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Report to the Chairman, Committee on Commerce, Science, and Transportation, U.S. Senate

October 2008

HIGHWAY SAFETY

Foresight Issues Challenge DOT's Efforts to Assess and Respond to New Technology-Based Trends

GAO-09-56

Highlights

Highlights of GAO-09-56, a report to the Chairman, Committee on Commerce, Science, and Transportation, U.S. Senate

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HIGHWAY SAFETY

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Why GAO Did This Study

Fatalities on U.S. roads now total over 40,000 each year. Future reductions may require the Department of Transportation (DOT) to address new trends such as evolving crash-avoidance technologies and rapidly changing electronic devices that may distract drivers who use them on the road. (See figure.) GAO was asked to examine how DOT is addressing fast-moving trends such as these. This report examines how DOT is (1) deciding on responses to the crash avoidance and electronic distractions trends—given available evidence and uncertainties; (2) developing new evidence on these trends' safety impacts; and (3) communicating with the Congress about these and other trends and related issues. To conduct this study, GAO analyzed DOT reports, peer-reviewed literature, and other documents; interviewed DOT officials and staff; and interviewed over 30 experts.

What GAO Recommends

GAO recommends that DOT (1) develop an approach to guide decision-making on new, fast-moving trends that can affect highway safety; (2) evaluate whether new data systems and analytic techniques are needed to provide information on such trends; and (3) employ specific strategies and schedules in communicating with the Congress about these and other trends. DOT disagreed with the first of these and did not comment on the other two. GAO continues to recommend all three.

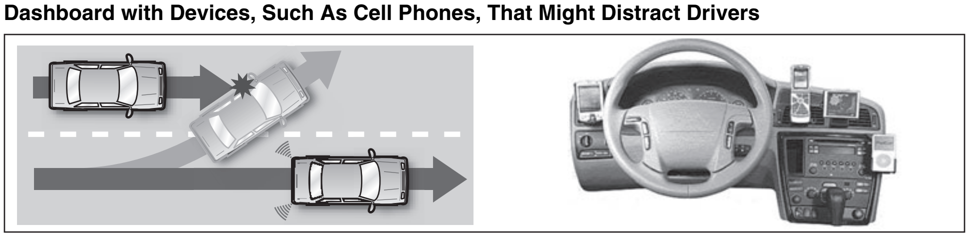
To view the full product, click on GAO-09-56. For more information, contact Nancy R. Kingsbury at 202-512-2700, kingsburyn@gao.gov, or Katherine A. Siggerud at 202-512-2834, siggerudk@gao.gov.

What GAO Found

New fast-moving technology-based trends are characterized by uncertainties, and the main criteria that DOT's National Highway Safety Administration (NHTSA) officials use in deciding how to respond—quantitative evidence that a sizable problem exists and knowledge of a promising countermeasure—do not address uncertainty. One technology-based trend presents potential opportunities to improve future safety: evolving crash avoidance technologies. With somewhat limited data on actual safety benefits, NHTSA is pursuing such opportunities by, for example, providing consumer information about new car technologies designed to help avoid some crashes. A different trend represents a new threat to safety: rapidly changing and proliferating electronic driver distractions. Although NHTSA is conducting studies to understand this trend's nature and scope, it is not self-initiating actions or research designed specifically to counter new distractions, citing a lack of evidence that these are as significant a problem as, for example, failure to use seatbelts. Literature and experts suggest alternative approaches to decision-making, such as anticipatory risk management and expansion of networks, which might help with decisions about investments to shape or counter fast-moving trends.

DOT also faces challenges in developing additional, higher quality or more timely evidence on the changing sizes of the safety impacts of such trends—despite attempting to obtain appropriate data through both long-standing and new methods. For example, analyses of existing crash datasets produce valid comparisons of crashes in cars with and without new technologies, but such analyses require years of accumulated results and thus cannot keep pace with a fast-moving trend. Developing more timely, high-quality evidence would (1) improve evaluations of new safety technologies' benefits and (2) identify the level of threat presented by evolving driver distractions—thus reducing uncertainty and supporting decisions. Innovative approaches, such as data collection that uses emerging technologies for wireless transfer of crash data or new analysis techniques, might help provide more timely, high-quality evidence on the impacts of trends and how these change over time.

Example of Type of Crash That New Safety Technology Is Designed to Help Drivers Avoid and Dashboard with Devices, Such As Cell Phones, That Might Distract Drivers



Sources: GAO and ProClip (portable device holders).

DOT currently communicates some relevant information to the Congress on emerging trends but these communications are not designed to provide a long-term view of highway safety, including trends such as evolving crash avoidance technologies and rapidly changing electronic driver distractions—and their implications for the years ahead—together with timely updates. DOT has not synthesized the results of its work for the Congress to look at how overall trends will impact highway safety in 2020 and beyond. Some of DOT's own practices and other models from the United States and abroad might provide improved strategies for communication.

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Abbreviations

ACAT	Advanced Crash Avoidance Technologies
CEA	Consumer Electronics Association
CICAS	Cooperative Intersection Collision Avoidance System
DOT	Department of Transportation
ESC	electronic stability control
Euro NCAP	European New Car Assessment Programme
EVSCA	Effectiveness of Vehicle Safety Communications Applications
FARS	Fatality Analysis Reporting System
FCW	forward collision warning
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FOT	field operational test
GDL	graduated drivers licensing
GHSA	Governors Highway Safety Association
GPRA	Government Performance and Results Act of 1993
GPS	global positioning system
LDW	lane departure warning
MMIRE	Model Minimum Inventory of Road Elements
NASS CDS	National Accident Sampling System's Crashworthiness Data System
NCAP	New Car Assessment Program
NCSA	National Center for Statistics and Analysis
NHTSA	National Highway Traffic Safety Administration
NOPUS	National Occupant Protection Use Survey
NTSB	National Transportation Safety Board
RITA	Research and Innovative Technology Administration
SHRP 2	Second Strategic Highway Research Program
TIA	Telecommunications Industry Association
TRB	Transportation Research Board
V2V	vehicle-to-vehicle communications
VII	Vehicle Infrastructure Integration
VMT	vehicle miles traveled

United States Government Accountability Office
Washington, DC 20548

October 3, 2008

The Honorable Daniel Inouye
Chairman
Committee on Commerce,
Science, and Transportation
United States Senate

Dear Mr. Chairman:

Reducing future highway fatality rates (defined as the number of road fatalities per vehicle mile traveled) is an important national objective. Traffic deaths on U.S. roads total over 40,000 each year, and although past technology developments and government actions substantially reduced fatality rates, earlier progress has now slowed. Projections from the Department of Transportation (DOT) suggest that as many as 500,000 deaths could occur on U.S. roads between now and 2020, unless vehicle miles traveled (VMT) substantially decrease or progress in reducing fatality rates improves.

A variety of ongoing or anticipated trends—ranging from the aging of the U.S. population and the increasing use of motorcycles to fast-paced technology-based trends—have the potential to transform the highway safety landscape, for better or for worse. Future progress in reducing fatality rates may depend on DOT's ability to exercise foresight by addressing potentially significant but somewhat uncertain trends.[1] The most challenging of these may be technology-based trends that proceed at a high clockspeed, that is, (1) a faster pace than trends DOT has dealt with previously, especially with respect to new products that can affect safety, or (2) a quantitative rate of change that is either exponential or exhibits a

[1]Exercising foresight consists of basing policies on an understanding of forces shaping the future (see Coates 1985, 33; full citations are provided in the reference list at the end of this document). In this context, a potentially significant trend is one that, although somewhat uncertain, may substantially affect progress toward basic goals across a time horizon more than 5 years forward. (As a point of comparison, the Government Performance and Results Act of 1993 (GPRA) requires that agencies' strategic plans cover a period not less than 5 fiscal years forward.)

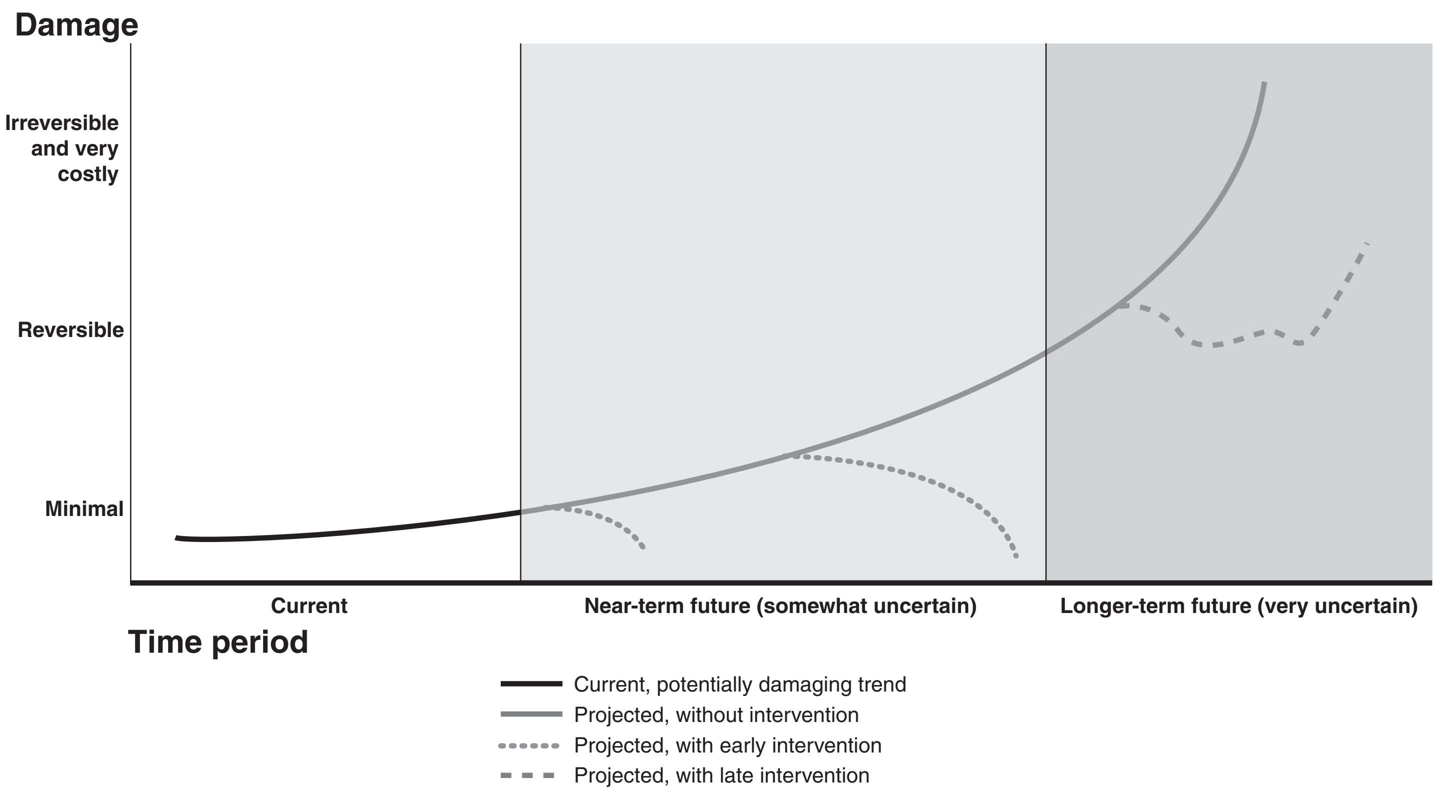
pattern of doubling or tripling within 3 or 4 years, possibly on a repeated basis.[2]

Our *21st Century Challenges* report raises the issue of whether federal agencies are poised to address fast-paced technology-based changes (GAO 2005a). This and other analyses suggest that unless agencies and the Congress can stay abreast of technological changes, they may find themselves "in a constant catch-up position and lose the capacity to shape outcomes" (Rejeski and Wobig 2002, 15).[3] And foresight literature illustrates the potential future consequences of falling behind a damaging trend that could be countered by early action. As indicated by figure 1, early intervention in this situation can be effective, and delaying intervention can result in negative outcomes.

[2]We developed this definition from the concept of "clockspeed" as a characteristic of product-development, introduced by Fine (1998).

[3]Michael Stanton (Stanton 2007), Chief Executive Officer, Association of International Automobile Manufacturers (AIAM), expressed a similar view with respect to automotive developments.

Figure 1: Potential Consequences of Falling behind a Damaging Trend That Could Be Effectively Countered by Early Action: Illustration from Foresight Literature



Source: Adapted from Rejeski (2003).

Currently, high-clockspeed technology-based trends alternatively present an opportunity to reduce highway fatality rates and a threat that, if not countered, may result in increased fatalities:[4]

- *Evolving crash avoidance technologies.* Key developments include technologies that are (1) increasingly available in luxury vehicles or (2) being developed for a future vehicle-road communication system. They

[4]Risk management and strategic planning literature emphasizes the need for organizations to recognize and address both (1) opportunities—that is, potential solutions (or partial solutions) to one or more problems and (2) threats, each of which represents a potential problem. Within the context of this report, a trend presents an opportunity for improving future safety if it promises to reduce future fatalities (or to further reduce them) if DOT successfully promotes, encourages, or helps develop that trend.

are designed to help drivers by, for example, alerting them to hazards, potentially decreasing fatality rates.

- *Rapidly changing and proliferating electronic driver distractions.* This includes portable devices such as cell phones with text messaging capabilities that may distract drivers who use them on the road, risking safety and possibly increasing fatality rates.[5]

There is no governmentwide guidance on how federal agencies should conduct foresight across a time horizon more than 5 years forward.[6] However, when an agency concerned with improving safety faces a set of potentially significant high-clockspeed technology-based trends, it may exercise foresight by successfully carrying out activities such as

- considering what is known about the safety impact of each high-clockspeed trend and deciding how to respond to it (for example, by researching how to shape or counter the trend or taking action),[7]
- reducing uncertainty as needed by developing additional evidence about the safety impact of such a trend, and
- communicating with the Congress and others about high-clockspeed and other trends, agency responses, and policy implications.

We defined these three activities on the basis of literature and interviews with experts and discuss them further in appendix I. We recognize that these activities can be challenging because of uncertainty about the level of safety impact that a new, high-clockspeed trend may have (that is, its significance) or the kinds of response options that may be effective; limitations of data systems and analysis techniques that may be inappropriate for new trends because they were designed at an earlier time; and the lack of governmentwide guidance on how agencies should conduct foresight or communicate with the Congress about new trends and responses. As figure 2 shows, the three activities may interact in various ways. One example is that new evidence about a high-clockspeed

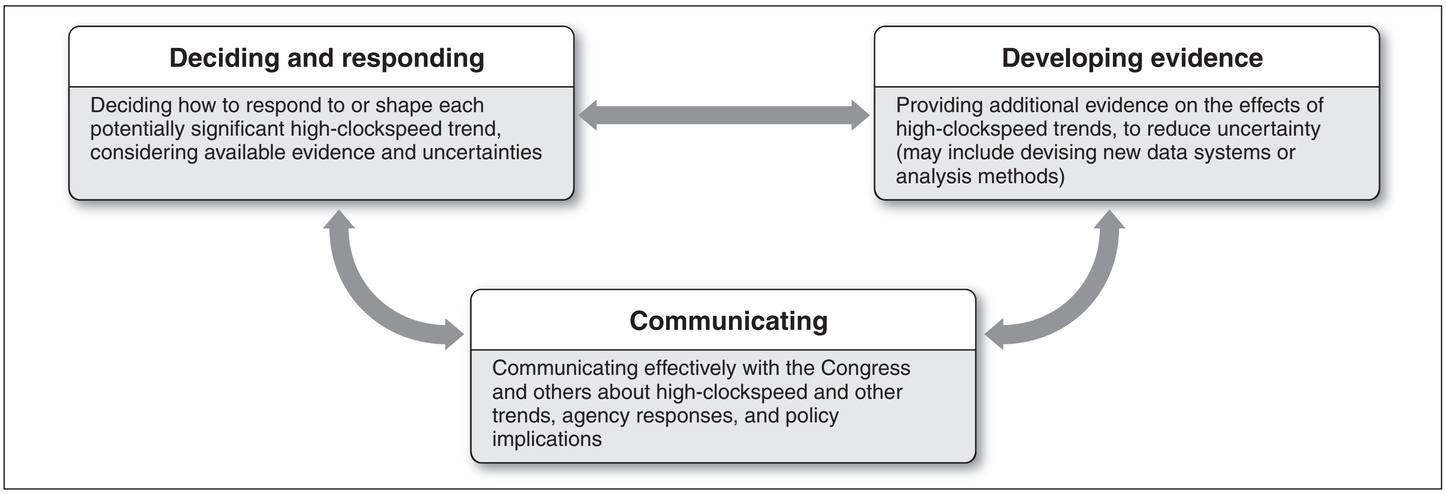
[5]Each technology-based trend in this list combines (1) an evolving series of technology developments and new products with (2) consumer adoption and patterns of use.

