishment after reviewing a study comparing drunk driving in nearby jurisdictions with different punishments that found that probability of detection is more deterring than severity of punishment.[1005]

> In a sense, the ultimate punishment for drunk driving is death in a traffic crash, and if this severity does not deter the behavior it is not surprising that increased fines or prison sentences do not generate observable changes. It is the probability of being arrested, rather than the severity of punishment after arrest, which exercises a larger control on behavior. As the probability of being arrested in the US on a drunk driving trip is about one in one thousand, even doubling the police resources devoted to detection would increase this to only one in five hundred. In the face of such miniscule levels of actual threat, the proclaimed penalties lose credibility.[1006]
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> . . . .
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> In the traffic safety context, the view that probability of detection is more important than severity of punishment in deterring undesired behavior has been persuasively presented . . .. A high probability of a minor adverse consequence exercises a much larger influence on driver behavior than, say, the factors influencing the probability of being killed or injured. The prospect of a . . . fine . . .

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[1000] *Id.*
[1001] *Id.*
[1002] *Id.*
[1003] *Id.*
[1004] *Id.*
[1005] *Id.*
[1006] *Id.*

> controls traffic speeds more than does the relationship between fatality risk and speed.[1007]

Laws partly reflect and partly influence social norms.[1008] They can impact the fatality rate as happened when it dropped 34 percent in 1974 from the preceding year when the speed limit was reduced to 55 mph and after 1987 when the speed limit was increased to 65 mph in places.[1009] Interestingly, experiments in Nova Scotia found that police warning speeders obtained more lasting reductions of speeding than ticketing the offenders.[1010] Police could warn more frequently than ticket because it involves less work and they preferred it because it was a less unpleasant interaction than ticketing offenders.[1011]

It is difficult to link "changes in safety to broad changes in social norms regarding driving."[1012] Large, permanent changes occur gradually so that "[t]here is no possibility of a simple 'before' and 'after' comparison. The problem of evaluating any process occurring continuously over many decades against a background of innumerable other changes seems intractable."[1013] Changing public attitudes is more easily done when a device can be shown to have saved an identified occupant than when modified behavior might have avoided a crash and saved an unidentified person.[1014] "An intervention which saves one or two identifiable lives may attract far more public support than one which saves thousands of anonymous lives."[1015] Evans concludes that social norms play the largest role increasing traffic safety and suggests future countermeasures should so emphasize.[1016] "[W]hen one makes comparisons with other spheres, such as public health, there is convincing evidence that such approaches have generated large effects."[1017] He repeated the effect that changed social norms have had on driving drunk thanks to activists, amended transportation codes and media coverage.[1018] Evans thinks that mass media should deglamorize harmful driving behavior as it has drunkeness and smoking because those efforts succeeded and

> [m]any movies . . . specifically aimed at young people contain scenes that depict unrealistic occupant kinematics under crash conditions. . . . Young people already have a social norm relative to driving that differs from the overall norm. A change in the norms of this group towards increasingly responsible use of the

[1007] Evans, *supra* note 54, at ch. 11 (citations omitted).
[1008] *Id.* at ch. 13.
[1009] *Id.*
[1010] *Id.*
[1011] *Id.*
[1012] *Id.*
[1013] *Id.*
[1014] *Id.*
[1015] *Id.*
[1016] *Id.*
[1017] *Id.*
[1018] *Id.*

> automobile would probably generate larger safety benefits than changes in any other group.[1019]

A statutory or regulatory restriction on driver distractions does not yet appear to be warranted based upon available data. Should future data demonstrate the necessity of a restriction, a well-drawn restriction and its adequate enforcement would be a critical element to improve traffic safety.

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[1019] *Id.*

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# STATUTORY AND OTHER STRATEGIES

## SOME LAWS COAST TO COAST

National Highway Traffic Safety Administration estimates that 73 percent of subscribers to wireless telephone services use this service while driving.[1020] The "[i]nflux of potentially distracting gadgets and technologies in motor vehicles has heightened concern about traffic safety. However, there is no consensus on whether cell phones are a greater threat in the car than are eating, applying makeup, tuning the radio or talking with passengers."[1021] Conversely, there is a consensus that viewing television while driving is a greater threat because most jurisdictions forbid it. All jurisdictions forbid reckless driving, and most forbid driving that is variously characterized as careless, inattentive or negligent. Some relevant laws from around the country follow.

**Arizona** requires school buses to have and school bus drivers to use a 2-way voice communication system. It forbids a school bus driver from wearing an audio headset or earphones or using a cellular telephone whenever the school bus is in motion.[1022] It forbids a person from driving a motor vehicle equipped with a means of viewing a televised broadcast while operating the vehicle.[1023]

**California** requires every renter of a motor vehicle with cellular or radio telephone equipment to provide the person who rents the motor vehicle with written operating instructions concerning the safe use of the equipment.[1024] It also forbids driving a motor vehicle equipped with a television receiver viewable by a driver while operating the motor vehicle.[1025] Department of California Highway Patrol is studying and compiling data to recommend regulatory action to address "driver distractions and inattention as they relate to associated factors to the cause of traffic collisions."[1026] To do this, it is directed to "review and analyze a sample of existing studies and statistics" and must report by the end of 2002.[1027] From the approximately 14,000 crashes involving driver inattention that were tracked by this department from January through April 2001, distractions

[1020] Matt Sundeen, Nat'l Conf. of St. Legis., Cell Phones and Highway Safety: 2001 State Legislative Update 1(Aug. 2001).

[1021] *Id.*

[1022] Ariz. Admin. Code R17-9-104 (Supp. 2000-4).

[1023] Ariz. Rev. Stat. Ann. § 28-963 (West 1998).

[1024] Cal. Veh. Code § 28090 (West 2000).

[1025] *Id.* at § 27602.

[1026] *Id.* at § 2407.5.

[1027] *Id.*

were specified for only 2.5 percent of those crashes.[1028] Of those that were specified, approximately 31.7 percent were adjusting audio equipment and approximately 29.7 were cell phone related; however, these percentages represent approximately 0.8 percent and 0.7 percent, respectively, of the 14,000 crashes involving driver inattention.[1029]

**Florida** forbids operation of a motor vehicle on its highways if equipped with television receiver visible from the driver's seat.[1030] A headset in conjunction with a cellular telephone may be worn if it only provides sound through one ear and allows surrounding sounds to be heard with the other ear.[1031] For the first six months of 2001, preliminary data of Florida crashes shows careless driving to have been a contributing cause in almost half of crashes reported to police with failure to yield being a contributing cause in a little more than a quarter.[1032] Driver distraction is coded as a contributing cause in less than 1 percent of these crashes; within the driver distraction coding, inattention amounts to 30.8 percent of those and cell phone is the next largest distraction at 23.2 percent.[1033]

On its highways, **Illinois** forbids television broadcast receiver equipment to be located in a motor vehicle so that its screen is visible from the driver's seat.[1034] While driving a motor vehicle on its highways, a single sided headset receiver on one ear is allowed for two-way radio vocal communications and for a cellular or other mobile telephone.[1035]

Earlier this year, **Louisiana**'s legislature created Task Force on Driver Distractions to study both technological and nontechnological distractions and report thereon by the end of 2002.[1036] Louisiana also forbids a person from driving a motor vehicle equipped with a television receiver so that broadcast is visible to the driver.[1037]

**Massachusetts** allows a person to operate a motor vehicle "while using a citizens band radio or mobile telephone as long as one hand remains on the steering wheel at all times."[1038] It forbids a person from operating a motor vehicle

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[1028] *See* Automotive Fleet, Survey Says Car Stereos Are No. 1 Driver Distraction in California*, at* http://www.fleet-central.com/af/passnews_c.cfm?rank=1431 (Sept 18, 2001).

[1029] *See id.*

[1030] Fla. Stat. Ann. ch. 316.303 (West 2001).

[1031] *Id.* at ch. 316.304.

[1032] Fla. Dep't of Hghway Safety & Motor Vehicles, Preliminary Crash Data and Driver Distraction Overview (2001).

[1033] *Id.* Florida's crash forms with an added box for driver distraction box were distributed this past January, but law enforcement might have continued to use up existing inventory before using the new form.

[1034] 625 Ill. Comp. Stat. Ann. 5/12-604 (West Supp. 2001).

[1035] *Id.* at -610.

[1036] H.R. Con. Res. 35, 2001, Reg. Sess. (La. 2001).

[1037] La. Rev. Stat. Ann. § 32:365 (West Supp. 2000).