[6]In contrast, GPRA requires that agencies' strategic plans cover a period not less than 5 fiscal years forward.

[7]In some cases, it may be appropriate to consider a technology-based trend as a whole (for example, electronic driver distractions); in other cases, it may be more appropriate to focus separately on various types of products or the specific impacts associated with them (for example, differentiating driver voice calls from driver text messaging).

trend (such as its changing trajectory over time) may affect agency decisions about whether or how to respond to that trend.[8] Another is that communicating with the Congress and others may affect an agency's ability to take certain actions in response to a trend.

Figure 2: Exercising Foresight by Addressing High-Clockspeed Trends: Three Challenging Agency Activities



Source: GAO.

Having discussed your interest in trends that affect future fatality rates and, in particular, understanding how DOT is addressing high-clockspeed technology-based trends that may affect these rates, we focused this report on two such trends—currently evolving electronic crash avoidance technologies (including in-vehicle technologies and applications for a future system of road-vehicle communication, as these relate to passenger vehicles) and rapidly changing electronic driver distractions—and related challenges that DOT may face.[9] Specifically, we examine in this report

[8]Trajectory refers to the path of a trend's forward movement and future phases (see Fisher, Mahajan, and Mitcham 2002). A trend's impact can change over time, either increasing or decreasing. Such changes can occur at various rates—for example, increasing at an exponential rate or decreasing at a slow, incremental rate.

[9]For in-vehicle crash avoidance technologies, we focus specifically on those introduced after electronic stability control (ESC). Introduced in the mid-1990s, ESC improves vehicle stability when a driver is in danger of crashing; for example, ESC helps prevent loss of control—which can lead to run-off-the-road rollovers—by applying brakes differentially to each wheel to increase stability. DOT has required ESC in all passenger vehicles manufactured after September 1, 2011. (Our focus on crash avoidance technologies does not address commercial vehicles or roadway systems that do not involve in-vehicle technology.)

three foresight issues corresponding to the challenging activities outlined in figure 2:

1. available evidence on the highway safety impact of two high-clockspeed trends—that is, the crash avoidance and distraction trends defined above—and the decisions that DOT, especially the National Highway Traffic Safety Administration (NHTSA), is making in response;

2. DOT efforts to develop new evidence on the highway safety impacts of these trends;

3. DOT communications with the Congress and others about these and other new trends, DOT responses, and policy implications.

To collect data on each of these issues, we obtained documents from and interviewed officials and staff of relevant DOT administrations, the Office of the Secretary, and the Transportation Research Board (TRB), and we interviewed experts from the private sector, universities, and other organizations—ranging from safety advocates and industry sources to foresight experts and research methodologists (see app. II). We also consulted DOT's and TRB's Web sites, attended conferences, and reviewed varied literature.

To obtain the states' perspectives on available evidence and DOT decisions, we interviewed state officials, and we reviewed documents such as newsletters and reports from relevant associations. To further identify available evidence on evolving crash avoidance technologies and electronic driver distractions, possible new methods and strategies for developing evidence, and ways information on trends and implications for highway safety might be considered and usefully communicated, we reviewed a variety of literature, including peer reviewed journal articles, industry reports, and documents from conference presentations and interviewed experts. We also reviewed a number of publicly available DOT reports dating from 2001 (or in some cases earlier) to the present, selected on the basis of their possible relevance to the future of highway safety. (Appendix III describes our review of studies of driver phoning and highway safety.[10])

[10]We use highway safety to refer to safety on any public road.

Finally, in summarizing evidence on the safety impacts of each high-clockspeed trend examined here and on DOT responses, we used a reporting framework that highlights varied levels of evidence and categories of governance options; this reporting framework is detailed in the background section of this report.

While several DOT administrations have missions related to highway safety, we focused our work on issues 1 and 2 on relevant initiatives, primarily those conducted by NHTSA and the Research and Innovative Technology Administration (RITA). For issue 3, our review included NHTSA, RITA, the Federal Motor Carrier Safety Administration (FMCSA), and the Federal Highway Administration (FHWA), as well as the Office of the Secretary.

We conducted our performance audit from June 2006 through September 2008 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings based on our audit objectives.

Results in Brief

Although high speed technology-based trends are characterized by limited available data and other uncertainties, the main criteria that NHTSA officials use in deciding how to respond to such trends do not address uncertainty. Available evidence confirms that technology-based, high-clockspeed trends are affecting highway safety and suggests the potential for stronger impacts in the future. But in addressing such trends, DOT faces a challenge in making decisions because of the uncertainties associated with them. For example, DOT lacks strong quantitative evidence on the specific levels of (1) safety benefits associated with evolving crash avoidance technologies and (2) safety risks posed by changing driver distractions—which makes prioritization difficult. Given available evidence and uncertainties,

- NHTSA has decided to expand its New Car Assessment Program (NCAP) from evaluating crashworthiness and rollover performance to also evaluating in-vehicle crash avoidance technologies (to the extent possible) and providing related consumer information. Additionally, NHTSA, RITA, and FHWA are working together to explore ways to use crash avoidance technology in a future vehicle-road information system that DOT is planning.

- NHTSA is initiating statistical studies to improve evidence on whether or how electronic driver distractions impact highway safety. However, NHTSA officials have stated that at this time they will not initiate action or research aimed specifically at countering the trend of new driver distractions.

Although there are some uncertainties in both cases, one difference is that while a large number of crashes are documented as falling into categories addressed by crash avoidance technologies (for example, rear end collisions, which are addressed by forward collision warning, or FCW), less evidence is available that a large number of crashes involve electronic driver distractions. NHTSA based its decisions on two main criteria that were met by one trend (crash avoidance) but not the other (electronic driver distractions): existing evidence that the size of the problem is large and knowledge of a promising approach to address it.

However, neither criterion is designed to address the uncertainties associated with high-clockspeed trends that can affect safety. Some approaches that might be emphasized to better facilitate decision making under conditions of uncertainty include, among others, prioritizing research on ways of responding to trends; weighing potential gains from focusing on new versus old problems and solutions; expanding networks; and using anticipatory risk management practices.

DOT also faces challenges in developing additional, higher quality or more timely evidence on the safety impacts of these trends—and over time, the changing sizes of these impacts. DOT recognizes that uncertainty could be reduced by developing better quantitative evidence on the safety impacts of high-clockspeed trends—including data that would (1) allow better evaluations of new safety technologies' benefits and (2) increase information on the level of threat presented by driver distractions. But DOT faces an evidence-development challenge because, for high-clockspeed trends, strong data would need to be not only technically adequate but also timely and able to measure change over time. Recognizing this, DOT has tried both long-standing and newer methods. For example, NHTSA's assessment of electronic stability control analyzed drivers' real-world experiences, including the numbers of crashes for similar vehicles with and without ESC, based on existing crash datasets—but this required years of accumulated data.

To achieve a more timely evaluation of new crash avoidance technologies that are appearing at a relatively fast pace, NHTSA used field operational tests (FOT) in which subjects drove special vehicles with sensors and recording equipment installed to provide specific data on driving experiences. The FOTs tracked each driver for a number of weeks. However, with relatively short test periods, it is not possible to compare actual crashes occurring with and without a new technology, and the resulting data are limited. Additionally, the expense of an FOT is a limiting factor in terms of repeating tests as new or improved technologies become available. Similar difficulties face DOT in tracking new driver distractions and their impact on safety. For example, existing data cannot capture the extent to which distraction is a factor in crashes. For the future, new technology might provide possible directions for collecting additional data more quickly, allowing frequent updates and reducing uncertainty about high-clockspeed trends that impact highway safety.

A final challenge for DOT is to effectively inform stakeholders, including the Congress, about the implications of high-clockspeed technology trends. Potential avenues for such information might include DOT's recent framework for reauthorization and planning and accountability materials. These, however, are not designed or intended to provide a long-term, comprehensive view and analysis of trends that could affect highway safety in the future. As a result, while such materials acknowledge the existence of demographic and other trends, they do not provide a detailed discussion of the interactions and implications of these and other trends for the years ahead.

Other materials specifically focused on highway safety, such as the recent *DOT 1.0 Fatality Rate Goal* report, which focuses on the year 2011 as requested by congressional committees, are also not designed to discuss multiple trends and their interactions in time periods such as 2020 and beyond. And they are not issued on a continuing or periodic basis, since they are produced in response to specific requests. In addition, these materials are not comprehensive in that some trends are omitted; for example, they do not include coverage of electronic driver distractions. While efforts to look toward 2020 and beyond have been conducted by DOT administrations, and in some cases, an ongoing process has been set up to conduct futures-related activities, the results of this work have not been synthesized for use by the Congress. Such work includes an FMCSA assessment of the operational implications of new trends for its mission, given motor carrier industry trends for 2025, and FHWA's review of safety best practices abroad as part of its ongoing technology scanning program. The production of new futures-oriented information and synthesis of existing information within DOT could enhance decision making and deliberations by DOT and congressional policymakers concerned with how to best position transportation policies and programs for the future. A review of best practices and foresight models from the United States and abroad could provide strategies for DOT's use in dealing with this challenge of communicating on new trends.

To help ensure that DOT has the most robust information possible when evaluating policy options in response to new trends in highway fatalities, even under conditions of uncertainty, and communicating the most relevant information to the Congress, we are making recommendations to the Department of Transportation to (1) develop an approach to guide decision making on high-clockspeed trends that affect highway safety, (2) evaluate whether or not new data and analytical systems are needed to better track new trends related to highway safety, and (3) use a systematic and periodic approach to reporting to the Congress on a range of trends related to highway safety, including information on high-clockspeed, technology-based trends.

DOT commented on a draft of this report. DOT disagreed with the first of these recommendations, giving reasons including difficulty in foreseeing specific future developments and the significant level of resources, data, and analysis needed to implement it. We retain this recommendation because, for example, the techniques we discuss emphasize flexibility in decision-making strategies to cover a variety of potential trends, and DOT has recently used such techniques despite the challenges they cite. DOT did not comment on our other two recommendations.

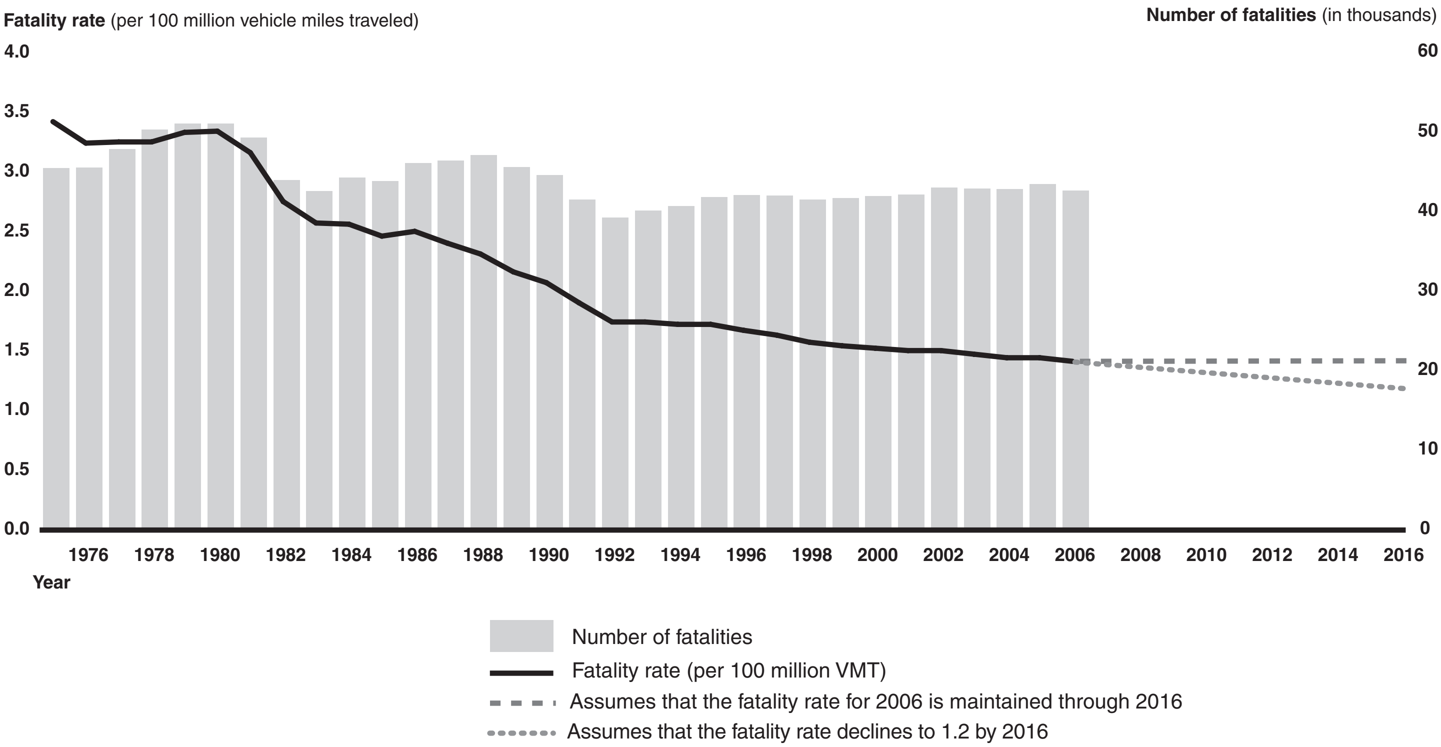
Background

Highway Fatalities

In 1980 through 1992, the overall highway fatality rate (fatalities per 100 million VMT) declined substantially (as figure 3 shows).[11] Progress reducing the rate has since become incremental, and the future is uncertain.

[11]According to DOT, VMT measurement should be improved; for example, current procedures may underestimate motorcycle travel and do not measure pedestrian exposure.

Figure 3: Actual Overall Fatality Rates and Number of Fatalities, 1975 through 2006, and Rates Projected through 2016



Source: GAO analysis of National Highway Traffic Safety Administration (NHTSA) data.

The declines in the fatality rate between 1980 and 1992 were associated with (1) the development and spread of technologies that improve crashworthiness such as seatbelts, airbags, and improved car design—as well as a related behavior change—increased seatbelt use; (2) declines in driver alcohol use; and (3) according to DOT, other factors, such as roadway improvement. DOT estimates that technology-related improvements saved over 325,000 lives on U.S. roads from 1960 to 2002 (Kahane 2004). But despite continuing improvement in seatbelt use, driver alcohol use has plateaued, and highway fatalities remain the leading cause of death for children, teens, and young adults (NHTSA 2008c; GAO 2008c). While DOT's prior goal for 2008 was an overall fatality rate of 1 fatality per 100 million vehicle miles traveled, the figure is still close to 1.4 fatalities per 100 million VMT.[12] The dashed and dotted lines of figure 3 are based on

[12]The rate most recently reported, in August 2008, was 1.38 fatalities per 100 million VMT for 2007.

the alternative assumptions about future fatality rates that a DOT official used to project fatalities for 2016 (Kanianthra 2007).[13]

The annual *number* of fatalities (see grey bars of figure 3) is related to the fatality rate and VMT—both of which are uncertain in the future.[14] VMT reflects population size and mobility patterns, which in turn reflect factors such as the economy, fuel costs, and the availability of alternative modes of transportation. If trajectories such as those projected for the fatality rate in figure 3 were to extend through 2020—and if VMT were to remain steady—highway fatalities over the next 12 years could be close to 500,000.[15] Declining VMT would be likely to be associated with reduced fatalities, but efforts to reduce future fatality rates would remain a highly important priority for the federal and state governments.