[1038] Mass. Gen. Laws Ann. ch. 90, § 13 (West 2001).

when anything interferes or impedes with its proper operation.[1039] No person may "drive any motor vehicle equipped with any television viewer, screen or other means of visually receiving a television broadcast which is located in the motor vehicle at any point forward of the back of the driver's seat, or which is visible to the driver while operating such motor vehicle."[1040] Except in the case of an emergency, no person may operate a moving school bus while using a mobile telephone.[1041]

On public highways in **New Jersey**, motorists may not operate motor vehicles equipped with a television viewable by the driver while operating the vehicle.[1042] Beginning in 2002, New Jersey will require its accident reports to sufficiently detail the causes and conditions of motor vehicle accidents to include whether a vehicle's operator was using a cell phone when the accident occurred.[1043] The state's commissioner of transportation must annually compile and make this information publicly available.[1044]

A motor vehicle equipped with a television receiver viewable by the driver may not be driven on **New York**'s public highways.[1045] Motorists wearing more than one earphone may not operate motor vehicles on New York's public highways.[1046] A driver is required to always keep at least one hand on the steering wheel when the motor vehicle is moving.[1047] Except for an emergency, New York forbids a person from operating a motor vehicle upon a public highway while holding a mobile telephone to his ear when the vehicle is moving.[1048] This act preempts any local laws relating to the operation of a motor vehicle while using a mobile telephone, except that any state or local agency may more stringently restrict the use of mobile telephones by individuals it regulates.[1049] The commissioner of motor vehicles must consult with the superintendent of the state police to "study the effects of the use of mobile telephones and similar equipment in conjunction with the operation of a motor vehicle, and the effects of other forms of driver inattention and distraction, on highway and traffic safety, and" report to the governor and legislature by 28 June 2005.[1050] The report must examine motor vehicle accident statistics relating to the use of mobile telephones or similar equipment while operating a motor vehicle as well as other forms of driver inattention and distraction.[1051] The report must review and analyze studies examining the effects of the use of mobile telephones or similar equipment on

[1039] *Id.*
[1040] *Id.*
[1041] *Id.* at § 7B.
[1042] N.J. Rev. Stat. Ann. § 39:3A-1 (West 1990).
[1043] *Id.* at § 39:4-131.
[1044] *Id.* at § 27:1A-5.19.
[1045] N.Y. Veh. & Traf. Law § 375 (Consol. 1992).
[1046] *Id.*
[1047] *Id.* at § 1226.
[1048] *Id.* at § 1225-c.
[1049] 2001 N.Y. Laws ch. 69, §§ 2, 3.
[1050] *Id.* at § 6.
[1051] *Id.*

highway and traffic safety and studies and statistics relating to other types of driver inattention and distraction that affect highway and traffic safety.[1052] It must recommend improvements to highway and traffic safety and reducing motor vehicle accidents related to driver inattention and distraction.[1053] Beginning in 2004, the commissioner of motor vehicles must annually summarize motor vehicle accident statistical information relative to the types of driver inattention by the operator of a motor vehicle that contributed to, or were a factor in accidents.[1054]

**Oklahoma** expressly preempts political subdivisions from legislating on inattentive driving and cellular phone usage in automobiles.[1055] On Oklahoma's highways, a person may not operate a motor vehicle that is equipped with a television screen viewable by the driver.[1056]

Beginning in 2002, **Oregon** will lkewise forbid local government from regulating the use of cellular telephones in motor vehicles.[1057] Motor vehicles equipped with a television receiver viewable to a driver may not be operated on Oregon's highways.[1058]

**Pennsylvania** forbids a driver from operating a vehicle while wearing earphones but allows a headset for a cellular telephone to be worn if it provides sound only through one ear and ambient sounds can be heard by the other ear.[1059] Our Commonwealth also forbids driving a vehicle in careless, willful or wanton disregard for the safety of persons or property.[1060] Television receivers are also forbidden to be visible to a driver when a motor vehicle is operated on a highway in Pennsylvania.[1061]

**Virginia**'s Department of Motor Vehicles is studying "the dangers imposed by distracted drivers" and, while considering all types of distractions, is specifically examining drivers using telecommunications devices.[1062] Its findings and recommendations are due by the end of November 2001.[1063] Motor vehicles with a television receiver visible to the driver may not be used in Virginia.[1064] A person with earphones on both ears may not operate a motor vehicle on Virginia's highways.[1065]

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[1052] *Id.*
[1053] *Id.*
[1054] *Id.* at § 7.
[1055] Okla. Stat. tit. 47, § 11-901a.
[1056] Okla. Stat. Ann. tit. 47, § 12-411 (West 2000).
[1057] 2001 Or. Laws ch. 133.
[1058] Or. Rev. Stat. § 815.240 (1999).
[1059] 75 Pa. C.S. § 3314.
[1060] *Id.* at §§ 3714, 3736.
[1061] *Id.* at § 4527.
[1062] S. J. Res. 336, 2001 Leg. Sess. (Va. 2001).
[1063] *Id.*
[1064] Va. Code Ann. § 46.2-1077 (Michie 1998).
[1065] *Id.* at -1078 (Michie Supp. 2001).

"[A]t least 20 states collect information about cell phones and driver distractions on crash report forms" and several other jurisdictions are studying the topic.[1066]

## RECOMMENDATIONS FROM OTHERS

A relatively recent safety campaign of our Commonwealth's Department of Transportation is *DRIVE* SMART[1067] that asks "ARE YOU AWARE?" It attributes most accidents to inattention: looking elsewhere, reaching for a map, arguing, daydreaming, and other losses of concentration. Because fatigue adversely affects one's ability to concentrate, this campaign asserts that tired driving "can be just as dangerous as driving while intoxicated." This safety campaign also observes, "After alcohol and drugs, the biggest cause of traffic accidents in Pennsylvania may be the driver's emotions." Impatience and anger can lead to aggressive driving, and Department of Transportation tells us, "Angry drivers do dumb things." The department suggests relaxing, "Put something soothing on the stereo." This suggestion is in the same literature that the department publishes to inform readers that "tuning the radio" may keep someone from paying attention by taking his concentration off the road. It's ironic that a potentially hazardous activity[1068] is recommended to ameliorate another potentially hazardous status.[1069] This irony says a lot because one can infer that driving attentively and safely can involve an ambivalent dictate. Researchers, engineers, motorists and legislators all recognize this ambivalent dictate, which makes it challenging to recommend strategies and legislative or regulatory action.

## INTERFACE

It seems self-evident that a system in-vehicle should support a driver by having unobstructive controls and displays compatible with attentional demands of driving.[1070] Systematic controls and displays should be:

- operable with few, brief glances;
- operable with short, interruptable sequences;
- operable at a driver's pace;

[1066]Sundeen, *supra* note 1020, at 3.

[1067]"Unless you're constantly aware of everything around you, in total control of yourself and your car, you're simply not driving smart."

[1068]Tuning the radio.

[1069]Anger.

[1070]Wiel Janssen, Driver Distraction in the European Statement of Principles on In-vehicle HMI: A Comment 2 (manuscript on file with J. St. Gov't Comm'n).

✍ inoperable by a driver if too demanding to use while driving; and
✍ operable audiovocally, if beneficial.[1071]

When assessing safety, "it is important to also appreciate the potential benefits that information and communication systems may provide. For example, a navigation system may encourage the driver to direct brief glances away from the road, but may be preferable to using a conventional map."[1072]

## PLANS TO COMBAT DISTRACTED DRIVING

Canadian Wireless Telecommunications Association and its U.S. counterpart maintain that safe driving is a motorist's first priority.[1073] This association has advocated avoidance of unnecessary calls, brief conversations and suspending them during hazardous driving conditions.[1074] This association asserts that the number of traffic accidents has declined or remained steady while the number of cellular phones has annually increased by more than 30 percent.[1075] Some tips and plans that typify educational messages from business and consumer groups follow.

SenseAble *driving* tips from GM.[1076] GM advises drivers to exercise good judgment and attend to the road.

Keep both EYES on the road,

✍ If you use a cellular phone, try to use a hands-free model.

✍ Don't take notes or look up a phone number while driving.

✍ When possible, use memory dialing while making calls from the car.

Both HANDS on the wheel.

✍ Program your favorite stations into the radio.

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[1071] *Id.* at 2-5.

[1072] Alan Stevens & Gulam Rai, Development of Safety Principles for In-vehicle Information and Communication Systems 6 (2000) (manuscript on file with J. St. Gov't Comm'n).

[1073] Can. Wireless Telecomm. Ass'n, *Some Facts on Wireless Phones and Driving* (Sept. 15, 1998), *at* http://www.drivers.com/cgi-bin/go.cgi?type=ART&id=000000189&static=1 (last visited Aug. 30, 2000).

[1074] *Id.*

[1075] *Id.*

[1076] GM, Safety: SenseAble Driving, *at* http://gm.com/company/gmability/safety/senseable/tips/driving_tips.html (last visited Oct. 23, 2001).

- Arrange CDs in an easy-to-reach spot.
- Don't try to retrieve items that fall to the floor while driving.
- Teach your children the importance of good behavior while in a vehicle.
- Avoid eating while driving and make sure all drinks are in cup-holders.

And your MIND on the drive!

- Designate a passenger to help navigate rather than fumble with maps.
- If you find yourself "lost in thought" while driving, take a break.
- Avoid stressful or confrontational conversations while driving.

AAA's 10-Point Plan. AAA pledged to:[1077]

1. Nationally offer a free, educational brochure on cell phones and driving.
2. With state departments of motor vehicles, educate novice drivers on distracted driving.
3. Test telematics to develop a protocol on their distractability.
4. Develop voluntary, safety standards for telematics.
5. Collaborate with policymakers.
6. Encourage research to better understand distracted driving.
7. Disseminate current research
8. Instruct on driver distractions in its educational programs.
9. Encourage corporations to educate employees and customers.
10. Educate AAA employees.

[1077] News Release, AAA, Traffic Safety News: AAA Offers 10-Point Plan to Combat Distracted Driving, *at* http://www.aaa.com/news12/Releases/Legislative/distract.htm (last visited June 15, 2001).

To manage driver distractions, AAA advises one to:[1078]

- Recognize that driving requires full attention.
- Avoid talking on a phone while driving. If unavoidable, phone when and where it is safe to do so and use the message taking function.
- Become familiar with a vehicle's equipment prior to driving it and preset controls.
- Secure items so that they remain stationary.
- Avoid smoking and consuming food and beverage.
- Pull out of traffic to deal with children.
- Not to groom in a vehicle.
- View maps prior to driving.
- Monitor traffic before engaging in a secondary task.
- Ask a passenger for assistance.

Using Your Sprint PCS Phone Responsibly.[1079] Before using a new phone, Sprint asks its users to consider:

- Getting to know their phone and its features.
- Using a hands-free device while driving.
- Positioning the phone within easy reach and refraining from taking notes.
- Being courteous around others.
- Reporting serious emergencies by dialing 9-1-1.
- Placing calls when their vehicle is stationary.
- Vocally and one-touch dialing.[1080]

It gives customers a $5 discount on select hands-free accessories.

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[1078] AAA, Stay Focused: Keep Your Mind on the Road.

[1079] Sprint, Sprint PCS' Clear Commitment to Wireless Responsibility, *at* http://www.sprintpcs.com/aboutsprintpcs/community/articles/wirelessresponsibility.html (last visited Oct. 23, 2001).

[1080] All Sprint PCS customers can vocally operate their phones.

# DRIVING DISTRACTIONS METHODOLOGY

Pennsylvania Senate Resolution No. 127 of 2000 charges the Joint State Government Commission to review and analyze statistics relating to all types of driver distractions that affect safety. The first step in this process was to collect data on driver-distracted crashes in Pennsylvania, since no detailed data exists on the subject. The Pennsylvania Department of Transportation (PennDOT) and the Pennsylvania State Police are repositories for police accident reports.[1081] Those reports, which are stored on microfilm, are the raw material for statistics herein.

The next step before actually reviewing the reports was to determine how driving distraction data could be retrieved and what information it was necessary to obtain, then evaluate and record. The State Police and all local police departments in the Commonwealth use a standard Pennsylvania accident reporting form. The narrative portion of each accident report that contained a distraction was read to determine the described distraction. All the accident reports read to gather the statistics were recorded on the old forms.[1082]

Despite the fact that both PennDOT and the State Police are repositories for microfilmed accident reports, PennDOT processes all completed local accident reports and sends them out to be microfilmed. After the local reports are returned and the State Police reports are received, critical data is entered into the Accident Record System. The PennDOT analysts finally determine whether the distraction was a contributing factor based upon the narrative. Following a standard protocol for setting a factor as a distraction, PennDOT's analysts also decide if the distraction was a primary or secondary cause and if there were multiple distractions involved. Additional information would need to be pulled from the accident reports because their data fields did not precisely match the information needed for this study.

PennDOT provided Commission staff with an electronic list by accident report number of all accident reports with a distracted crash in Pennsylvania for the years 1999 and 2000. A total of 1,542 State Police and 3,705 local police

[1081] PennDOT's Bureau of Highway Safety and Traffic Engineering's Crash Information Systems and Analysis Division processes all accident reports but is only a repository for local reports. State Police reports are sent to its Traffic Accident Records Unit at headquarters, where they are microfilmed in house. The reports are then sent to PennDOT, where certain data is entered into the Accident Record System, a database for traffic crash statistics.

[1082] *See* appendix A for a blank copy of the "Old" Accident Reporting Form and appendix B for a blank copy of the "New" Accident Reporting Form, effective 2001. *Infra* pp. 166,168.

distracted crashes were identified for 1999, and 1,448 State Police and 3,620 local police reports were identified for 2000. This identified all accidents solely or contributorily cause by a distraction. PennDOT identified 19 data fields for each accident report to support the project.[1083]

Commission staff then created its database in Microsoft Access, incorporating PennDOT's 19 fields of data and added 6 more.[1084] Those additional 6 fields would also have to be retrieved from the microfilmed accident reports. The next step was to retrieve the necessary information from the 10,315 distracted crashes.

A method was devised to compare the numbers compiled from Pennsylvania crashes to available national statistics. Prior to this study, no national or state data was available for a precise comparison on driving distractions. The National Highway Traffic Safety Administration collects national crash data for its Crashworthiness Data System (CDS), which is used to generate statistics on all types of passenger vehicle accidents where a vehicle was towed from the scene. The AAA Foundation for Traffic Safety's recent study, *The Role of Driver Distraction in Traffic Crashes*, by the University of North Carolina's Highway Safety Research Center, identified which accidents in CDS from recent years involved a distraction. The study was used to compare Pennsylvania with national data.

For each of the 11 categories, Commission staff followed the AAA foundation's study's descriptions of which categories specific distractions should fall under.[1085] The AAA foundation's study generally followed guidelines established by CDS, which gave examples for determining the category each specific distraction would fall under.

There were some instances of incomplete data from the police agencies who completed the accident report forms. By not completing certain parts of the forms, reversing the information of the involved drivers and skipping certain sections entirely without submitting the proper supplements, the accuracy of the data suffered. In some cases, the primary cause of the accident was in question. Within the narratives themselves, officers did not always specify the distraction so it could be clearly placed in the taxonomy used herein. For example, stating, "Driver reached for an item." Depending on the item, it could be characterized as moving object in vehicle, brought into the vehicle, object in the vehicle, smoking or eating and drinking. In addition, the item could have been a cell phone, the radio, climate controls, something a child or passenger dropped, something the driver dropped, or even a cigarette. Narratives were often vague, forcing staff to interpret the meaning to accurately reflect the distraction. When a cause could not be interpreted, the "Other" or "Unknown" categories were used.

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[1083] Appendix C, *infra* p. 178.
[1084] Appendix D, *infra* p. 179.
[1085] Appendix E, *infra* p. 180.

In some cases, accidents that did not contain a distraction were included in the lists provided to Commission staff. Certain reports containing a key word, like cell phone, were identified and, if not read thoroughly, that report is deemed a distracted crash. In one instance, a driver stopped at a red light was talking on a cell phone when he was rear ended by a driver looking at an outside object. The driver on his cell phone was listed as the distracted driver and the driver of the other vehicle was not listed as being distracted. In a few instances, distracted crashes that were not on PennDOT's list were found while some crashes on PennDOT's list had no evidence of a distraction. These problems occurred in a relatively low number of cases--less than one percent of the total.

PennDOT identified some crashes as "Double Distraction" crashes, meaning either a driver was distracted by more than one thing or two different drivers were distracted. The most common examples were crashes identified as doubles that did not contain a second distraction. For example, "Driver took his attention off the road to reach for his cell phone." In other cases, only one distraction was identified when there were clearly multiple distractions involved: "Driver was eating a hoagie and smoking a cigarette."

At each repository one analyst gathered data for the Commission, just as PennDOT had several analysts performing data entry, which could have caused the same problem as described above. To avoid this, if any aspect of the accident report was unclear or a specific distraction or double distraction was in question, the reports were printed and a mutual decision was made by the Commission's analysts.

After the database was complete it was thoroughly reviewed and revised to ensure the integrity of the results. Each specific distraction category was thoroughly reviewed to make sure all distractions within it were accurately reflected. All accidents in the "Unknown" and "Other" categories were given particular attention in the effort to eliminate as many of those as possible by including them in a specific category. In some instances, where a specific distraction could have fit in several categories, a decision was made by the Commission's analysts to put it in the category that most nearly represented the distraction and that pattern was followed consistently.

Recommendations for any further study should include improved data gathering procedures. Police officers should be trained and encouraged to be as accurate as possible when completing the forms, ask follow-up questions, and specifically describe the distraction. Revising the standardized data entry protocol for identifying and analyzing distracted crashes will help PennDOT employees improve its accuracy. In addition, checking the microfilm before the actual reports are destroyed will ensure all information is intact, which will provide the opportunity to review all crash reports containing distractions.

Initially, Commission staff sought to procure all distracted crashes for the years 1999, 2000 and the first six months of 2001. No 2001 accidents were incorporated into this study due to unavailability. PennDOT is implementing new software to record and store the accident reports for which it is responsible. To provide better access and make data recording more accurate, new computer scanning equipment is being used beginning with this year's accident report. With computer glitches and personnel adjustments to the new system, a large backlog of reports to be scanned developed, making data for the first part of the 2001 unavailable. The new accident reporting form is now ten pages as opposed to the old two-page version. The expansion of many categories may help improve the accuracy of the report by containing, for example, a section on cell phone use; however, this reporting form is already being revised.

# APPENDICES

# Appendix A

**COMMONWEALTH OF PENNSYLVANIA**
**POLICE ACCIDENT REPORT**

(XX.) REFER TO OVERLAY SHEETS — REPORTABLE ☐ NON - REPORTABLE ☐ — PENNDOT USE ONLY

## POLICE INFORMATION

| | |
|---|---|
| 1. INCIDENT NUMBER | |
| 2. AGENCY NAME | |
| 3. STATION/ PRECINCT | 4. PATROL ZONE |
| 5. INVESTIGATOR | BADGE NUMBER |
| 6. APPROVED BY | BADGE NUMBER |
| 7. INVESTIGATION DATE | 8. ARRIVAL TIME |

## ACCIDENT INFORMATION

| | |
|---|---|
| 9. ACCIDENT DATE | 10. DAY OF WEEK |
| 11. TIME OF DAY | 12. NUMBER OF UNITS |
| 13. # KILLED / 14.# INJURED | 15. PRIV. PROP. ACCIDENT Y ☐ N ☐ |
| 16. DID VEHICLE HAVE TO BE REMOVED FROM THE SCENE? UNIT 1 Y ☐ N ☐ UNIT 2 Y ☐ N ☐ | 17. VEHICLE DAMAGE 0 - NONE 1 - LIGHT 2 - MODERATE 3 - SEVERE UNIT 1 ☐ UNIT 2 ☐ |
| 18. HAZARDOUS MATERIALS Y ☐ N ☐ | 19. PENNDOT PROPERTY Y ☐ N ☐ |