Whether the overall fatality rate will increase or decline between now and 2020 is uncertain. Fatalities may rise because of anticipated increases in some vulnerable road-user groups—including older drivers, occupants of small cars (a group that may increase if small-car sales continue to surge in response to rising fuel prices), and motorcyclists.[16] Conversely, fatalities may decline because of new technology or other ongoing safety efforts (such as programs to make the road environment safer through better materials or signs or to emphasize speeding enforcement). However, how DOT deals with fast-paced technological changes may also play a role in the trajectory of the highway fatality rate. While many new technology developments may affect the future of highway safety, experts view two—both of them high-clockspeed trends—as clearly significant. Post-ESC crash avoidance technologies present an apparent opportunity for improving highway safety—ESC, in particular, is likely to provide

[13]NHTSA recently told us that it should meet the 1.0 fatality rate for occupants of passenger cars and that the higher overall rates reflect fatalities involving pedestrians, motorcyclists, and heavy trucks, as well as those for passenger-car occupants. NHTSA also said that more accurate measures of exposure are needed.

[14]The fatality rate can be calculated as the number of fatalities divided by VMT. If such rates decline, the number of fatalities may or may not decline, depending on trends in VMT.

[15]VMT is currently declining as fuel costs rise, but whether the decline will continue through future years is uncertain.

[16]Roughly half of all fatalities occur for potentially vulnerable road-user groups, defined as including elderly persons, pedestrians, bicyclists, motorcyclists, occupants of compact cars (who may be vulnerable in crashes involving larger vehicles), and occupants of other cars when encountering heavy trucks. (We discuss trends in vulnerable groups in appendix IV.)

considerable safety benefits (see Dang 2007)—and electronic driver distractions present an apparent threat to safety

Trends Related to Post-ESC Crash Avoidance Systems

Several factors are contributing to the nature and clockspeed of the crash avoidance trend:

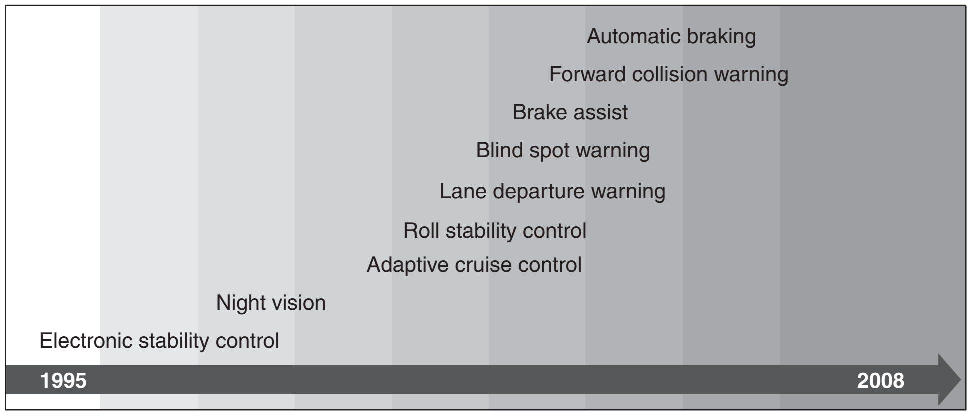
- Automobile manufacturers are developing new kinds of new crash avoidance systems (electronic systems aimed at assisting drivers), making them available in luxury cars and increasingly including them in other new models.[17]
- Statements by recent NHTSA administrators and others point to a recognition that automobile manufacturers are developing new safety technologies at an unprecedented rate.
- Rapid advances in sensing and microprocessor technologies have allowed a faster pace for the introduction of in-vehicle safety systems, according to an industry representative.

Post-ESC in-vehicle crash avoidance technologies include systems to warn drivers who are drifting out of their lane or risking rear-end collisions. Several in-vehicle systems were developed by automotive suppliers and introduced by automobile manufacturers within about 8 years. Figure 4 lists a number of these systems.[18]

[17]A different kind of new safety technology that carmakers are including in some vehicles is automatic crash notification. Private sector companies are also developing other new technologies for surveillance or enforcing safety rules. These include systems to more effectively enforce (1) speed limits and (2) laws on elevated blood alcohol content (BAC).

[18]While automobile manufacturers introduce new model cars every 4 to 6 years, they introduce new options more frequently. Additionally, major manufacturers are adjusting their strategies to better compete in a “higher clockspeed” world (Fine 1998, 64 and 238–239).

Figure 4: Evolving In-Vehicle Crash Avoidance Technologies



Source: Adapted from information provided by NHTSA.

Note: The in-vehicle technologies in this figure were all introduced within the period shown. However, different automobile manufacturers introduced different technologies at different times, and the specific order of introduction may have varied.

The crash avoidance technologies listed in figure 4 are already available in some new cars, especially luxury cars, and the percentage of cars on the road that have these technologies is likely to increase. But despite the relatively fast pace at which these technologies are introduced, increases in the percentage of cars with these technologies will be relatively slow. That is, because the average car now stays on the road for several years, it will be some time before new cars with the new technologies are sold to enough customers to become a high percentage of vehicles on the road.[19]

Automobile manufacturers, DOT, and others are planning other approaches to crash avoidance, including the following:

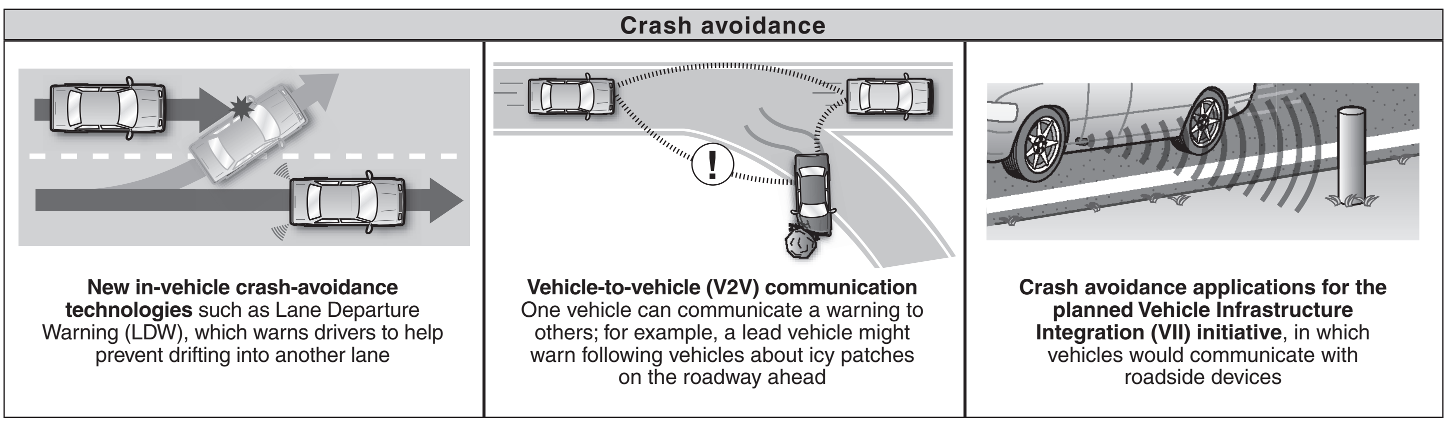
- *Vehicle-to-vehicle communications (V2V)*. Some automobile manufacturers are designing V2V communications so that, for example, a car encountering an icy patch could signal this potential hazard to following cars.

[19]The length of time to reach a given percentage of cars on the road depends on sales volumes for new vehicles with the technology in each model year. If manufacturers install a particular new technology in only luxury models at first, it takes longer for it to reach a majority of vehicles on the road.

- *Safety applications planned for Vehicle Infrastructure Integration (VII).* DOT, in partnership with others, is planning a “smart roads” VII system of real time vehicle-road communication. Applications could include crash avoidance—as well as electronic payments for tolls, parking, and fuel and other applications.[20]

Experts told us that V2V and VII (that is, vehicle-to-vehicle communications and vehicle infrastructure integration) are intended to provide each car with information beyond what its own sensors can detect—for example, information about a road blockage (such as a recent crash) or other hazard around a curve or over a hill. Figure 5 illustrates the three interrelated types of crash avoidance applications.

Figure 5: Three Major Types of Crash Avoidance Applications



Source: GAO.

Some crash avoidance applications use audible or tactile warnings.[21] Others provide visual information on screens—for example, backup cameras, night vision screens, and V2V signal screens.[22] Issues for safety technologies such as these can be complex, depending on how drivers

[20] A limited toll collection application (EZ pass) operational in some locations allows drivers with prepaid accounts to pass through toll booths without stopping.

[21] Also referred to as a haptic warning, one example of a tactile warning is vibration on one side of the driver’s seat.

[22] Backup cameras positioned in the rear of the car transfer images to a dashboard screen when the car is in reverse (two such screens are illustrated in appendix V).

interface with or react to new signals or systems (see Wochinger and others 2008). Even more basic technologies or improvements that provide a safer vehicle or contribute to a safer road environment (for example, widening roads) may encourage some to drive faster or less carefully, reducing the overall safety benefit below what had been anticipated.[23]

Automobile manufacturers, suppliers, and various experts view crash avoidance technologies as the wave of the future because of their potential to reduce the number and severity of accidents. Studies of ESC promise eventual fatal crash reductions by nearly one-third, and in 2007 the chairman of the National Transportation Safety Board (NTSB) stated that

> "while we accomplished much . . . to improve the crashworthiness of automobiles, we have reached some practical limits in combating the physical forces involved in crashes. It is time to . . . enter a new era where technology will help us prevent accidents." (Rosenker 2007)

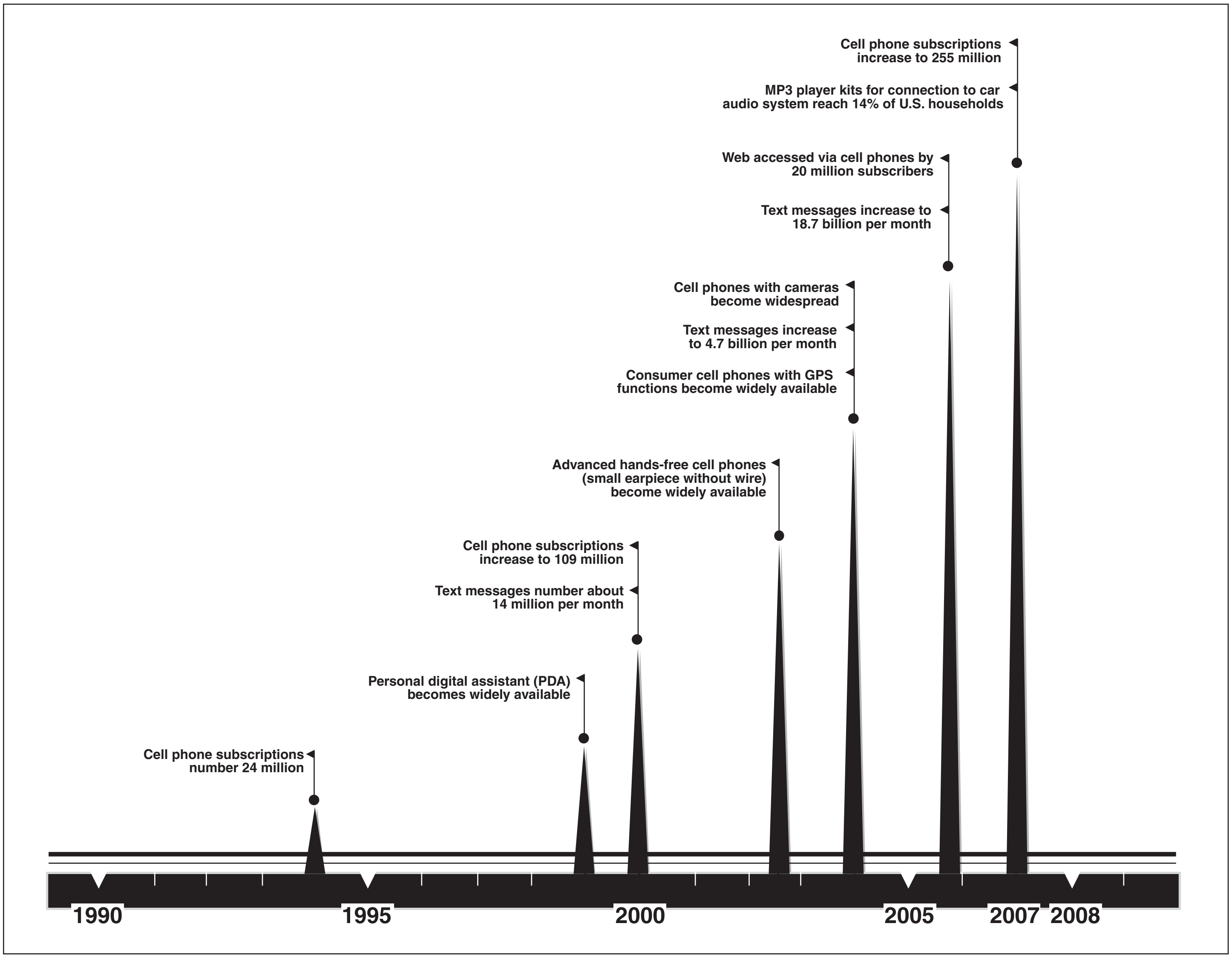
Others, including a recent NHTSA administrator, have expressed similar views. A NHTSA official told us that some new in-vehicle crash avoidance technologies, such as lane departure warning (LDW), would be likely to mitigate the effect of electronic driver distractions, such as driver cell phone use. Effective crash avoidance and other technologies might also help counter the effects of driving while drowsy or with elevated blood alcohol content, and even failing to wear seat belts.

[23]Changes toward riskier driver behavior in response to new technologies designed to increase safety have been variously termed risk compensation, risk homeostasis, moral hazard, and the usability paradox.

Trends Related to Evolving Electronic Driver Distractions

Another major technology-based trend relates to the growing use of electronic devices that could distract drivers. The electronics industry is developing new devices or new features for existing devices for portable communication, information access, and entertainment and introducing them to consumers, who purchase and use them at an ever accelerating rate. Using electronic devices is distinct from other behavior that can distract drivers, such as eating or grooming, because the new devices are proliferating and evolving quickly with great complexity (see figure 6).

Figure 6: The Evolution and Spread of Portable Electronic Devices in the United States



Source: GAO analysis based on expert opinion and data from Consumer Electronics Association (CEA), CTIA—The Wireless Association®, Telecommunications Industry Association (TIA), and documents such as industry reports and estimates.