## ACCIDENT LOCATION

| | |
|---|---|
| 20. COUNTY | CODE |
| 21. MUNICIPALITY | CODE |

### *PRINCIPAL ROADWAY INFORMATION*

| | | |
|---|---|---|
| 22. ROUTE NO. OR STREET NAME | | |
| 23. SPEED LIMIT | (24.) TYPE HIGHWAY | (25.) ACCESS CONTROL |

### *INTERSECTING ROAD:*

| | | |
|---|---|---|
| 26. ROUTE NO. OR STREET NAME | | |
| 27. SPEED LIMIT | (28.) TYPE HIGHWAY | (29.) ACCESS CONTROL |

### *IF NOT AT INTERSECTION:*

| | |
|---|---|
| 30. CROSS STREET OR SEGMENT MARKER | |
| 31. DIRECTION FROM SITE N S E W | 32. DISTANCE FROM SITE FT. MI. |
| 33. DISTANCE WAS MEASURED ☐ ESTIMATED ☐ | |
| (34.) CONSTRUCTION ZONE ☐ | (35.) TRAFFIC CONTROL DEVICE PRINCIPAL ☐ INTERSECTING ☐ |

## UNIT # 1

| | | |
|---|---|---|
| 36. LEGALLY PARKED ? Y ☐ N ☐ | 37. REG. PLATE | 38. STATE |
| 39. PA TITLE OR OUT-OF-STATE VIN | | |
| 40. OWNER | | |
| 41. OWNER ADDRESS | | |
| 42. CITY, STATE & ZIPCODE | | |
| 43. YEAR | 44. MAKE | |
| 45. MODEL - (NOT BODY TYPE) | | 46. INS. Y ☐ N ☐ UNK ☐ |
| (47.) BODY TYPE | (48.) SPECIAL USAGE | (49.) VEHICLE OWNERSHIP |
| (50.) INITIAL IMPACT POINT | (51.) VEHICLE STATUS | (52.) TRAVEL SPEED |
| (53.) VEHICLE GRADIENT | (54.) DRIVER PRESENCE ☐ | (55.) DRIVER CONDITION |
| 56. DRIVER NUMBER | | 57. STATE |
| 58. DRIVER NAME | | |
| 59. DRIVER ADDRESS | | |
| 60. CITY, STATE & ZIPCODE | | |
| 61. SEX | 62. DATE OF BIRTH | 63. PHONE |
| 64. COMM. VEH. Y ☐ N ☐ | 65. DRIVER CLASS | |
| 67. CARRIER | | |
| 68. CARRIER ADDRESS | | |
| 69. CITY, STATE & ZIPCODE | | |
| 70. USDOT # | ICC # | PUC # |
| (72.) VEH. CONFIG. | (73.) CARGO BODY TYPE | 74. GVWR |
| 75. NO. OF AXLES | (76.) HAZ ARDOUS MATERIALS | 77. RELEASE OF HAZMAT Y ☐ N ☐ UNK ☐ |

## UNIT # 2

| | | |
|---|---|---|
| 36. LEGALLY PARKED ? Y ☐ N ☐ | 37. REG. PLATE | 38. STATE |
| 39. PA TITLE OR OUT-OF-STATE VIN | | |
| 40. OWNER | | |
| 41. OWNER ADDRESS | | |
| 42. CITY, STATE & ZIPCODE | | |
| 43. YEAR | 44. MAKE | |
| 45. MODEL - (NOT BODY TYPE) | | 46. INS. Y ☐ N ☐ UNK ☐ |
| (47.) BODY TYPE | (48.) SPECIAL USAGE | (49.) VEHICLE OWNERSHIP |
| (50.) INITIAL IMPACT POINT | (51.) VEHICLE STATUS | (52.) TRAVEL SPEED |
| (53.) VEHICLE GRADIENT | (54.) DRIVER PRESENCE ☐ | (55.) DRIVER CONDITION |
| 56. DRIVER NUMBER | | 57. STATE |
| 58. DRIVER NAME | | |
| 59. DRIVER ADDRESS | | |
| 60. CITY, STATE & ZIPCODE | | |
| 61. SEX | 62. DATE OF BIRTH | 63. PHONE |
| 64. COMM. VEH. Y ☐ N ☐ | 65. DRIVER CLASS | |
| 67. CARRIER | | |
| 68. CARRIER ADDRESS | | |
| 69. CITY, STATE & ZIPCODE | | |
| 70. USDOT # | ICC # | PUC # |
| (72.) VEH. CONFIG. | (73.) CARGO BODY TYPE | 74. GVWR |
| 75. NO. OF AXLES | (76.) HAZ ARDOUS MATERIALS | 77. RELEASE OF HAZMAT Y ☐ N ☐ UNK ☐ |

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2321044

| 78. RESPONDING EMS AGENCY | INCIDENT #: |
|---|---|
| 79. MEDICAL FACILITY | ACCIDENT DATE: |

80. PEOPLE INFORMATION

| A | B | C | D | E | F | G | NAME | ADDRESS | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

81. ILLUMINATION

82. WEATHER

83. ROAD SURFACE

84. PENNSYLVANIA SCHOOL DISTRICT (IF APPLICABLE)

85. DESCRIPTION OF DAMAGED PROPERTY

OWNER

ADDRESS

PHONE

86. DIAGRAM

o

87. NARRATIVE - IDENTIFY PRECIPITATING EVENTS, CAUSATION FACTORS, SEQUENCE OF EVENTS, WITNESS STATEMENTS, AND PROVIDE ADDITIONAL DETAILS. LIKE INSURANCE INFORMATION AND LOCATION OF TOWED VEHICLES, IF KNOWN.

| INSURANCE INFORMATION | COMPANY | INSURANCE INFORMATION | COMPANY |
|---|---|---|---|
| UNIT 1 | POLICY NO | UNIT 2 | POLICY NO |

| 88. WITNESSES | NAME | ADDRESS | PHONE |
|---|---|---|---|
| | NAME | ADDRESS | PHONE |

| | 89. VIOLATIONS INDICATED | 90. SECTION NUMBERS (ONLY IF CHARGED) | TC | NTC |
|---|---|---|---|---|
| UNIT 1 | | | ☐ | ☐ |
| UNIT 2 | | | ☐ | ☐ |

| UNIT 1 | 91. PROBABLE USE | 92. TYPE TEST | 93. RESULTS 0.__ __% | ☐ NO TEST ☐ REFUSE ☐ UNK | UNIT 2 | 91. PROBABLE USE | 92. TYPE TEST | 93. RESULTS 0.__ __% | ☐ NO TEST ☐ REFUSE ☐ UNK | 94. INVESTIGATION COMPLETE ? YES ☐ NO ☐ |
|---|---|---|---|---|---|---|---|---|---|---|

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# Appendix B

Crash Number

COMMONWEALTH OF PENNSYLVANIA
POLICE CRASH REPORTING FORM

◯ New

AA 45 C 1

Page:

◯ Change/ Continuation

**Commercial Vehicle Information**

Unit Number

Carrier Phone ( ) -

Carrier Name

Address

GVWR

*Oversize Load*
◯ Yes ◯ No
◯ Unknown

City

State

Zip

USDOT#

ICC #

PUC #

*Cargo Body Type*
◯ Not Applicable
◯ Van/Enclosed Box
◯ Cargo Tank
◯ Flat Bed
◯ Dump
◯ Concrete Mixer
◯ Auto Transport
◯ Garbage/Refuse
◯ Bus
◯ Other/Unknown

*Vehicle Configuration*
◯ Not Applicable
◯ Passenger Car - Only Record if HazMat Placard Displayed
◯ Light Truck (Van, Mini-Van, Panel, Pickup or SUV with HazMat Placard)
◯ Single Unit Truck (2 Axles, 6 Tires)
◯ Single Unit Truck (3 or More Axles)
◯ Single Unit Truck (Unknown Number of Axles)
◯ Truck/Trailer(s)
◯ Truck Tractor (Bobtail)
◯ Tractor/Semi-Trailer(s)
◯ Medium/Heavy Truck - Cannot Classify
◯ Small Bus (Seats 9-15 People, Including Driver)
◯ Bus (Seats More Than 15 People, Including the Driver)
◯ Other
◯ Unknown

*Hazardous Material*
◯ Yes ◯ No

Enter 4-digit hazardous material code and corresponding 1-digit release indicator

*Release Indicator* 1 = No Release 2 = Release Occurred 9 = Unknown

**Commercial Vehicle Information**

Unit Number

Carrier Phone ( ) -

Carrier Name

Address

GVWR

*Oversize Load*
◯ Yes ◯ No
◯ Unknown

City

State

Zip

USDOT#

ICC #

PUC #

*Cargo Body Type*
◯ Not Applicable
◯ Van/Enclosed Box
◯ Cargo Tank
◯ Flat Bed
◯ Dump
◯ Concrete Mixer
◯ Auto Transport
◯ Garbage/Refuse
◯ Bus
◯ Other/Unknown

*Vehicle Configuration*
◯ Not Applicable
◯ Passenger Car - Only Record if HazMat Placard Displayed
◯ Light Truck (Van, Mini-Van, Panel, Pickup or SUV with HazMat Placard)
◯ Single Unit Truck (2 Axles, 6 Tires)
◯ Single Unit Truck (3 or More Axles)
◯ Single Unit Truck (Unknown Number of Axles)
◯ Truck/Trailer(s)
◯ Truck Tractor (Bobtail)
◯ Tractor/Semi-Trailer(s)
◯ Medium/Heavy Truck - Cannot Classify
◯ Small Bus (Seats 9-15 People, Including Driver)
◯ Bus (Seats More Than 15 People, Including the Driver)
◯ Other
◯ Unknown

*Hazardous Material*
◯ Yes ◯ No

Enter 4-digit hazardous material code and corresponding 1-digit release indicator

*Release Indicator* 1 = No Release 2 = Release Occurred 9 = Unknown

FORM # AA-45C (01/01)

PENNDOT COPY

Crash Number

**COMMONWEALTH OF PENNSYLVANIA**
**POLICE CRASH REPORTING FORM**

AA 45 F 1 Page: [ ] [ ] [ ]

○ New
○ Change/ Continuation

**Road Surface Type**
○ Concrete ○ Blacktop ○ Brick or Block ○ Slag, Gravel or Stone ○ Dirt ○ Other ○ Unknown

**Special Jurisdiction**
○ No Special Jurisdiction ○ National Park ○ Military ○ Indian Reservation ○ College/University Campus ○ Other Federal Sites ○ Other ○ Unknown

Please complete Unit Information for ***each*** unit involved in a ***fatal*** crash. Do not repeat the information in the fields above on multiple pages.

## Unit Information

Unit Number [ ] [ ]

**Driver Restrictions Compliance**
○ No Restrictions/ Not Applicable ○ Restrictions Complied With ○ Restrictions Not Complied With ○ Compliance Unknown ○ Not a Pennsylvania Driver ○ Unknown Compliance

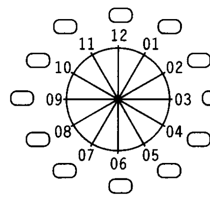
**Driver Endorsement Compliance**
○ None Required ○ Required - Complied With ○ Required - Non Compliance ○ Required - Compliance Unknown ○ Not a Pennsylvania Driver ○ Unknown Compliance

**Driver License Compliance**
○ Not Licensed ○ Not Required for Vehicle Class ○ No Valid License for Class ○ Valid License for Class ○ Unk if CDL or CDL Required ○ Not a Pennsylvania Driver ○ Unknown

**Drug Test Type**
○ None ○ Blood ○ Urine ○ Other ○ Unknown if Test Given

**Drug Test Results - (Up to Four Results)**
0 = No Test Given
1 = No Drug Reported
2 = Marijuana
3 = Cocaine
4 = Opiates
5 = Amphetamines
6 = PCP
8 = Other
9 = Unknown Test Results
▶ [ ] [ ] [ ] [ ]

**Principle Impact Point**
○ Non-Collision ○ Top ○ Undercarriage ○ Towed Unit ○ Unknown




**Avoidance Maneuver**
○ No Avoidance Maneuver ○ Braking - Skid Marks Evident ○ Braking - No Skid Marks, Driver Stated ○ Braking - Other Evidence ○ Steering - Evidence or Driver Stated ○ Steering and Braking Evidence or Stated ○ Other Avoidance Maneuver ○ Inconclusive ○ Unknown

**Under Ride Indicator**
○ No Underride or Override ○ Underride, Compartment Intrusion ○ Underride, No Compartment Intrusion ○ Underride, Compartment Intrusion Unknown ○ Override, Other Vehicle ○ Unknown if Underride or Override

**Emergency Use**
○ Not in Emergency Use ○ Lights Flashing ○ Siren Sounding ○ Both Lights and Siren ○ Unknown

## Unit Information

Unit Number [ ] [ ]

**Driver Restrictions Compliance**
○ No Restrictions/ Not Applicable ○ Restrictions Complied With ○ Restrictions Not Complied With ○ Compliance Unknown ○ Not a Pennsylvania Driver ○ Unknown Compliance

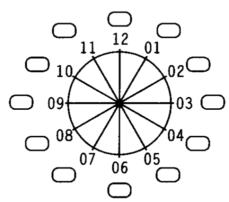
**Driver Endorsement Compliance**
○ None Required ○ Required - Complied With ○ Required - Non Compliance ○ Required - Compliance Unknown ○ Not a Pennsylvania Driver ○ Unknown Compliance

**Driver License Compliance**
○ Not Licensed ○ Not Required for Vehicle Class ○ No Valid License for Class ○ Valid License for Class ○ Unk if CDL or CDL Required ○ Not a Pennsylvania Driver ○ Unknown

**Drug Test Type**
○ None ○ Blood ○ Urine ○ Other ○ Unknown if Test Given

**Drug Test Results - (Up to Four Results)**
0 = No Test Given
1 = No Drug Reported
2 = Marijuana
3 = Cocaine
4 = Opiates
5 = Amphetamines
6 = PCP
8 = Other
9 = Unknown Test Results
▶ [ ] [ ] [ ] [ ]

**Principle Impact Point**
○ Non-Collision ○ Top ○ Undercarriage ○ Towed Unit ○ Unknown




**Avoidance Maneuver**
○ No Avoidance Maneuver ○ Braking - Skid Marks Evident ○ Braking - No Skid Marks, Driver Stated ○ Braking - Other Evidence ○ Steering - Evidence or Driver Stated ○ Steering and Braking Evidence or Stated ○ Other Avoidance Maneuver ○ Inconclusive ○ Unknown

**Under Ride Indicator**
○ No Underride or Override ○ Underride, Compartment Intrusion ○ Underride, No Compartment Intrusion ○ Underride, Compartment Intrusion Unknown ○ Override, Other Vehicle ○ Unknown if Underride or Override

**Emergency Use**
○ Not in Emergency Use ○ Lights Flashing ○ Siren Sounding ○ Both Lights and Siren ○ Unknown

FORM # AA-45F (01/01)

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**COMMONWEALTH OF PENNSYLVANIA**
**POLICE CRASH REPORTING FORM**

Crash Number
P0042343

○ New
○ Change/ Continuation

AA 45 1 1

Case Closed ○ Yes ○ No

Page:

## Police Agency Data

Incident Number | Police Agency | Patrol Zone

Agency Name | Precinct | Investigation Date (MM-DD-YYYY)

Dispatch Time *(mil)* | Arrival Time *(mil)* | Investigator | Badge Number

Reviewer | Badge Number | Approval Date (MM-DD-YYYY)

## Crash Data

County | County Name | Municipality | Municipality Name

Crash Date (MM-DD-YYYY) | Crash Time *(Military)* | No of Units | No of People | No Injured | No Killed (If > 00, Complete Form: AA 45 F 1)

*Day of Week*
○ Sun ○ Thu
○ Mon ○ Fri
○ Tue ○ Sat
○ Wed ○ Unk

| Reportable Crash | Notify Highway Maintenance | School Bus Related | School Zone Related | PennDOT Property |
|---|---|---|---|---|
| ○ Yes ○ No | ○ Yes ○ No | ○ Yes ○ No | ○ Yes ○ No | ○ Yes ○ No |

## Unit Information

Unit Number

Delete? ○

*Type Unit* ▶ ○ Motor Vehicle in Transport ○ Pedestrian ○ Hit & Run Vehicle ○ Pedestrian on Skates, in Wheelchair, etc ○ Illegally Parked ○ Disabled From Previous Crash ○ Legally Parked ○ Train ○ Non - Motorized ○ Phantom Vehicle

Owner Last Name (*If Pedestrian, skip to Form AA 45 3 1*) | FI | MI | Telephone Number

Address | City | State | Zip

VIN | Model Year | Vehicle Make*

License Plate | Reg. State | Travel Speed

*Refer to List on Back of Overlay

***Commercial Vehicle***
○ Yes
○ No
(If Yes, Complete Form: AA 45 C 1)

*Insurance* ○ Yes ○ No ○ Un-known | Insurance Company | Policy No | Insurance Company Phone

*Vehicle Towed* ○ Yes ○ No | Towed To | Towed By | Tow Agency Phone

## Unit Information

Unit Number

Delete? ○

*Type Unit* ▶ ○ Motor Vehicle in Transport ○ Pedestrian ○ Hit & Run Vehicle ○ Pedestrian on Skates, in Wheelchair, etc ○ Illegally Parked ○ Disabled From Previous Crash ○ Legally Parked ○ Train ○ Non - Motorized ○ Phantom Vehicle

Owner Last Name (*If Pedestrian, skip to Form AA 45 3 1*) | FI | MI | Telephone Number

Address | City | State | Zip

VIN | Model Year | Vehicle Make*

License Plate | Reg. State | Travel Speed

*Refer to List on Back of Overlay

***Commercial Vehicle***
○ Yes
○ No
(If Yes, Complete Form: AA 45 C 1)

*Insurance* ○ Yes ○ No ○ Un-known | Insurance Company | Policy No | Insurance Company Phone

*Vehicle Towed* ○ Yes ○ No | Towed To | Towed By | Tow Agency Phone

FORM # AA-45 (01/01)

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**POLICE CRASH REPORTING FORM**

Crash Number
P0042343

○ New

AA 45 2 1

Page: ☐☐☐ ○ Change/ Continuation ☐☐☐☐☐☐☐☐

## Vehicle Information

Unit Number ☐☐

*Trailing Unit(s)* Number of Trailing Units: ☐

*Type of Unit*
1=Towing Passenger Veh
2=Towing Truck
3=Towing Utility Trailer
4=Mobile or Modular Home
5=Camper
6=Trailer
7=Semi-Trailer
8=Other
9=Unknown

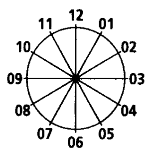
☐ Tag No ☐ Tag Year ☐ Tag State ☐
☐ Tag No ☐ Tag Year ☐ Tag State ☐

*Vehicle Color* ☐☐
01=Blue
02=Red
03=White
04=Green
05=Black
06=Yellow
07=Silver
08=Gold
09=Brown
10=Orange
11=Purple
12=Other
99=Unknown