Indicators of rapid change include

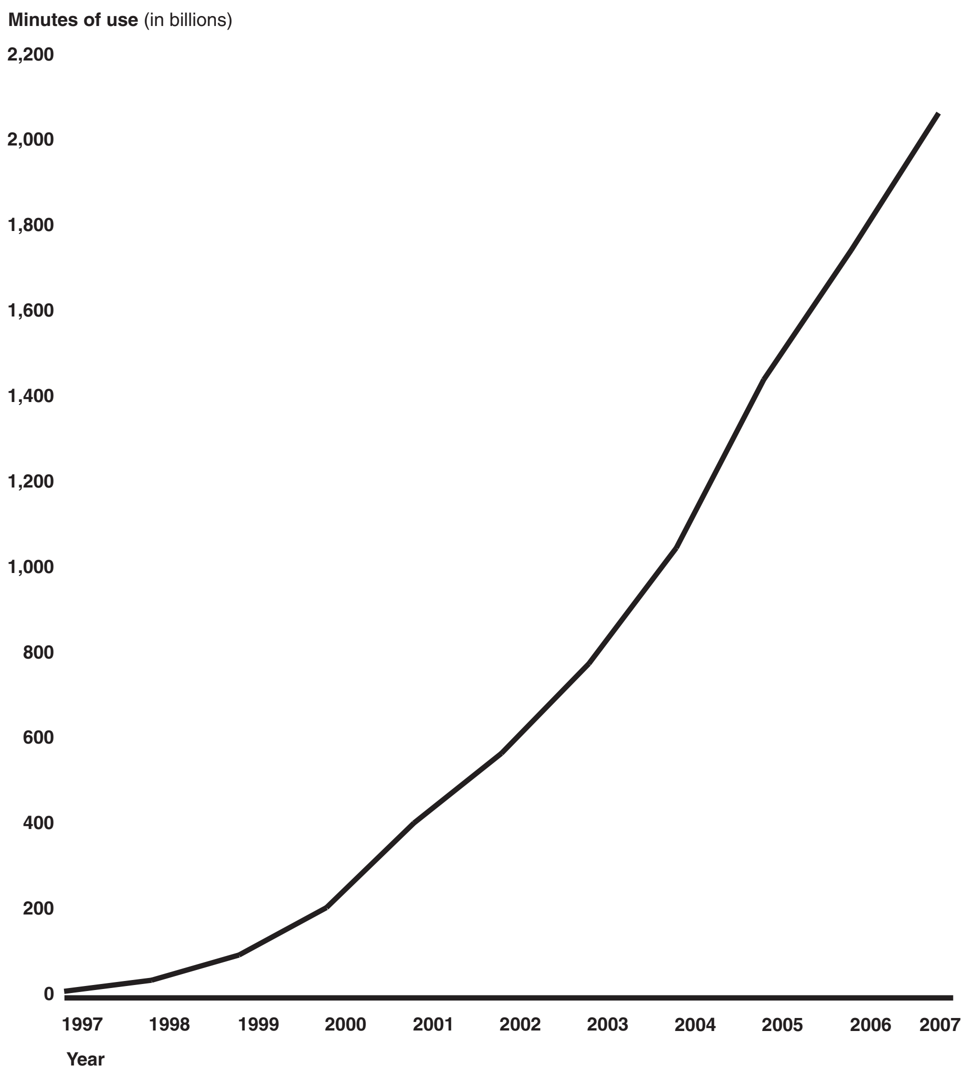
- the rate at which the average cell phone subscriber replaces a hand set—about every 17 months (which allows many consumers to obtain new features quickly);

- the number of minutes of cellular usage, which has increased at an exponential rate (see figure 7);

- new phones that include streaming TV and video calling and MP3 players that feature screens for movies; and

- new kinds of screens (see figure 8).

Figure 7: Overall Minutes of Cellular Use in the United States, 1997–2007

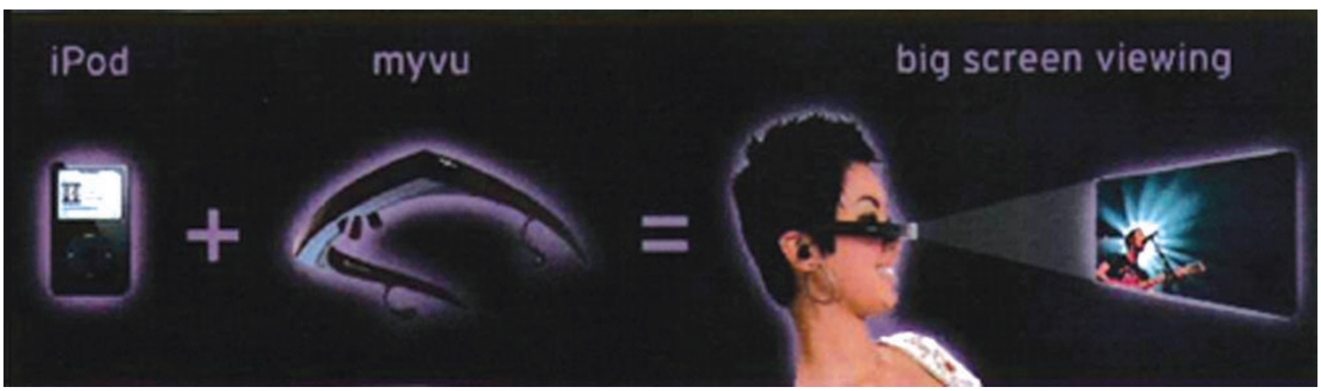


Source: GAO presentation of data provided by CTIA—The Wireless Association® (used by permission).

Figure 8: Touch Screens and Virtual Screens

Example of flowing touch screen

Example of clear "video eyeglasses"



Example of virtual big screen with see-around opaque eyewear

Source: GAO (touch screen), eyeglasses image courtsey of Lumus Ltd., and Myvu Corporation (virtual big screen).

DOT Units with Highway Safety Missions

Several DOT administrations are involved in monitoring and addressing trends that affect highway safety. NHTSA has historically been charged with setting new car safety standards and testing new cars for compliance with those standards. It is also responsible for conducting research and administering grant programs designed to assist states in addressing driver behavior issues, such as seatbelt and booster seat use, and state alcohol-impaired driving programs. NHTSA has addressed new car safety through research, regulation, and consumer information. For example, NHTSA's evidence-based New Car Assessment Program has been designed to increase consumer demand for safer cars and thus encourage automobile manufacturers to improve safety.

Working with the states, NHTSA has also addressed driver behavior issues by (1) awarding and overseeing grants to aid states in developing safety programs and enforcing highway safety laws; (2) conducting public information campaigns on the effectiveness of countermeasures, such as seatbelts; and (3) promoting compliance with legislative requirements that make grants contingent on state action, such as passing a child booster seat law.[24]

NHTSA also houses the National Center for Statistics and Analysis (NCSA), which maintains crash datasets—such as the Fatality Analysis Reporting System (FARS), which provides data on all fatal motor vehicle crashes on U.S. roads—and other datasets based on observational and telephone surveys.[25]

RITA, another DOT administration, coordinates the department's research programs. For example, RITA is the lead administration for the VII project through its Intelligent Transportation Systems program, which directs research investments in developing future intelligent transportation systems. RITA's Administrator is also principal science adviser to the Secretary on science and technology matters and oversees DOT's Volpe National Transportation Systems Center and more than 60 University Transportation Centers.

While TRB is not a part of DOT, it is a part of the National Academies and conducts a variety of activities. Its oversight of research includes safety research, often in coordination with DOT.[26]

The responsibilities of the Office of the Secretary of Transportation, FMCSA, and FHWA also relate to highway safety. For example, the Office of the Secretary of Transportation provides policy development, oversight,

[24]Our recent reviews of NHTSA safety grants to states include GAO 2008b and 2008d.

[25]Information on selected crash datasets and driver-behavior datasets maintained by NCSA is in appendix VI.

[26]TRB conducts the second Strategic Highway Research Program (SHRP 2), authorized by the Congress in 2005 to study comprehensive crash causation, congestion, and many other topics. RITA is the liaison to TRB for SHRP 2.

and coordination for the overall planning and direction of DOT, including DOT's strategic plan and budget request. DOT's strategic planning efforts are guided by governmentwide requirements. Although some foresight-related activities are conducted by the Office of the Secretary, there is no specific foresight unit. The Office of the Secretary also performs or sponsors some research independently of other DOT agencies.

FMCSA is charged with reducing crashes involving commercial vehicles (large trucks and buses), including developing and enforcing related regulations. FHWA also performs safety-related functions. Notably, FHWA administers the Highway Safety Improvement Program, through which it allocates money to states annually for infrastructure-related safety improvements, and the State and Community Highway Safety Grant Program, which supports state highway safety programs designed to reduce traffic crashes and resulting deaths, injuries, and property damage. FHWA also adopts standards for the design of roadways receiving federal funds and told us that "safety is fully considered when developing these standards." Finally, FHWA has a research mission; its current work includes creating a dataset of roadway characteristics identifiable with global positioning system (GPS) coordinates. In addition, FHWA has initiated the Model Minimum Inventory of Road Elements (MMIRE) project, designed to set a baseline of information for states to collect and use in selecting safety-related roadway improvements.

Foresight Reporting Framework for High-Clockspeed Trends

To help describe how DOT is considering evidence and otherwise addressing post-ESC crash avoidance technologies and electronic driver distractions, we developed a framework with categories for levels of evidence and governance options. Specifically, this framework provides a way to summarize and analyze

- the level of available evidence on each trend's impact and
- the various governance options that DOT has employed in response or could potentially employ.

Evidence about an evolving or fast-changing trend's safety impact may vary across a continuum of certainty or level of knowledge. Toward one end of the continuum, relatively weak early signals may suggest that a new trend or phase of a trend is likely and might impact highway safety, now or in the future. Early signals may consist, for example, of anecdotal evidence, such as a few widely reported crashes involving driver use of a new technology or interviews with key industries in which possible plans for future technologies are outlined. Toward the opposite end of the continuum, strong quantitative data would, if available, provide evidence of the scope and magnitude of the impact on highway safety associated with an evolving trend—as well as, where relevant, how safety impacts have changed over time or are currently changing.[27] More than one level of evidence may be relevant to a high-clockspeed evolving trend, because different sets of evidence may apply to various phases of such a trend. Figure 9 shows three levels of evidence on safety impacts.

[27]For example, a particular trend's impact may be increasing at a fast pace or changing very slowly. We define quantitative data as "strong" depending on validity, reliability, and generalizability. Validity refers to unbiased counts or measurement of what one intends to measure; reliability concerns reproducibility and consistency (that is, the achievement of similar results if a study were repeated using the same procedures); generalizability refers to the applicability of study results to the population of interest. An additional indication of strength would be multiple studies or different sources of data.

Figure 9: Foresight Reporting Framework for High-Clockspeed Trends

Levels of evidence on safety impacts
of a new technology-based opportunity or threat

Level 1: Early signals

Networking with industry to learn about products "in the pipeline," scanning for instances or qualitative data indicating possible impacts on safety. May signal future developments or interrelationships among trends

Level 2: Confirming qualitative or limited quantitative evidence

Results from studies or tests that confirm the existence of an evolving opportunity for or threat to safety; suggest a general level of impact on safety or how that impact is changing[a]

Level 3: Strong quantitative evidence

Results from studies that quantify the magnitude of the overall safety impact of an opportunity or threat; may also define the pace of change and anticipated trajectory of an evolving trend[a]

Governance options
for addressing a new safety opportunity or threat

Option A: No self-initiated response

- Decision not to self-initiate efforts to pursue opportunities or counter threats at this time

Option B: "Starting point" actions

- Discussion forums (issue clarification, agenda setting), early work to develop policy proposals or priorities, outlining a "vision"

Option C: Research to explore or evaluate approaches to action or to stimulate action; early interventions

- Research to explore new countermeasures or other programs; evaluation and demonstrations programs
- Information programs designed to be supportable by Level 1 or Level 2 evidence
- Involve manufacturers or suppliers in conducting research to encourage development of certain types of new safety products

Option D: Mid-level interventions

- Consumer information programs that include very specific or comparative safety information or require competing products to be directly compared in terms set by the government
- Provide information to states; encourage states to develop new programs or pass new laws

Option E: Stronger interventions

- Regulation
- Federal incentives
- Grants to states

Source: GAO.

Note: "Governance options" refers to tools or strategies for research and action that agencies can use to pursue goals; they include official tools such as regulation and informal approaches such as networking. Various agencies may use different terminology for this and other concepts in this figure. The categories shown illustrate issues relevant to this report and may not be comprehensive; additionally, more than one category may be relevant to some DOT responses.

[a]Level 2 evidence falls short of strong quantitative evidence, defined as valid, reliable, and generalizable (Level 3). To illustrate, one aspect of validity for evidence of safety impact concerns whether data include information on serious or fatal crashes. (See appendix III for a further definition of validity, reliability, and generalizability.) Other key characteristics relevant to strong evidence on high-clockspeed trends include timeliness and measurement of change. Results from multiple quantitative studies conducted by different investigators are another indication of strength.

Describing levels of available evidence on safety impacts can be important, because stronger evidence may allow an agency to more confidently make decisions about whether or how to respond to a trend. At the same time, early signals about possible safety impacts, now or in future, may suggest anticipatory research or action.

DOT's responses to a technology-based trend (that is, DOT choices of governance options) may be based on its own judgments about evidence as well as the requirements or suggestions of others—for example, statutory mandates. Options available to DOT include (1) forgoing the "self-initiation" of research or action to promote or counter a technology-based trend; (2) pursuing exploratory research and development efforts to identify what kinds of actions might effectively address a new trend or sponsoring limited demonstration programs to facilitate broader action in the future; (3) providing the general public with consumer information or conducting an information campaign; (4) providing information to states (an option that may be especially relevant for driver behaviors that the states regulate); and (5) regulation on its own initiative or as mandated by the Congress. Figure 9 illustrates these governance options.

Agencies may pursue various options through traditional policy tools or organizational networking or a combination of these.[28] The various options are not mutually exclusive, and a department such as DOT could respond to a single trend by employing multiple options—self-initiating some, carrying out others in response to congressional interest or directives, and so forth.[29] Additionally, some options may be pursued in preparation for using others—for example, research to explore or assess possible interventions may be pursued in preparation for later action.

Finally, there is not a prescribed one-to-one link between a particular level of evidence on safety impact and a corresponding governance option. This is because in choosing an option, an agency may weigh many interrelated factors and trade-offs. More generally, proposed safety improvements may sometimes be weighed against mobility needs, possible impacts on congestion, or other issues.

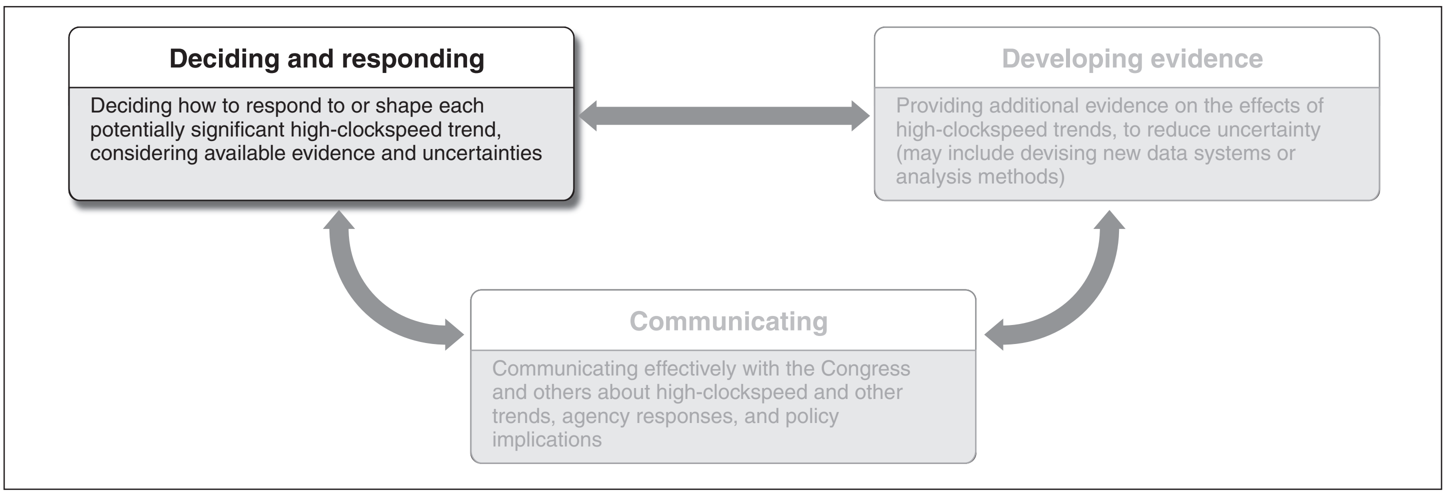
[28]Organizational networking involves establishing relationships with others within one's organization and in other organizations (in both the public and private sectors) in order to exchange information and, in some cases, influence debates or actions.

[29]DOT actions are limited by its authority and budget.

Uncertainty about New Opportunities and New Threats from High-Clockspeed Trends Challenges DOT Decision Makers

High-clockspeed trends based on fast-paced innovation and consumer adoption of new products can be associated with high levels of uncertainty, and making decisions about when and how to address such trends presents a fundamental foresight challenge (Rejeski 2003, 56). (See fig. 10.)

Figure 10: Exercising Foresight by Addressing High-Clockspeed Trends, with Deciding and Responding Highlighted



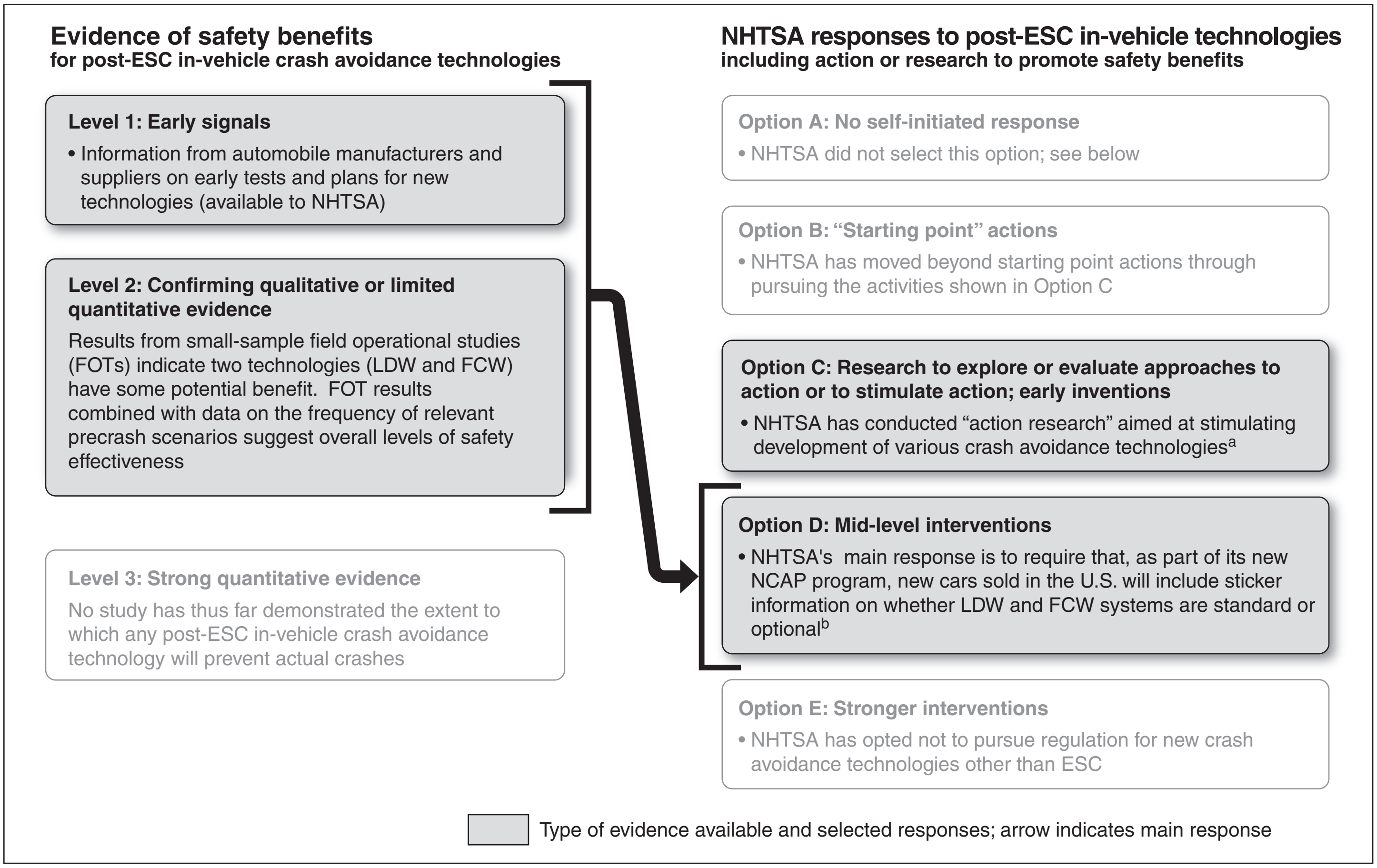
Source: GAO.

Evidence on safety impacts shows that evolving post-ESC crash avoidance technologies present an opportunity to enhance safety and that electronic driver distractions pose a threat to safety. But there are uncertainties about the magnitude of safety impacts and the effectiveness of possible actions. As a result, it is uncertain how many lives might be saved by pursuing the crash-avoidance opportunity or countering the distraction threat. In the absence of a governmentwide structure for exercising foresight across a horizon more than 5 years forward—and in the face of potentially significant, although somewhat uncertain, high-clockspeed trends that can affect highway safety (with one trend presenting a new opportunity, the other a threat)—DOT administrations are responding by actively attempting to shape one trend (crash avoidance) but have decided not to counter the other (electronic distractions) at this time. The main criteria NHTSA officials told us they used in making these decisions are that (1) existing quantitative evidence demonstrates that a sizable safety problem already exists (for example, roughly as many fatalities are counted for the new problem as for a recognized major problem such as lack of seatbelt use) and (2) a promising strategy exists for dealing with the new problem. These criteria do not specifically target the uncertainty of high-clockspeed trends, which may be greater than for slower trends or long-standing problems. Literature and experts suggest a variety of approaches to dealing with uncertainty in decision making, including anticipatory risk management, prioritization of research on new strategies, and expansion of networking, among others.

Although DOT Administrations Face Some Uncertainty Regarding Crash Avoidance Technologies, They Are Moving to Actively Shape This Trend

Some evidence exists regarding the effect of crash avoidance technology. NHTSA has obtained early evidence on new safety technologies that automobile manufacturers are developing by attending transportation or safety conferences and by networking with automobile manufacturers and suppliers about plans and early tests. Evidence from such activities corresponds to Level 1 in figure 11.

Figure 11: Foresight Reporting Framework: Post-ESC In-Vehicle Crash Avoidance Technologies



Source: GAO.

[a]A NHTSA official told us that its Advanced Crash Avoidance Technologies (ACAT) program, in which NHTSA partners with automobile manufacturers to improve information on safety impacts of crash avoidance technologies, is intended to encourage manufacturer efforts to develop such technologies. Also, NHTSA has conducted varied fundamental research aimed at understanding crash processes or factors relevant to crash avoidance technologies—for example, human factors research. This could help support judgments about precrash scenarios and new technologies that might be successful in addressing them. A possible alternative or supplementary option would consist of other forms of consumer education on new technologies, such as how to best use them.

[b]73 Fed. Reg. 40,016 (July 11, 2008).

NHTSA has obtained systematic evidence on safety effectiveness from FOTs on two technologies that have been shown to have some safety benefit—LDW and FCW systems.[30] The NHTSA-sponsored FOTs are not large or lengthy enough to provide definitive quantitative evidence on levels of safety benefit or to compare serious or fatal crashes in vehicles with or without each new technology (as we discussed later). However, NHTSA has combined the FOT data with other information on the frequency of relevant crash and precrash scenarios to obtain estimates of "safety effectiveness."[31] For example, rear-end collisions, which are addressed by FCW, are a frequent type of crash. These combined estimates represent "confirming qualitative or limited quantitative evidence"—Level 2 evidence in figure 11. However, there is a lack of strong, quantitative (Level 3) evidence for safety benefits such as how many serious crashes would be prevented by LDW and FCW.

In response to the existing evidence on safety impacts, NHTSA has made decisions to actively shape the in-vehicle crash avoidance trend by pursuing two governance options:

- The first is to spur industry safety innovations and encourage manufacturers and suppliers to develop such technologies by involving them in related research. Using existing resources, NHTSA has carried out some initiatives to achieve this goal (Option C in figure 11).

- The second, NHTSA's main response to this trend thus far, is to capitalize on the potential opportunities afforded by crash avoidance technologies. As of model year 2010, NHTSA will add information on LDW and FCW (and ESC) systems to NCAP labels on new cars in order to indicate whether such technologies are standard or optional (Option D in Figure 11). This is aimed at accelerating consumer interest in buying cars with new safety technologies.[32]

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[30]An FOT is a test conducted under typical operating conditions for the technology being tested. Each FOT discussed here involved outfitting a limited number of cars with sensors and other equipment and had a relatively small sample; for example, one used 78 drivers and 11 cars, with each driver using a vehicle for 4 weeks.

[31]NHTSA's estimates indicate that LDW and FCW technologies are, respectively, 6–11 percent and 15 percent safety effective. In comparison, NHTSA characterizes ESC as 59 percent safety effective.

[32]NHTSA will be using three criteria for including crash avoidance technologies in NCAP—(1) the safety technology addresses a major crash problem, (2) estimates or projections of safety benefits are available, and (3) performance tests and procedures are in place to ensure adequate performance for each labeled model. For the future, automobile manufacturers have pointed to the importance of efforts to develop better evidence on new technologies. (We discuss post-ESC in-vehicle crash avoidance technologies in appendix VII.)

NHTSA officials told us that in addition to considering the FOT results on LDW and FCW and other relevant results, their decision to encourage these in-vehicle technologies was inspired by the demonstrated success of ESC, which is expected to cut fatalities by a substantial margin once widely deployed, and their knowledge of the variety of crash avoidance technologies being designed by suppliers and manufacturers. They also said that congressional interest in crash avoidance, as well as our recommendations concerning the need to update NCAP, influenced their decision (GAO 2005b, 58–59). Additionally, NCAP has successfully encouraged crashworthiness in vehicles, and NHTSA decision makers, as well as automobile manufacturers, anticipate that expanding NCAP to include crash avoidance technologies will have a positive result (although this has not been tested).[33]

Maximizing the benefits of evolving crash avoidance technologies may be challenging, however, given various uncertainties about safety impacts, including the limitations of data and interactions between crash avoidance and other trends. For example, an article by NHTSA staff raised a variety of issues about the future of in-vehicle crash avoidance as the population of older road users increases—ranging from the potential for crash avoidance technologies to substantially enhance both safety and mobility for this vulnerable group to the need to design technologies with this group's limitations in mind (Band and Perel 2007). However, it was noted that crash avoidance technologies "might encourage older adults to continue driving well beyond when they would ordinarily cease operating vehicles," thus raising risks (based on increased exposure to crash risks because of more vehicle miles traveled). The implication was that such risks would not be raised so high as to negate overall safety benefits, but the article did not analyze relative risks. In addition, representatives of the automobile industry have said that consumer training in the use of new technologies could be key to maximizing safety benefits. The final notice of changes to NCAP acknowledges this point and states that NHTSA will continue to conduct marketing studies in order to assess consumer reaction to new technologies.

For the longer term, DOT faces uncertainties about how the crash avoidance trend will impact safety in the future, depending on whether or how it moves toward V2V and VII. Some manufacturers are working to develop V2V, but it is unclear whether this will be widely adopted or how

[33]We discuss issues related to crash avoidance and NCAP in appendix VII.

interoperability will be achieved. NHTSA is working with FHWA and RITA to develop possible crash avoidance applications for VII.[34] Although some DOT administrations and others have long discussed the potential safety benefits of VII and RITA's Volpe Center is preparing a benefit-cost analysis, actual data on VII's safety or other benefits are limited, and how government or private sector groups would fund VII is unclear. RITA envisions a public-private partnership that will implement a high-speed data network for collecting anonymous data from moving vehicles and providing information to them.[35] As figure 12 shows, the VII system would

- provide a link to each vehicle equipped with an onboard transceiver by roadside devices or other wireless technologies, using multiple paths of communications to ensure redundancy[36] and

- accomplish crash avoidance by, for example, alerting a driver to hazards, including some that neither the driver nor sensors in the vehicle would otherwise detect in time to stop (such as a runaway truck heading for an intersection obscured by buildings or a crash around a sharp curve in the roadway ahead).[37]

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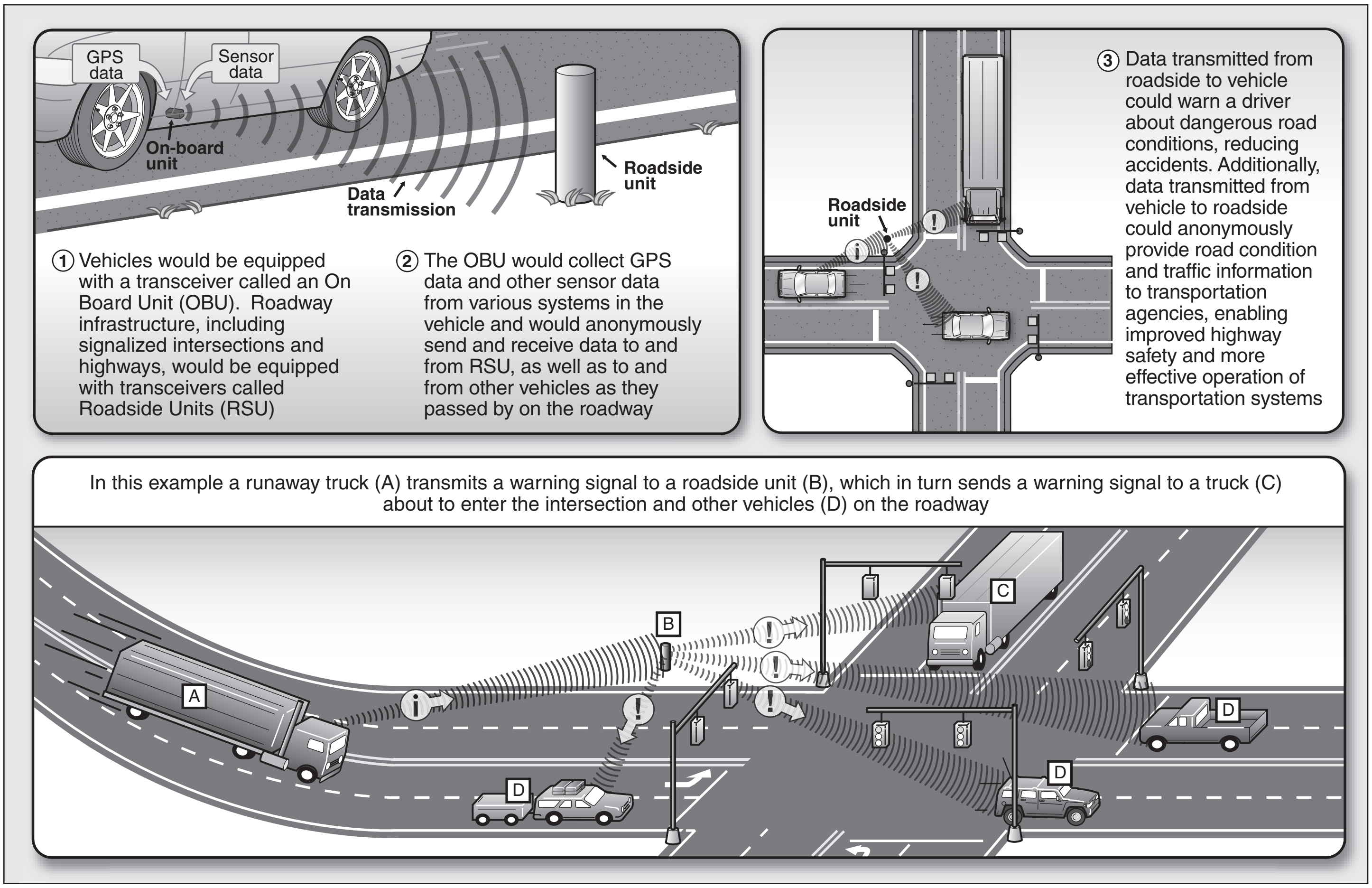
[34]FMCSA and FHWA have established a parallel VII initiative called Smart Roadside, to address the development of VII for the commercial vehicle industry.