*Vehicle Type* ☐☐
01=Automobile
02=Motorcycle
03=Bus
04=Small Truck
05=Large Truck
10=Snowmobile
11=Farm Equip
12=Construction Equip
18=Other Type Special Veh
19=Unknown Type Special Veh
20=Unicycle, Bicycle, Tricycle
21=Other Pedalcycle
22=Horse and Buggy
23=Horse and Rider
24=Train
25=Trolley
98=Other
99=Unknown

*Special Usage* ☐☐
00=Not Applicable
01=Fire Veh
02=Ambulance
03=Police
08=Other Emergency Vehicle
11=Pupil Transport
12=Commercial Passenger Carrier
13=Taxi
21=Tractor Trailer
22=Twin Trailer
23=Triple Trailer
31=Modified Veh
99=Unknown

*Initial Impact Point* ☐☐




00=Non-Collision
13=Top
14=Undercarriage
15=Towed Unit
99=Unknown

*Damage Indicator* ☐
0=None
1=Minor (Driveable)
2=Functional (Moderate Damage, May Not be Driveable)
3=Disabling (Severe - Not Driveable)
9=Unknown

*Vehicle Role* ☐
0=Non-Collision
1=Striking
2=Struck
3=Both Striking and Struck

*Vehicle Position* ☐☐
00=Not Applicable
01=Right Lane (Curb)
02=Right Turn Lane
03=Left Lane
04=Left Turn Lane
05=2-Direction Center Turn Lane
06=Other Forward Moving Lane
07=Oncoming Traffic Lane
08=Left of Trafficway
09=Right of Trafficway
10=HOV Lane
11=Shoulder Right
12=Shoulder Left
13=One Lane Road
98=Other
99=Unknown

*Direction of Travel* ☐
N=North
S=South
E=East
W=West
U=Unknown

*Movement* ☐☐
01=Going Straight
02=Slowing/Stopping in Lane
03=Stopped in Traffic Lane
04=Passing/Overtaking Veh
05=Leaving a Parked Position
06=Parked
07=Entering a Parked Position
08=Trying to Avoid Animal, Ped, Object, Veh, etc
09=Turning Right on Red
10=Turning Right
11=Turning Left on Red
12=Turning Left
13=Making a U-Turn
14=Backing Up
15=Changing Lanes or Merging
16=Negotiating Curve - Right
17=Negotiating Curve - Left
98=Other
99=Unknown

*Gradient* ☐
1=Level Roadway
2=Uphill
3=Downhill
4=Sag/Bottom of Hill
5=Crest/Top of Hill
9=Unknown

*Alignment* ☐
1=Straight
2=Curved
9=Unknown

## Vehicle Information

Unit Number ☐☐

*Trailing Unit(s)* Number of Trailing Units: ☐

*Type of Unit*
1=Towing Passenger Veh
2=Towing Truck
3=Towing Utility Trailer
4=Mobile or Modular Home
5=Camper
6=Trailer
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☐ Tag No ☐ Tag Year ☐ Tag State ☐
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01=Blue
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03=White
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05=Black
06=Yellow
07=Silver
08=Gold
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10=Orange
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12=Other
99=Unknown

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19=Unknown Type Special Veh
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12=Commercial Passenger Carrier
13=Taxi
21=Tractor Trailer
22=Twin Trailer
23=Triple Trailer
31=Modified Veh
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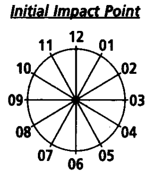
*Initial Impact Point* ☐☐

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07=Oncoming Traffic Lane
08=Left of Trafficway
09=Right of Trafficway
10=HOV Lane
11=Shoulder Right
12=Shoulder Left
13=One Lane Road
98=Other
99=Unknown

*Direction of Travel* ☐
N=North
S=South
E=East
W=West
U=Unknown

*Movement* ☐☐
01=Going Straight
02=Slowing/Stopping in Lane
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04=Passing/Overtaking Veh
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99=Unknown

*Gradient* ☐
1=Level Roadway
2=Uphill
3=Downhill
4=Sag/Bottom of Hill
5=Crest/Top of Hill
9=Unknown

*Alignment* ☐
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9=Unknown

FORM # AA-45 (01/01)

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**POLICE CRASH REPORTING FORM**

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New

Change/ Continuation

Crash Number
P0042343

## Vehicle Driver/Pedestrian Information

Unit Number | Last Name | FI | MI | Telephone Number

Address | City | State | Zip

License Number | State

*If License Number is unknown or driver is not licensed, see manual*

***Alcohol/Drugs Suspected***
- No
- Illegal Drugs
- Medication
- Alcohol
- Alcohol and Drugs
- Unknown

***Alcohol Test Type***
- Test Not Given
- Breath
- Other
- Blood
- Urine
- Unknown if Test Given

***Alcohol Test Results***
0.
- Test Refused
- Unknown Results
- Test Given, Contaminated Results

**Pedestrian Only Information**

***Pedestrian Signal at Scene of Crash***
- No Pedestrian Signal
- Not at Intersection
- Pedestrian Signal

***Pedestrian Location***
- Marked Crosswalks at Intersection
- At Intersection - No Crosswalks
- Non-Intersection Crosswalks
- Driveway Access
- In Roadway
- Not in Roadway
- Median
- Island
- Shoulder
- Sidewalk
- < 10 Feet Off Road
- > 10 Feet Off Road
- Outside Trafficway
- Shared Paths/ Trails
- Unknown

***Driver or Pedestrian Physical Condition***
- Apparently Normal
- Illegal Drug Use
- Fatigue
- Medication
- Had Been Drinking
- Sick
- Asleep
- Unknown

***Vehicle Code*** List any Vehicle Code Section this driver has violated and mark if they were charged. | Charged with Violation?
- Yes / No
- Yes / No

***Owner/Driver Code***

00=Not Applicable
01=Private Vehicle Owned/ Leased by Driver
02=Private Vehicle Not Owned/Leased by Driver
03=Rented Vehicle
04=State Police Vehicle
05=PennDOT Vehicle
06=Other State Gov Vehicle
07=Municipal Police Vehicle
08=Other Municipal Government Vehicle
09=Federal Gov Vehicle
98=Other
99=Unknown

***Driver Presence***

1=Driver Operated Vehicle
2=No Driver
3=Driver Fled Scene
4=Hit and Run
9=Unknown

## Vehicle Driver/Pedestrian Information

Unit Number | Last Name | FI | MI | Telephone Number

Address | City | State | Zip

License Number | State

*If License Number is unknown or driver is not licensed, see manual*

***Alcohol/Drugs Suspected***
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- Other
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- Unknown Results
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- Not at Intersection
- Pedestrian Signal

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- Marked Crosswalks at Intersection
- At Intersection - No Crosswalks
- Non-Intersection Crosswalks
- Driveway Access
- In Roadway
- Not in Roadway
- Median
- Island
- Shoulder
- Sidewalk
- < 10 Feet Off Road
- > 10 Feet Off Road
- Outside Trafficway
- Shared Paths/ Trails
- Unknown

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- Apparently Normal
- Illegal Drug Use
- Fatigue
- Medication
- Had Been Drinking
- Sick
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08=Other Municipal Government Vehicle
09=Federal Gov Vehicle
98=Other
99=Unknown

***Driver Presence***

1=Driver Operated Vehicle
2=No Driver
3=Driver Fled Scene
4=Hit and Run
9=Unknown

FORM # AA-45 (01/01)

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**POLICE CRASH REPORTING FORM**

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◯ New

◯ Change/ Continuation

Crash Number

P0042343

**People Information**

**A** *Person Type:*
1=Driver
2=Passenger
7=Pedestrian
8=Other
9=Unknown

**B** *Sex:*
F =Female
M=Male
U =Unknown

**C** *Injury Severity:*
0=Not Injured
1=Killed
2=Major Injury
3=Moderate Injury
4=Minor Injury
9=Unknown

**D** *Seat Position:*
00=Not A Passenger/Occupant
01=Driver - All Vehicles
02=Front Seat Middle Position
03=Front Seat Right Side
04=Second Row - Left Side Or Motorcycle Passenger
05=Second Row - Middle Position
06=Second Row - Right Side
07=Third Row Or Greater - Left Side
08=Third Row Or Greater - Middle Position
09=Third Row Or Greater - Right Side
10=Sleeper Section Of Truckcab
11=In Other Enclosed Passenger Or Cargo Area
12=In Open Area (Back Of Pickup, Etc.)
13=Trailing Unit
14=Riding On Vehicle Exterior
15=Bus Passenger
98=Other
99=Unknown

**E** *Safety Equipment One:*
00=None Used / Not Applicable
01=Shoulder Belt Used
02=Lap Belt Used
03=Lap And Shoulder Belt Used
04=Child Safety Seat Used
05=Motorcycle Helmet Used
06=Bicycle Helmet Used
10=Safety Belt Used Improperly
11=Child Safety Seat Used Improperly
12=Helmet Used Improperly
90=Restraint Used, Type Unknown
99=Unknown

**F** *Safety Equipment Two:*
00=None Used / Not Applicable
01=Front Air Bag Deployed (For This Seat)
02=Side Air Bag Deployed (For This Seat)
03=Other Type Air Bag Deployed
04=Multiple Air Bags Deployed
05=Motorcycle Eye Protection
06=Bicyclist Wearing Elbow/Knee/ Other Pads
10=Air Bag Not Deployed, Switch On
11=Air Bag Not Deployed, Switch Off
12=Air Bag Not Deployed, Unk Switch Setting
13=Air Bag Removed (Prior To Crash)
19=Unknown If Air Bag Deployed
99=Unknown

**G** *Ejection:*
0=Not Applicable
1=Not Ejected
2=Totally Ejected
3=Partially Ejected
9=Unknown

**H** *Ejection Path:*
0=Not Ejected / Not Applicable
1=Through Side Door Opening
2=Through Side Window
3=Through Windshield
4=Through Back Door
5=Through Back Door Tailgate Opening
6=Through Roof Opening (Sunroof/ Convertible Top Down)
7=Through Roof Opening (Convertible Top Up)
9=Unknown

**I** *Extrication:*
0=Not Applicable
1=Not Extricated
2=Extricated By Mechanical Means
3=Freed By Non - Mechanical Means
8=Other
9=Unknown

| Unit No | Person No | Delete? | Date of Birth (MM-DD-YYYY) | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ◯ | - - | | | | | | | | | |

Name / Address / Phone

EMS Transport ◯ Yes ◯ No

| Unit No | Person No | Delete? | Date of Birth (MM-DD-YYYY) | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ◯ | - - | | | | | | | | | |

Name / Address / Phone

EMS Transport ◯ Yes ◯ No

| Unit No | Person No | Delete? | Date of Birth (MM-DD-YYYY) | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ◯ | - - | | | | | | | | | |

Name / Address / Phone

EMS Transport ◯ Yes ◯ No

| Unit No | Person No | Delete? | Date of Birth (MM-DD-YYYY) | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ◯ | - - | | | | | | | | | |

Name / Address / Phone

EMS Transport ◯ Yes ◯ No

| Unit No | Person No | Delete? | Date of Birth (MM-DD-YYYY) | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ◯ | - - | | | | | | | | | |

Name / Address / Phone

EMS Transport ◯ Yes ◯ No

| Unit No | Person No | Delete? | Date of Birth (MM-DD-YYYY) | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ◯ | - - | | | | | | | | | |

Name / Address / Phone

EMS Transport ◯ Yes ◯ No

FORM # AA-45 (01/01)

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**POLICE CRASH REPORTING FORM**

AA 45 5 1

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○ New ○ Change

Crash Number: P0042343

## Type Location

*Intersection Type*
○ Midblock ○ 4 Way Intersection ○ "T" Intersection ○ "Y" Intersection ○ Traffic Circle/ Round About ○ Multi-Leg Intersection ○ On Ramp ○ Off Ramp ○ Crossover ○ Railroad Crossing ○ Other

*Special Location*
○ Not Applicable ○ Underpass ○ Ramp ○ Bridge ○ Tunnel ○ Toll Booth ○ Cross Over Related ○ Driveway/Parking Lot ○ Ramp & Bridge ○ Unknown

*(If "Ramp" is indicated, please see manual)*

## Principal Road

Complete the ***Principal Road*** Section for all type of crashes. For crashes at intersections, enter information in the Intersecting Road Section or the GPS Section. If you have a midblock crash, you should enter information in the "Distance from Landmark" Section, the GPS Section, or the House Number Section in the Principal Road area.

County | Route Number | Segment (Optional) | Travel Lanes | Speed Limit | House Number (if applicable)

Street Name | Street Ending

Orientation: ○ North ○ South ○ East ○ West ○ Unknown

*Route Signing*
○ Interstate (Not Turnpike) ○ Turnpike (East/West) ○ Turnpike Spur ○ State Highway ○ County Road ○ Local Road or Street ○ Private Road ○ Other/ Unknown

## Intersecting Road

*Use For Intersection Crashes*

County | Route Number | Segment (Optional) | Travel Lanes | Speed Limit

Street Name | Street Ending

Orientation: ○ North ○ South ○ East ○ West ○ Unknown

*Route Signing*
○ Interstate (Not Turnpike) ○ Turnpike (East/West) ○ Turnpike Spur ○ State Highway ○ County Road ○ Local Road or Street ○ Private Road ○ Other/ Unknown

## Distance From Landmark

*Use For Mid-Block Crashes*

Please Enter Information for ***BOTH*** Landmarks if Using This Option

Landmark 1: Intersecting Rt Num | Or Mile Post | Or Segment Marker
Or Intersecting Street Name | St Ending
Ramp Use Only: ○ North ○ South ○ East ○ West

Landmark 2: Intersecting Rt Num | Or Mile Post | Or Segment Marker
Or Intersecting Street Name | St Ending
Ramp Use Only: ○ North ○ South ○ East ○ West

Feet
Or Miles

Distance From Crash Scene to Landmark 1 *(For Crash between Landmark 1 and Landmark 2)*

## GPS

Latitude: Degrees | Minutes | Seconds
Longitude: Degrees | Minutes | Seconds

## TCD

*Traffic Control Device*
○ Not Applicable ○ Flashing Traffic Signal ○ Traffic Signal ○ Stop Sign ○ Yield Sign ○ Active RR Crossing Controls ○ Passive RR Crossing Controls ○ Police Officer or Flagman ○ Other Type TCD ○ Unknown

*TCD Functioning*
○ No Controls ○ Device Not Functioning ○ Device Functioning Improperly ○ Device Functioning Properly ○ Emergency Preemptive Signal ○ Unknown

## Work Zone

*Type of Work Zone (If "Not a Work Zone", skip rest of Work Zone section)*
○ Not a Work Zone ○ Construction ○ Maintenance ○ Utility Company ○ Other

*Work Zone Location*
○ Before 1st Work Zone Warning Sign ○ Advance Warning Area ○ Transition Area ○ Activity Area ○ Termination Area ○ Other

*Work Zone (Mark all that apply)*
☐ Lane Closure ☐ Road Closed with Detour ☐ Work on Shoulder or Median ☐ Intermittent or Moving Work ☐ Flagger Control ☐ Other

*Work Zone Speed Limit*

*Workers Present* ○ Yes ○ No ○ Unknown

## Lane Closure

*Because of Crash*

*Lane Closed (If "Not Applicable", skip rest of the Lane Closure section)*
○ Not Applicable ○ Partially ○ Fully ○ Unknown

*Lane Closure Direction*
○ North ○ South ○ East ○ West ○ North and South ○ East and West

*Traffic Detoured* ○ Yes ○ No

*Estimated Time Closed*
○ < 30 Minutes ○ 30-60 Minutes ○ 1-3 hours ○ 3-6 hours ○ 6-9 hours ○ 9-12 hours ○ > 12 hours ○ Unknown

FORM # AA-45 (01/01)

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**POLICE CRASH REPORTING FORM**

Crash Number

New P0042343

AA 45 6 1

Page:

Change/ Continuation

## General Crash Information
(If more than 2 Units only complete once)

*Crash Description*: 0=Non-Collision, 1=Rear End, 2=Head On, 3=Rear to Rear (Backing), 4=Angle, 5=Sideswipe (Same Direction), 6=Sideswipe (Opposite Direction), 7=Hit Fixed Object, 8=Hit Pedestrian, 9=Other/Unknown

*Relation to Roadway*: 1=On Travel Lanes, 2=Shoulder, 3=Median, 4=Roadside, 5=Outside Trafficway, 6=In Parking Lane, 7=Gore (Ramp Intersection), 9=Unknown

*Illumination*: 1=Daylight, 2=Dark - No Street Lights, 3=Dark - Street Lights, 4=Dusk, 5=Dawn, 6=Dark - Unknown Roadway Lighting, 8=Other

*Weather Conditions*: 1=No Adverse Conditions, 2=Rain, 3=Sleet (Hail), 4=Snow, 5=Fog, 6=Rain & Fog, 7=Sleet & Fog, 8=Other, 9=Unknown

*Road Surface Conditions*: 0=Dry, 1=Wet, 2=Sand, Mud, Dirt, Oil, 3=Snow Covered, 4=Slush, 5=Ice, 6=Ice Patches, 7=Water - Standing or Moving, 8=Other

## Unit(s) Event Information

Unit No | Harm Event | L/R | Most? | Utility Pole Number (1, 2, 3, 4)

*Please Put Events in Sequential Order*

Unit No | Harm Event | L/R | Most? | Utility Pole Number (1, 2, 3, 4)

*Please Put Events in Sequential Order*

***First Harmful Event in the Crash*** Unit No | Harm Event

***Most Harmful Event in the Crash*** Unit No | Harm Event

Do not repeat this information on multiple pages

*Harmful Events (Harm Event)*
01=Hit Unit 1
02=Hit Unit 2
03=Hit Unit 3
04=Hit Unit 4
05=Hit Unit 5
06=Hit Other Traffic Unit
07=Hit Deer
08=Hit Other Animal
09=Collision With Other Non Fixed Object
11=Struck By Unit 1
12=Struck By Unit 2
13=Struck By Unit 3
14=Struck By Unit 4
15=Struck By Unit 5
16=Struck By Other Traffic Unit
21=Hit Tree Or Shrubbery
22=Hit Embankment
23=Hit Utility Pole
24=Hit Traffic Sign
25=Hit Guard Rail
26=Hit Guard Rail End
27=Hit Curb
28=Hit Concrete Or Longitudinal Barrier
29=Hit Ditch
30=Hit Fence Or Wall
31=Hit Building
32=Hit Culvert
33=Hit Bridge Pier Or Abutment
34=Hit Parapet End
35=Hit Bridge Rail
36=Hit Boulder Or Obstacle On Roadway
37=Hit Impact Attenuator
38=Hit Fire Hydrant
39=Hit Roadway Equipment
40=Hit Mail Box
41=Hit Traffic Island
42=Hit Snow Bank
43=Hit Temporary Construction Barrier
48=Hit Other Fixed Object
49=Hit Unknown Fixed Object
50=Overturn/Roll Over
51=Struck By Thrown Or Falling Object
52=Pot Holes Or Other Pavement Irregularities
53=Jacknife
54=Fire In Vehicle
58=Other Non-Collision
99=Unknown Harmful Event