[35]RITA's Volpe Center is preparing a benefit-cost analysis on VII deployment scenarios (scheduled for delivery in late 2008).

[36]RITA officials told us that the identities of individual vehicles would not be recorded at any point in the data collection process.

[37]The VII system would be more complex than figure 12 shows, because it involves GPS satellite communications to identify a vehicle's location and possibly other technologies, such as wireless Internet or other modes of communication, as well as technology to allow interoperability across subsystems.

Figure 12: How VII Would Operate



Source: GAO.

NHTSA officials stated that some opportunities existed to incorporate VII into prior crash avoidance initiatives involving communications. For example, the Cooperative Intersection Collision Avoidance System (CICAS), which is managed by a team including NHTSA and FHWA staff, and Effectiveness of Vehicle Safety Communications Applications

(EVSCA) initiatives could utilize VII technology.[38] The future system would be implemented nationwide, in urban and rural areas, and could host a broad range of potential applications not geared to safety, ranging from toll payment to information on congestion reduction to a variety of commercial uses. Some have suggested that commercial applications of these might, if implemented, produce revenue to help fund the system.[39] DOT officials told us they expect to decide on whether it is feasible to move forward with field operational tests of a VII system sometime in fiscal year 2009.

Looking forward, VII faces a number of uncertainties, including limited data on its effectiveness and unclear sources of funding, but NHTSA and other DOT administrations, such as those participating in the CICAS team, are attempting to include a crash avoidance safety component in VII plans. In terms of the decision-option categories we developed for this report, DOT efforts to develop VII-related applications fall into the category of starting point actions (Option B in figure 9), with testing of safety applications falling into exploratory research (Option C in figure 9).

Although Evidence on Electronic Driver Distractions Points to Safety Risks, NHTSA Has Not Initiated Responses, Cites Uncertainties

Studies confirm that driver phoning raises safety risks. Based on a combination of NHTSA publications, peer-reviewed articles, and recent surveys, the overall safety impact of driver phoning appears to be substantial:

- A recent NHTSA-sponsored literature review concluded that (although key studies cited were conducted in Australia and Canada rather than the United States) “the available evidence suggests that cell phone use increases drivers’ crash risk by a factor of 4” (Ranney 2008, iii).

- Our review confirms that driver calls made with portable phones increase the risk of a crash. We sampled 13 primary studies that

[38]The goal of CICAS is to reduce accidents by alerting drivers when they or other vehicles are projected to violate traffic control devices and advising drivers about “gap acceptance” when deciding to maneuver through an intersection (after making a legal stop) or to make left turns. EVSCA is a NHTSA initiative to evaluate whether the effectiveness of vehicle-to-vehicle communications (either alone or in combination with stand-alone crash-avoidance technologies) could benefit from technologies allowing the vehicle to communicate with roadside or other sensors.

[39]Various functions could be added to VII incrementally as new technologies become available.

evaluated this issue, including those we identified in peer-reviewed journals and an additional NHTSA-sponsored study known as the "100 car study."[40] Of the 13 studies, 12 reported an increase in the risk of an actual crash, simulated crash, or near miss. Ten studies quantified the increase in risk, and of the ten, seven estimated an overall doubling or higher increase in risk (see appendix III).

- Two nationwide self-report surveys conducted in 2006 indicate that a majority of respondents admit to phoning while driving.[41] NHTSA's roadside observations indicate that at any one moment in 2007, 6 percent of drivers were observed holding phones to their ears (NHTSA 2008a).[42] NHTSA used data from a questionnaire survey to adjust for unobserved hands-free use, resulting in an overall phoning estimate of 11 percent in 2007.[43]

These results are "confirming qualitative or limited quantitative evidence"—Level 2 evidence of safety impact in figure 13. However, there is a lack of strong quantitative (Level 3) evidence of a major safety impact.

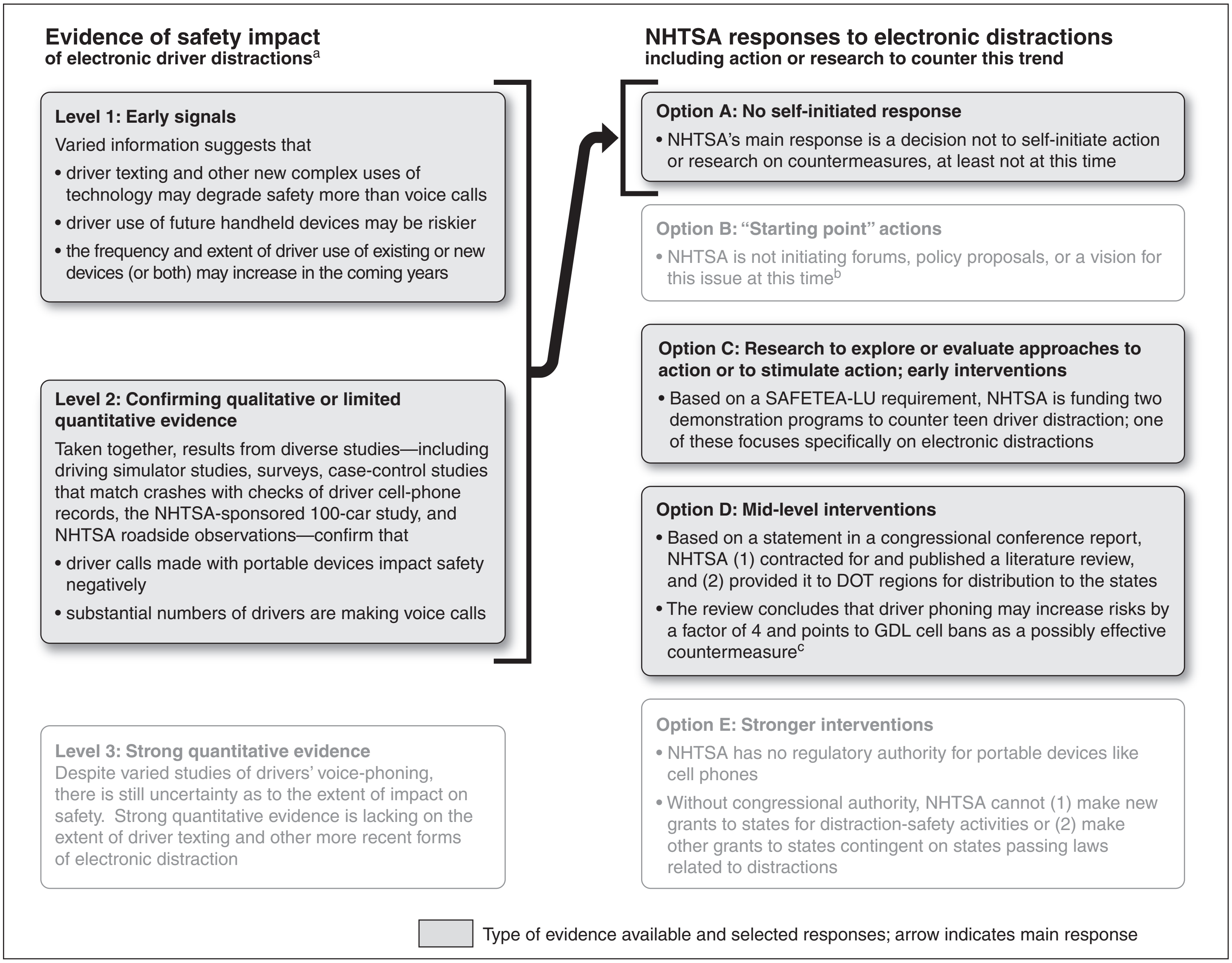
[40]In the 100-car study, video cameras and sensors were installed in approximately 100 vehicles, each tracked for about a year of "normal driving" within an 18-month period in 2003–2004. Designs for each of the 13 primary studies are characterized by strengths and weaknesses (see appendix III).

[41]The surveys were a Harris Interactive® poll and a Nationwide Mutual Insurance survey.

[42]The total amount of driver voice phoning is higher because the 6 percent figure does not include driver use of hands-free equipment (such as earpieces and speakerphones). The observations were obtained in the National Occupant Protection Use Survey (NOPUS) (see appendix VI).

[43]This questionnaire survey was based on landline telephone sampling and interviewing.

Figure 13: Foresight Reporting Framework: Evolving Electronic Driver Distractions



Source: GAO.

Note: The arrow indicates NHTSA's current main response to the driver distraction trend, which is not to self-initiate research or action to counter it at this time. Other highlighted boxes indicate other current or recent responses, based on congressional directives.

[a]Besides providing evidence on safety impact, research has examined the process of distracted driving and ways to study it; for example, a 2008 report NHTSA contracted for discussed two earlier studies' results on driver willingness to engage in distracted behaviors (Lerner, Singer, and Huey 2008, citing Lerner and Boyd 2004 and Lerner and Balliro 2003).

[b] A table in Lerner, Singer, and Huey (2008) outlines "possible countermeasures to address concerns" on distracted driving. These concerns are based on the earlier studies cited in note a, above. The outline could provide background for planning or conceptualizing new starting point actions (Option B) or new research on countermeasures (Option C). NHTSA's Internet forum and pilot teen-driver education campaign (Smart Drivers Just Drive) on distractions were both discontinued.

[c] GDL refers to graduated driver licensing programs that involve stages; some programs ban cell phone use for novice drivers or 16- and 17-year olds.

Additionally, although quantitative data on driver texting and the use of other new electronic distractions are more limited than data on driver voice-phoning, a number of "early signals" indicate that such behaviors also increase safety risks:

- Two driving-simulator studies—one of driver text messaging, the other of drivers' using MP3 players—indicate that these distractions have negative safety effects (Chisholm, Caird, and Lockhart forthcoming and Hosking and others 2006).[44]

- A lead investigator on the 100-car study and a similar ongoing study of teen drivers recently stated that texting, iPod and MP3 manipulation, and Internet interaction are (like cell phone dialing) riskier than talking on a cell phone (Dingus 2007).

- In a 2008 self-report survey of cell phone users, a slight majority of 20- to 29-year-old respondents said they text message while driving, as did more than one-third of respondents in their thirties and over a fourth of those in their forties (Vlingo 2008).[45]

These early signals are Level 1 evidence in figure 13.

Looking to the future, other early signals suggest that more distracting devices and greater amounts of driver use may further increase risks:

- *From now through 2015, more complex devices may emerge.* Industry representatives told us they "do not see technology slowing down" in the coming years. They expect continued evolution of electronic devices in a similar direction: increasing complexity of devices, more applications, detailed screens, and fast proliferation.

[44] Hosking and others (2006) indicate that driver texting increases glances away from the road to 40 percent of the time from a baseline of 10 percent.

[45] The self-report survey included responses from 4,800 cell phone users.

- *From 2015 through 2020, "cohort effects" may significantly increase the percentage of drivers using devices.* This would occur if young drivers continue texting and middle-aged drivers continue voice calling as they age and if new cohorts of teen drivers text or use newer complex devices at levels similar to or higher than today's teens.[46] (This assumes that technology or behavior changes do not alter these anticipated outcomes.)

Now and in the future, teens may have the highest risks. The recent NHTSA-sponsored literature review, which noted that cell phone use is increasing, cited findings that younger, and in some cases novice, drivers are "leading the way" in using various new devices and that the combination of distraction and lack of "fully developed driving skills" suggests accelerating risks for this group (Ranney 2008, 15).

Additionally, driver use of portable phones with touch screens can now be facilitated with dashboard holders with swivel mounts for landscape and portrait viewing. Motorcycle helmet equipment is also now available to facilitate phoning while riding (fig. 14).[47] Finally, wireless Internet is becoming available in cars that will become "a moving WiFi hotspot with Internet access" (Newman 2008).

[46]To further illustrate the cohort effect, by 2020 drivers now 18 to 28 years old will be 30 to 40 years old; those now 58 to 68 years old will be 70 to 80.

[47]Motorcycle mounts and car sun visors with built-in DVD players are also available.

Figure 14: Dashboard Mounts and Helmet Equipment for Phoning

Sources: ProClip (portable device holders); Cardo Systems, Inc. (helmet).

Note: Dashboard mounts (left) accommodate a smart phone or PDA (personal digital assistant), cell phone with screen, GPS device, and MP3 player.

NHTSA has acted on two directives shown in figure 13 Options C and D:

- *Option C:* With SAFETEA-LU, the Congress adopted a requirement that DOT fund at least two demonstration programs for mitigating the effect of distracted, inattentive, and fatigued driving.[48] NHTSA told us that as of July 2008, it was making final awards for subcontracts for two teen-driver distraction projects, one focusing specifically on electronic distractions.

- *Option D:* In response to a statement in the conference report accompanying DOT's fiscal year 2006 appropriation—which called for "an effort to consolidate current knowledge on driver distraction for use by policymakers …[with the purpose of assisting] state and local governments to formulate effective policies, regulations and laws"—DOT contracted for and published a literature review on driver

[48]Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, Pub. L. No. 109-59, § 2003(d) (2005).

distractions. DOT told us that it also provided for its distribution to states.[49]

These activities involve NHTSA's acting as a partner with the states.

However, at this time, NHTSA's main response to the electronic driver distraction issue is a decision not to self-initiate either research specifically aimed at countering such distractions or other actions—Option A in figure 13 (although NHTSA is studying the safety impact of distracting behaviors, including driver use of electronic devices). NHTSA has not yet implemented other suggestions or directives that government stakeholders, at the federal and state levels, have made. Two of these correspond to governance Option D in figure 9:

- The Congress directed DOT to develop uniform guidelines for state programs, including those aimed at reducing accidents resulting from unsafe driving behavior, such as the use of distracting electronic devices.[50] NHTSA told us that it will not begin drafting such guidelines until the SAFETEA-LU demonstration projects are completed.

- The Governors Highway Safety Association (GHSA) asked the federal government to fund a comprehensive media campaign to educate the public about the dangers of distracted driving (including but not limited to the dangers of electronic distractions) and how to manage distractions (GHSA 2003).[51] NHTSA told us that it is not planning to conduct such a campaign at this time.

An additional suggestion for possible research is contained in the congressional conference report that led NHTSA to conduct the literature review. The conference report suggested that the results of the literature review could help "focus the federal research effort in the most productive directions." The review stated that a useful research direction would be to evaluate the impact of state laws—and suggested that a promising approach to countering distractions might be state graduated drivers

[49]H.R. Rep. No. 109-307, at 181–182 (2005).

[50]23 U.S.C. § 402(a).

[51]The GHSA campaign was to have been joined by research sponsored by the American Automobile Association that analyzed potentially distracting activities of 70 volunteer drivers for 3 hours per driver, based on cameras placed in their vehicles. A range of distractions were observed.

licensing (GDL) programs that ban cell phone use by new drivers (Ranney 2008, 18).[52] NHTSA has not begun related research. (We discuss the suggested focus on a GDL cell ban in terms of possible research on state laws in appendix IX.)[53]

NHTSA officials did mention that crash avoidance technologies might mitigate distractions, but evolving crash avoidance and electronic distraction technologies—or other trends—might interact in other ways. (Examples of unintended consequences from trend interactions are in appendix VIII.)

In contrast to NHTSA's position, various industry groups are supporting, suggesting, or initiating responses to the driver-distraction trend. CTIA—The Wireless Association® (representing cell carriers) supports state bans on (1) text messaging for all drivers and (2) all cell phone use by provisional or novice drivers, except in emergencies. Telecommunications Industry Association (TIA) officials told us that the development of new technologies might mitigate this problem and that it is working to develop new technical standards to help speed the progress of such technologies. The Consumer Electronics Association (CEA) has developed driver education materials.[54]

Several safety advocates told us they are concerned that DOT is not aggressively addressing this trend. Finally, while policy on highway safety should not necessarily be driven by public opinion polls, recent polls indicate that a majority of those questioned believe that driver use of electronic devices is significantly more distracting than other activities and favor a ban on driver texting.[55] A poll of teens reported their opinion

[52]GDL programs typically involve three stages—driving with supervision, restricted driving without supervision (such as limited night-driving or number of teen passengers), and unrestricted driving. Minimum ages or other requirements are set for passing from one stage to another. A NHTSA guide describes such programs (NHTSA, 2008b, 4-4 and 4-9).

[53]NHTSA also told us that data from ongoing or planned studies, such as a large study using the basic methodology of the 100-car study, might suggest directions for developing countermeasures. (We describe the larger study—known as the 2,500-car study—later in this report.)

[54]CEA's driver education materials are displayed on its consumer Web site at www.DigitalTips.org.

[55]This statement is based on national polls conducted in 2007 and 2008 by Nationwide Mutual Insurance Company, Zogby International, and Harris Interactive®, as well as other regional and state polls conducted in the same time period.

that driver texting and other handheld device use (other than talking on a cell phone) is second only to alcohol in its negative impact on road safety (Ginsburg and others 2008).

Decision Making on High-Clockspeed Trends: NHTSA Criteria and Other Approaches

NHTSA officials state that they have specific criteria and that they have applied them consistently to decisions on the two trends we examine in this report, as well as to other decisions about highway safety. According to NHTSA officials,

- Their top criterion is evidence that the safety problem is large (of a size akin to lack of seatbelt use or alcohol use or lack of helmet use), and they have more evidence of this with respect to the “old” problems addressed by crash avoidance, such as cars running off the road or rear-ending other cars, than the new problem of electronic driver distractions.

- Their second main criterion is having a promising countermeasure to address the safety problem, and they have this for in-vehicle crash avoidance technologies that address issues, such as running off the road, but not in the case of electronic driver distractions—although NHTSA officials say they would work on exploring new strategies to address a problem once it is clear that the problem is large.

- In addition, NHTSA officials say that they take many other factors or criteria into account, as appropriate (costs, impacts on mobility, likely success in addressing the issue, diminishing returns from working on old problems, and so forth).

When we questioned NHTSA officials further about their current choice of the “no self-initiated response” option for electronic driver distractions, they listed decision criteria that represented possible constraints and that did not include considering the trajectory of this trend or its possible future phases.[56] They also said their decisions were made without using a formal risk management approach.[57]

[56]One possible source of information on new and future directions in technology development would be increased networking with associations or other sources in the electronics industry.

[57]A risk management approach can be broadly defined as “a strategic process for helping policymakers make decisions about assessing risk, allocating finite resources, and taking actions under conditions of uncertainty” (GAO 2008a, 1).

The approach to decision making that NHTSA described to us can result in its overlooking the potential significance of some high-clockspeed trends and possible ways of shaping or countering them. For example, the first main criterion—evidence of a large safety problem—does not allow for "worsening" problems (from high-clockspeed change) or difficulties in obtaining quantitative data on new problems (uncertainty). The second main criterion does not allow for exploratory research aimed at finding a promising countermeasure (and reducing uncertainty) until a problem has reached major proportions and been documented. Anticipatory risk management that embraces the uncertain environment that NHTSA faces is lacking in NHTSA officials' stated decision-making framework.

Furthermore, NHTSA may be inconsistent in selecting additional criteria to apply to new trends. For example, in the case of crash avoidance, NHTSA compared the safety gains that might be made using an old versus a new solution (that is, there was a sense of diminishing returns for crashworthiness, which might be reversed with a new technology) but this criterion may not be applied to all trends. Finally, although NHTSA officials explained their criteria to us, they had not documented them.

Foresight literature and our discussions with experts suggest a number of approaches to (1) reducing uncertainty to support decisions and (2) making decisions when substantial uncertainty exists. Both might be relevant to decisions on high-clockspeed trends. These varied approaches include the following:

- *Expanding existing networks as new trends develop.* Some industries may have been of limited relevance to old problems or long-established solutions but might provide early signals about new trends, such as information about new technologies "in the pipeline." Such information may help an organization anticipate new phases of a trend and potentially changing impacts (such as the changing safety impacts of driver distractions).

- *Anticipatory investing in research on ways to shape or counter new trends.* Prioritizing research responses to a new trend can produce information that reduces uncertainty about possible future action, should events prove to justify this. Anticipatory or preparatory research can facilitate timely action at a later date.

- *Clarifying criteria for action responses intended to shape "old" versus potential new solutions or to counter "old" versus new problems.* A number of different criteria may be applicable in different situations or may be appropriately balanced or combined in any one situation. Possible criteria include (1) the relative sizes of old and new problems; (2) diminishing returns from investments in old problems or old solutions, compared to potential returns from new investments; and (3) the cost-benefit ratio anticipated for a new research or action option.

- *Using a formal risk management approach that involves an anticipatory perspective.* Risk management frameworks suggest outlining various alternative responses to new trends and specifying the risks associated with pursuing them. For example, the risks of delaying action are higher—and an anticipatory approach may be more appropriate—when one or more of the following apply: (1) the trend in question has high clockspeed, (2) prospective interventions require long lead times, (3) high-stakes outcomes would be likely to be affected, and (4) a delayed intervention might allow negative developments to gain a foothold, making impacts difficult to contain or reverse.[58] In some cases, delaying research may rule out subsequent timely action.[59]

- *Considering adaptive strategies that avoid risky interventions based on a single, assumed future course of events.* Adaptive strategies are designed to change or evolve in response to new information as it becomes available. For example, an agency might plan back-up responses ("plan B" or "plan C") for use in the event that certain key ("plan A") assumptions fail. Another alternative that might be feasible in some cases is to choose an option that is robust in terms of its ability to work reasonably well across many—perhaps all or almost all—alternative future developments identified (see Popper, Lempert, and Bankes 2005 and Dewar 2006).

Developing new quantitative Level 3 evidence on the impact of new trends on safety could, if successful, reduce uncertainty, as discussed in the following section.

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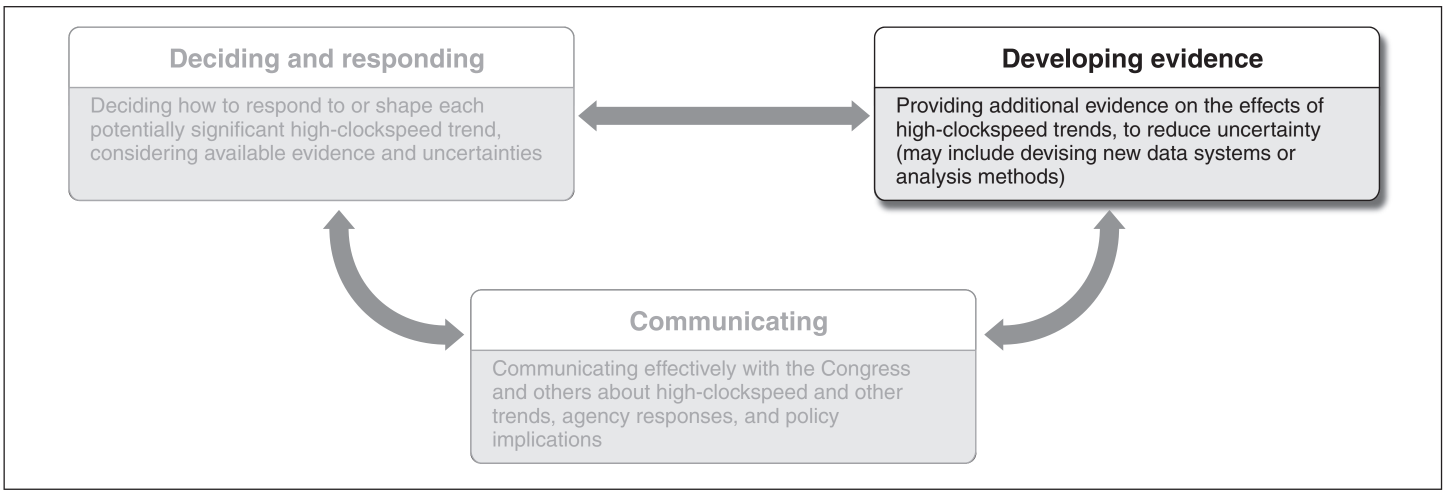
[58]With respect to high-stakes situations of this type, the precautionary principle, which is widely applied in the European Union, recognizes that government intervention beyond that normally justified by scientific evidence may be warranted if there are signals that a possible threat may, if unchecked, seriously harm the population.

[59]At the same time, some risk management experts have noted that such criteria may be appropriately balanced against the possibility that a trend may not develop as anticipated. For example, a trend that appears likely to carry a substantial future threat may, in time, be mitigated by unforeseen developments.

DOT Faces the Challenge of Devising Timely Measures of Change over Time

Developing strong quantitative evidence on the safety impact of a new trend—especially 21st century technology-based trends such as post-ESC crash avoidance technologies or electronic driver distractions—can be challenging. Long-standing methods may not be suited to studying new, high-clockspeed trends. However, successfully developing improved evidence can help decision makers by reducing a key source of uncertainty (see figure 15).

Figure 15: Exercising Foresight by Addressing High-Clockspeed Trends, with Evidence Development Highlighted



Source: GAO.

DOT has used both long-standing and newer methods to develop evidence on the safety impacts of crash avoidance technologies and electronic driver distractions. None are suited to producing strong quantitative evidence on safety impacts of high-clockspeed trends.[60] As defined here,

[60]Strong quantitative evidence is defined by figure 9 as Level 3 evidence.

such evidence combines three key characteristics: technical adequacy, timeliness, and the measurement of change over time.

- *Technical adequacy* includes validity, reliability, and generalizability, which are established methodological strengths for data and evidence in general and also relevant to producing evidence for foresight.[61]

- *Timeliness* is generally recognized as a strength of policy-relevant data.[62] Evidence that lags behind trends can result in decisions that are of fading relevance or that apply only to technologies or behaviors now replaced by newer ones. However, timeliness is a relative concept. In slow-changing areas, still-relevant data may have been developed in a 3-year project that was completed 5 or more years ago. But for high-clockspeed trends, timely evidence means recent evidence—for example, data or tests conducted during the previous year. More time-consuming methods of data collection or assessment would not be adequate.

- *Measurement of change over time* means tracking the trajectory of trends or their changing impacts and is related to timeliness. The measurement of change at relatively frequent intervals is an important characteristic of evidence on the impacts of high-clockspeed trends. If not updated at frequent intervals, the evidence will not be timely. Information on trajectories and currently changing impacts can suggest directions of future developments and can help shape forward-looking decisions and policies. However, tracking high-clockspeed trends requires repeated data collections at relatively frequent intervals. Unless methods are economical, repeated applications can be costly.

DOT has used both long-standing and newer methods in its attempts to develop evidence on post-ESC crash avoidance technologies and electronic driver distractions, but none combine all three characteristics discussed above.[63]

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[61]Validity refers to unbiased counts or measurement of what one intends to measure, reliability concerns reproducibility and consistency (that is, the achievement of similar results if the study were repeated using the same procedures), and generalizability refers to the applicability of study results to the population of interest.

[62]Recent research, such as a study by the Committee on National Statistics (2005), has recognized timeliness as a strength of high-quality policy-relevant data.

[63]We do not consider evidence development on VII here because it would be premature.

Existing Methods for Assessing Crash Avoidance Do Not Combine Technical Adequacy with Timeliness and Measurement of Change

Using NHTSA's NCSA crash datasets to test the safety effectiveness of new crash avoidance technologies can produce technically adequate data, as indicated in table 1. Notably, NHTSA earlier analyzed multiyear crash datasets to compare new or late-model cars with and without ESC and demonstrated a substantial ESC safety benefit.[64] However, NHTSA officials told us that this approach does not produce timely assessments of new crash avoidance technologies. Specifically, NHTSA estimated that, if it were to use its crash datasets, 5 to10 years would be needed to assess each technology. This would delay action to improve safety; moreover, by the time such assessments were issued, the tested technologies might have been replaced by newer versions. Lengthy assessments also make it difficult to measure change over time, because they essentially rule out repeated updates that track ongoing improvements in safety effectiveness.

Table 1: Methods for Assessing the Safety Impacts of Evolving Post-ESC Crash Avoidance Technologies Rated by Three Key Characteristics

	Characteristic applied in assessment			
Assessment method	**1. Is technically adequate**	**2. Is timely**	**3. Measures change over time**	**Assessment combines all three characteristics**
Long-standing: Analysis of crash data collected over multiple years (NCSA datasets)	Yes	No[a]	No[a]	No
Newer: Field operational tests with complex technologies (measures driver performance, not crashes)[b]	Not fully[c]	Yes	No	No

Source: GAO.

[a]It would take several years to amass sufficient data to test each new technology that evolves, thus ruling out the possibility of tracking changes as they occur from year to year.

[b]Field operational tests involve NHTSA or another DOT agency or contractor outfitting a limited number of cars with instruments such as cameras, sensors, and recorders to track driving experiences.

[c]There is some disagreement on whether studies involving cameras, sensors, or other technologies for intensively recording data change driver behavior. Some researchers told us that when drivers know they are being closely observed, they may not behave as they otherwise would; however, advocates of naturalistic studies said that many drivers become used to cameras and disregard them.

Using NHTSA's crash datasets to assess new in-vehicle technologies would involve lengthy time periods because a single year of new-car crash data from these datasets is not sufficient for making meaningful comparisons of crashes with and without the technology:

[64]The analysis separated crash data for vehicles with and without ESC and then, for these two vehicle groups, compared ratios of fatal crashes of the type addressed by ESC to other fatal crashes.

- initially, only some new cars are equipped with a particular new technology and newly purchased cars represent a relatively small percentage of cars being driven, and
- rather than encompassing all serious crashes, NHTSA's ongoing crash datasets are limited to either (1) the fraction of crashes that are fatal (the FARS dataset) or (2) a sample of more broadly defined serious crashes (the National Accident Sampling System's Crashworthiness Data System or NASS CDS).[65]

Additionally, states may take several months to collect, process, and report data to NHTSA, after which NHTSA researchers further process and analyze them. As a result, NASS CDS data are typically available in draft form, 9 months after the quarter in which a crash occurred.

To achieve more timely assessments of crash avoidance technologies, NHTSA used FOTs. Although FOTs produce some useful data, their small sample size limits results and means that driver performance measures, not crashes, must be used as the outcome. Notably, for LDW and FCW, the FOTs were not extensive enough for analysts to specify the magnitude or level of safety benefit that each technology provides. Recently, NHTSA combined FOT data with other information on the frequency of various types of crashes to project quantitative levels of "safety effectiveness." (In the previous section, we classified these projections as Level 2 evidence; the projected benefits were much smaller than demonstrated for ESC.) Additionally, a NHTSA official told us that FOTs using complex tracking technologies are relatively expensive, so from a practical cost perspective, it would be difficult to repeat them each time a new technology (or an improved version of recent technologies) is introduced.

Existing Methods for Assessing Distractions Do Not Combine Technical Adequacy with Timeliness and Measurement of Change

DOT encountered technical adequacy problems with both long-standing methods used to measure new driver distractions (see table 2):

- Crash datasets maintained by NCSA miss an unknown number of precrash distractions, since these may be hidden from police and investigators or may not be recorded on police accident reports.[66]

[65]We describe these and other datasets maintained by NCSA in appendix VI.

[66]We outline selected NCSA crash datasets in appendix VI.

- Roadside observations of driver phoning, as part of the National Occupant Protection Use Survey (NOPUS) that NHTSA developed earlier to measure seatbelt use, are likely to miss instances of hands-free phoning when drivers use earpieces or speakerphones.[67]

Table 2: Methods for Assessing the Safety Impacts of Evolving Electronic Driver Distractions Rated by Three Key Characteristics

	Characteristic applied in assessment			
Assessment method	**1. Is technically adequate**	**2. Is timely**	**3. Measures change over time**	**Assessment combines all three characteristics**
Long-standing: Analysis of data in NCSA crash datasets	No	Potentially, yes[a]	Potentially, yes[a]	No
Long-standing: Surveys of driver behaviors: observational and landline	No	Yes	No[b]	No
Newer: Naturalistic studies using cameras, sensors, and other tracking technologies[c]	Not fully[d]	Potentially, yes	No	No

Source: GAO.