*Left/Right (L/R)* L=Left R=Right O=Other U=Unknown

## Contributing Information

*Environmental / Roadway Potential Factors (E/R)* 1 | 2 | 3
00=None
01=Windy Conditions
02=Sudden Weather Conditions
03=Other Weather Conditions
04=Deer in Roadway
05=Obstacle On Roadway
06=Other Animal In Roadway
07=Glare
08=Work Zone Related
11=Slippery Road Conditions (Ice/Snow)
12=Substance On Roadway
13=Potholes
14=Broken Or Cracked Pavement
15=TCD Obstructed
16=Soft Shoulder Or Shoulder Drop Off
28=Other Roadway Factor
99=Unknown

*Possible Vehicle Failures (V)*
00=None
01=Tires
02=Brake System
03=Steering System
04=Suspension
05=Power Train
06=Exhaust
07=Headlights
08=Signal Lights
09=Other Lights
10=Horn
11=Mirrors
12=Wipers
13=Driver Seating/Control
14=Body, Doors, Hood, Etc
15=Trailer Hitch
16=Wheels
17=Airbags
18=Trailer Overloaded
19=Unsecure/Shifted Trailer Load
20=Improper Towing
21=Obstructed Windshield
99=Unknown

Unit No | 1 | 2

Unit No | 1 | 2

*Driver Action (D)*
00=No Contributing Action
01=Driver Was Distracted
02=Driving Using Hand Held Phone
03=Driving Using Hands Free Phone
04=Making Illegal U-Turn
05=Improper/Careless Turning
06=Turning From Wrong Lane
07=Proceeding W/O Clearance After Stop
08=Running Stop Sign
09=Running Red Light
10=Failure To Respond To Other Traffic Control Device
11=Tailgating
12=Sudden Slowing/Stopping
13=Illegally Stopped On Road
14=Careless Passing Or Lane Change
15=Passing In No Passing Zone
16=Driving The Wrong Way On 1-Way Street
17=Careless Or Illegal Backing On Roadway
18=Driving On The Wrong Side of Road
19=Making Improper Entrance to Highway
20=Making Improper Exit From Highway
21=Careless Parking/Unparking
22=Over/Under Compensation At Curve
23=Speeding
24=Driving Too Fast For Conditions
25=Failure To Maintain Proper Speed
26=Driver Fleeing Police (Police Chase)
27=Driver Inexperienced
28=Failure To Use Specialized Equip
98=Other Improper Driving Actions

Unit No | 1 | 2 | 3 | 4

Unit No | 1 | 2 | 3 | 4

***Indicated Prime Factor***
Do not repeat this information on multiple pages

Unit No | Factor Code

E/R V D P

*If E/R is the Prime Factor Type, leave Unit No blank*

*Pedestrian Action (P)*
00=None
01=Entering Or Crossing At Specified Location
02=Walking, Running, Jogging, Playing, Or Cycling
03=Working
04=Pushing Vehicle
05=Approaching Or Leaving Vehicle
06=Playing Or Working On Vehicle
07=Standing
98=Other

Unit No | Unit No

FORM # AA-45 (01/01)

**PENNDOT COPY**

**COMMONWEALTH OF PENNSYLVANIA**
**POLICE CRASH REPORTING FORM**

AA 45 7 1

Page: [ ][ ][ ]

⬭ New
⬭ Change/ Continuation
⬭ Delete Page

Crash Number

P0042343

[ ][ ][ ][ ][ ][ ][ ][ ]

Diagram

FORM # AA-45 (01/01)

**PENNDOT COPY**

**COMMONWEALTH OF PENNSYLVANIA**
**POLICE CRASH REPORTING FORM**

AA 45 8 1

Page:

Crash Number

P0042343

- New
- Change/ Continuation
- Delete Page

**Place emergency transport, witness, and other information here. It is not required to restate information from the form.**

**Witness Information and Narrative**

**Responding EMS Agency:** **Medical Facility:**

**Witness 1:** **Address:** **Phone:**

**Witness 2:** **Address:** **Phone:**

**Narrative:**

FORM # AA-45 (01/01)

**PENNDOT COPY**

Appendix C

- ✍Police incident number
- ✍Accident reporting number
- ✍Police agency completing accident report form
- ✍Date of accident
- ✍Time of accident
- ✍Day of the week
- ✍Age of distracted driver
- ✍Sex of distracted driver
- ✍Number of vehicles involved in the accident
- ✍Number of injuries (if any)
- ✍Number of fatalities (if any)
- ✍Was the distraction a prime factor in the accident
- ✍If the distraction was not the primary factor, what the primary factor was
- ✍Crash description
- ✍Illumination
- ✍Weather
- ✍Road surface
- ✍Driver condition
- ✍Intersection type

- Travel speed of distracted vehicle
- Speed limit
- Gradient
- Number of occupants in distracted vehicle
- Distraction category
- Specific distraction

Appendix E

- Outside object, person or event
- Adjusting radio/cassette/cd
- Other occupant
- Moving object in vehicle
- Using other device/object brought into vehicle
- Adjusting vehicle/climate controls
- Eating and/or drinking
- Using/dialing cell phone
- Smoking related
- Other distraction
- Unknown distraction

PRIOR PRINTER'S NOS. 1620, 1865 PRINTER'S NO. **1935**

**THE GENERAL ASSEMBLY OF PENNSYLVANIA**

# SENATE RESOLUTION

## No. 127 Session of 2000

INTRODUCED BY CONTI, THOMPSON, WAGNER, HELFRICK, HOLL, SALVATORE, COSTA, DENT, BELL, GERLACH, MOWERY, TOMLINSON, WENGER, BRIGHTBILL, LEMMOND, BOSCOLA AND MELLOW, JANUARY 26, 2000

AS AMENDED, MAY 8, 2000

A CONCURRENT RESOLUTION

Directing the Joint State Government Commission to study and make recommendations concerning the issue of highway safety and driver distractions, including communications technology, electronic entertainment and other nontechnological distractions.

WHEREAS, There are many opportunities for driver distractions while operating a motor vehicle, including, but not limited to, communications technology, electronic entertainment, COMPUTER <— USE, fatigue, reading, food and beverage consumption and passengers, including children and pets; and

WHEREAS, Persons who use Pennsylvania highways pay, through registration fees or the liquid fuels tax, for highway maintenance and construction; and

WHEREAS, The General Assembly has a responsibility to the taxpayers to ensure that the public roads and highways are as safe as possible by enacting enforceable traffic safety laws; therefore be it

RESOLVED (the House of Representatives concurring), That the

Senate direct the Joint State Government Commission:

(1) To study and develop recommendations concerning the issue of highway safety and driver distractions, including communications technology and electronic entertainment such as wireless telephones, pagers, facsimile machines, COMPUTERS, locator devices, AM/FM radios, compact disc <— players, audio cassette players, citizens band radios and dispatch radios, and all other forms of nontechnological distractions.

(2) To review and analyze studies and statistics relating to all types of driver distractions which affect highway and traffic safety.

(3) To inquire into innovative communications technologies being used or proposed to be used in motor vehicles that may help alleviate risks to highway and traffic safety.

(4) To develop recommendations for public and private strategies and recommendations for legislative or regulatory action if deemed appropriate to address these issues;

and be it further

RESOLVED, That the Department of Transportation and the Pennsylvania State Police assist the Joint State Government Commission in supplying and gathering statistics relating to all types of driver distractions which affect highway and traffic safety in this Commonwealth; and be it further

RESOLVED, That the Joint State Government Commission make an interim report on its findings and recommendations to the General Assembly ~~on December 1, 2000~~ BY JANUARY 2, 2001, and a <— final report ~~on~~ BY December 1, 2001. <—

## Appendix G

DROWSY DRIVER CRASHES[1]
PENNSYLVANIA V. THE UNITED STATES

| | 1995 | 1996[a] | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|
| United States | | | | | | |
| Total crash involved passenger vehicles[2] | 3,400,000 | 3,500,000 | 3,700,000 | 3,300,000 | 3,200,000 | -- |
| Drowsy driver vehicles | 68,000 | 87,500 | 33,300 | 39,600 | 73,600 | -- |
| Fatal drowsy crashes | 1,084 | 1,128 | 986 | 1,080 | 1,079 | 1,077 |
| Pennsylvania | | | | | | |
| Total crashes | 136,804 | 142,867 | 143,981 | 140,972 | 144,171 | 147,253 |
| Drowsy driver crashes[3] | -- | 2,941 | 2,549 | 2,409 | 2,582 | 2,363 |
| Fatal drowsy crashes | 38 | 37 | 36 | 18 | 17 | 23 |

1. National Highway Safety Administration estimates that falling asleep while driving is responsible for 100,000 crashes, 40,000 injuries, and 1,550 fatalities every year.

2. Includes automobiles, pickup trucks, light vans, sport utility vehicles, and a few non-passenger vehicles whose air bags may have deployed in the crash. These vehicles must be towed from the crash scene to be included.

3. Drowsy driver is a primary contributing factor only.

a. Pennsylvania crash facts and statistics had considerable layout changes in 1996.

SOURCE: U.S. total and drowsy crash involved vehicle data--AAA Found. for Traffic Safety, The Role of Driver Distraction in Traffic Crashes, 2001. Pennsylvania total and drowsy crash data--Bureau of Highway Safety & Traffic Eng'g, Pa. Dep't of Transp., Pennsylvania Crash Facts & Statistics, 1995-2000. U.S. and Pennsylvania fatal drowsy crash data--Nat'l Highway Traffic Safety Admin., U.S. Dep't of Transp., Fatality Analysis Reporting System (FARS), 2001.