[a]Because the population of drivers using portable electronic devices is extensive (and includes drivers of new and older cars), analyses focused on electronic driver distractions could be conducted using fewer years of data than would be required to assess new-car safety technologies.

[b]To the extent that hands-free phoning and cell-phone-only households are increasing, estimated trends would be invalid if based on either roadside observations that missed hands-free phoning or landline phone surveys that missed cell-phone-only households.

[c]Depending on the size of the study, near misses, not crashes, may be used as the outcome.

[d]Researchers disagree on whether subjects in such studies may change their behavior because they know they are being observed.

Newer methods of developing evidence on this trend are also not fully adequate. NHTSA told us that it is attempting to identify new technology that might improve future roadside observations—that is, technology that might be able to detect (from the roadside) whether a cell phone transmission is in progress. Most recently, NHTSA adjusted its observations-based estimate, using responses in a telephone survey, based on a sample of landline households. Key responses concerned how often drivers used handheld versus hands-free phones. One issue is that this landline telephone survey omits cell-phone-only households. According to a survey contractor we consulted, the omitted cell-phone-only households represented about 15 to 18 percent of the adult population and 20 to 30

[67]The NOPUS dataset is described in appendix VI.

percent of groups such as young adults—and omitting such households can yield biased estimates of behavior such as technology adoption.[68]

To better assess the safety impact of driver distractions (as well as to understand other aspects of how crashes occur), DOT pioneered naturalistic studies in which video cameras, other sensors, and recorders are installed in participating drivers' personal cars. Each car is then tracked over time, so that recordings provide analysts with volumes of detailed video and other data. Although smaller-scale studies of this type, such as the 100-car study and an ongoing study of teen drivers, can provide important insights into safety processes, results for crash risk are limited because of the small size of these studies.[69]

Larger-scale studies of this type can produce more technically adequate estimates of crash risk. TRB, in cooperation with DOT, is designing a 2,500-car study to measure many aspects of safety and driver behavior, including driver distraction. DOT officials anticipate that assuming the 2,500-car study is successfully fielded, it is likely to

- provide a useful snapshot of the nature of distracted driving behavior and the magnitude of the effect that distracted driving has on actual crashes as of 2009 to 2010[70] and
- test the validity of substituting near misses for actual crashes in analyses of specific kinds of driving or crash situations).[71]

Fieldwork on the 2,500-car study will begin in 2009 or 2010.[72] However, equipping large numbers of vehicles with cameras, sensors, and other equipment is costly and, therefore, in the opinion of a TRB official and a

[68]The percentage of adults living in cell-phone-only households has been steadily increasing (Blumberg and Luke 2008).

[69]With small samples, it is difficult to determine whether patterns observed occurred by chance alone.

[70]One caveat is that the results of this study may not be generalizable to the entire United States, in part because the study will be conducted in three or four geographic areas.

[71]For selected analyses, analysts will compare two sets of results from the 2,500-car study: those based on actual crashes and those based on near misses.

[72]Differences between the design of the 100-car pilot study and the 2,500-car study—mostly improvements instituted in the 2,500-car study—make it difficult to develop comparisons of data from the two. An additional future study, designed to be comparable to the 2,500-car study, would be needed to validly track change over time.

NHTSA official, it will be a challenge to fund similar studies in the near future.[73]

Given experience with naturalistic studies designed to date, the high cost of larger-scale versions of naturalistic studies appears to be limiting. The future of smaller-scale naturalistic studies may depend, in part, on how well, or under what conditions, near misses are shown to be valid surrogates for actual crashes. Additionally, estimates of the impact of driver distractions based on naturalistic studies may not be directly comparable to estimates of the impact of elevated driver blood alcohol content, based on crash datasets, because naturalistic studies exclude some dangerous drivers who are included in crash datasets.

The newer methods tried to date have the potential to meet the timeliness criterion but have not so far been suited to measuring change over time. Specifically, it seems unlikely that large-scale naturalistic studies such as the one described above will be repeated and, therefore, it is also unlikely that studies like this could be used to track changing impacts of evolving electronic distractions over time (that is, meet the criterion of tracking change).

Meeting the Evidence-Development Challenge for High-Clockspeed Technology Trends

Developing high-quality evidence on the impacts of high-clockspeed technology-based trends is considerably more difficult than continuing to study long-established or slow-changing safety technologies or behavioral issues. This is because the criteria above—in particular timeliness and tracking change over time—are more important for high-clockspeed trends. In addition, new kinds of safety technologies may be sufficiently different from older technologies that previously developed assessment methods cannot be applied.[74] In addition, methods must be flexible enough to work across multiple stages of an evolving trend. Technologies or behaviors may change as trends evolve, so that—in at least some cases—

[73]A TRB official stated that this study, as originally proposed, was to include 4,000 cars tracked over 3 years but, for budgetary reasons, was cut back to 2,500 cars tracked for 2 years.

[74]For example, barrier crash tests are not suited to assessing crash avoidance technologies, and the crash datasets are not suited to achieving valid counts of crashes in which drivers were using electronic devices, such as hands-free phones or texting.

methods that worked at an early generation or stage may not be suited to studying a later one.[75]

Some examples of the kinds of new data systems or analyses that might address these issues were suggested by experts we talked with as well as the literature that we reviewed, including a recent NHTSA-sponsored report. We have not determined the costs of such systems. The systems and analyses include

- *A new research tracking system, with equipment built into new cars—provided that appropriate privacy protections are designed and incorporated.* OnStar™ tracks crashes for cars equipped with OnStar™. Recent General Motors models with OnStar™ can track all crashes involving a certain level of impact (with and without airbag deployment). Crash data are sent wirelessly to a remote location, where they are analyzed by OnStar™ researchers to determine if ways may exist to design safer vehicles. Logically, similar technology might be used to track crashes for most or all new cars in the future.[76]

- *Use of new or developing technologies to track driver use of electronic equipment—in general and in relation to crashes—provided that, where needed, appropriate privacy protections are designed and incorporated.* Varied technologies now available or under development can potentially (1) help roadside observers detect cell phone use in passing cars or (2) otherwise allow researchers to track driver use of cell phones, including whether they were phoning just before a crash (Brennan, Adi, and Campbell 2008). NHTSA officials told us that NHTSA is investigating the former. The latter is more speculative in that it would require installing special equipment in each car to be tracked; however, it has the advantage of being able to distinguish driver use of a device from passenger use and voice transmissions from data transmissions.

- *Statistical models that combine varied data and can support simulated premarket testing.* Recent conference papers and a DOT-issued report by a NHTSA contractor outline the possibility of models

[75]For example, NOPUS roadside observations of electronic driver distractions worked for driver use of handheld portable phones but not for more recent, more difficult to observe uses of electronic devices.

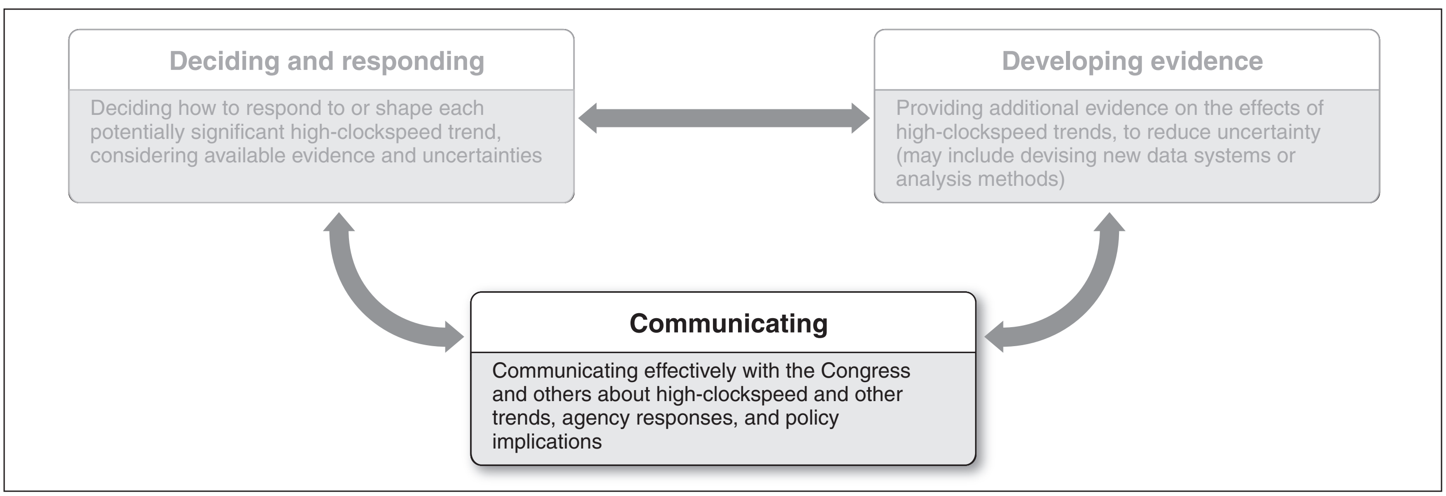
[76]We have not researched the privacy issues or solutions relevant to such a tracking system.

that would detail precrash and crash descriptors (starting with precipitating events such as a car's drifting out of its lane, proceeding to the driver's attempting to avoid a crash, and then to the first harmful event, and so forth). Such models would allow researchers to combine data from NHTSA's crash datasets and naturalistic data to, for example, define scenarios for use in designing test-track assessments of new crash avoidance technologies (Burgett, Srinivasan, and Rangunathan 2008).

DOT Faces the Challenge of How and When to Communicate Information on Trends to the Congress

A final challenge for DOT is to effectively inform stakeholders, including the Congress, about the implications of high-clockspeed technology trends (see figure 16). These trends could have an impact on key decisions made during the reauthorization of funding for surface transportation programs. While DOT recently developed a framework to prompt deliberation by the Congress and other stakeholders, this framework and DOT-wide planning and accountability materials are not designed or intended to provide a long-term view or comprehensive analysis of trends that could affect highway safety in the future—including evolving crash avoidance technologies and rapidly changing electronic driver distractions—and their interactions and implications for the years ahead.

Figure 16: Exercising Foresight by Addressing High-Clockspeed Trends, with Agency Communication Highlighted



Source: GAO.

In addition, DOT has not synthesized the results of its various foresight efforts in order to show how overall trends might impact highway safety in 2020 and beyond. Some of DOT's own practices and other models from the

United States and abroad might provide strategies for communication specifically intended to inform and update the Congress about trends with the purpose of enhancing or supporting foresight in decision making.

DOT Provides Limited Information on Highway Safety Trends in Reauthorization Framework and GPRA Materials

We have reported that an agency's assessment of trends or factors that are external to its environment may help the Congress in judging the likelihood of achieving strategic goals and actions needed to meet those goals (GAO 1997, 18). Information on external trends or factors can also enable an agency to explain why performance goals are not met.[77] And according to one expert, a detailed analysis of long-range trends can provide support for government, including congressional, decision making. Available mechanisms for the provision of such information include the reauthorization of funding for programs and GPRA-related documents, such as the strategic plan and performance and accountability report.

According to DOT officials, DOT formally communicated to the Congress in advance of reauthorization, on July 29, 2008, putting forth a framework intended to spur local, state, and federal debate about the way U.S. transportation decisions and investments are made (DOT 2008b). According to DOT, "ongoing demographic, economic, technological, political and institutional trends have major implications for our Nation's transportation system now and well into the future." With respect to safety, DOT "heavily emphasize(s) the potential of various crash prevention technologies to significantly reduce highway fatalities." The document does not provide information on trends beyond the references above that could be used by the Congress.

In terms of a future horizon, DOT's strategic plan acknowledges future long-term trends with the inclusion of VMT and demographic projections for periods ranging from 2030 to 2050 but does not address how other new and emerging trends might affect highway safety beyond the plan's 6-year projection. DOT has met the GPRA requirement that agency plans cover a period of not less than 5 years forward from the reporting fiscal year.

[77]GPRA requires that strategic plans contain "an identification of those key factors external to the agency and beyond its control that could significantly affect the achievement of . . . goals and objectives." Such factors, according to Office of Management and Budget Circular No. A-11, may remain stable, change "within predicted rates," or vary to an unexpected degree.

An Overall Context That Considers Multiple Trends Is Lacking

According to DOT, "interrelated facets of the transportation problem . . . must all be considered together in evaluating the complete costs and benefits of transportation measures."[78] We found limited attention in departmentwide materials to laying out such interactions and their implications for the future, either in recent, focused reviews conducted in response to congressional interest or in planning and accountability materials issued on a continuing basis.[79] The recent DOT *1.0 Fatality Rate Goal* report cited the example of aging of baby boomers and rising fuel prices as they might affect motorcycle fatalities in the near-term future (DOT 2008a).[80] It did not explicitly discuss how trends might interact to either positively or negatively affect highway safety in a future beyond 2011.

The *DOT 1.0 Fatality Rate Goal* report also did not include information on the trend of electronic driver distractions, which is important for understanding the interaction of multiple trends. Relevant information is included in a NHTSA-sponsored review of literature on driver distractions initiated in response to the conference report for the 2006 DOT appropriations bill. The NHTSA-sponsored review discussed cell phones as "the contemporary icon of driver distraction," summarized the results of existing studies, and acknowledged that problems may increase from (1) the continually increasing number of cell phone users and (2) the "secondary use" of cell phones for activities other than talking, such as text messaging by teenage drivers who may lack fully developed driving skills (Ranney 2008). As a result, "we may expect to observe a synergistic acceleration in the resulting safety problem." Despite being in the NHTSA-

[78]Citing the tradeoff between safety and mobility, a DOT official discussed the following examples: safety can benefit from congestion because drivers are traveling at lower speeds; safety can suffer from efforts to alleviate congestion by widening highways because such modifications are conductive to higher speeds. (DOT also told us that congestion can result in a high differential in speed, which could cause crashes.)

[79]DOT planning and accountability materials include the strategic plan, performance and accountability report, and budget proposal.

[80]This report, a collaborative effort by FHWA, FMCSA, NHTSA, and the Office of the Secretary, discussed why DOT did not meet its 2008 fatality reduction goal and how its programs could achieve its 2011 goal (1 fatality per 100 million VMT). Four fatality submeasures were established—passenger vehicle occupants, nonoccupants, motorcycle riders, and large-truck and bus-related fatalities. The purpose of this approach is to more closely examine the fatality rates of the different segments of highway users and "devote greater energy and resources and develop new strategies to combat sub-measure trends that are impeding progress to the overall 1.0 goal." The report noted that "by isolating fatalities by class of road user, the Department believes that it has the greatest opportunity to develop appropriate new strategies to address the factors and behaviors that cause each type of fatality."

sponsored review, such observations were excluded from the *DOT 1.0 Fatality Rate Goal* report.

DOT's GPRA-related documents focus their discussion on well-established trends, such as the aging of the U.S. population, and do not address how interrelated trends related to the transportation system as a whole could affect highway safety. In addition, they are not designed to discuss the implications of trends (whether well-established or in the early stages of development) in a detailed fashion. GPRA and related OMB guidance do not require such specificity in these materials.

In the past, DOT initiated major efforts aimed at understanding multiple trends as part of the broad scope of change affecting transportation and considered highway safety within this context. For example, the Secretary of DOT initiated a series of "2025 Visioning Sessions" with hundreds of transportation stakeholders around the country on how transportation would be likely to change in the next 25 years. The results of such sessions provided input for two reports DOT issued in 2000: *The Changing Face of Transportation* and *Transportation Decision Making: Policy Architecture for the 21st Century* (DOT 2000a, b). The first report outlined major trends expected to unfold in the next 25 years, and the second provided a framework to support decision making in transportation.[81]

More recently, the Office of the Secretary convened policy salons intended to educate DOT officials and staff on broad transportation trends, with some attention to highway safety developments, such as GM's technology plans for the future, but this effort no longer exists and no report was issued analyzing the results of these sessions for use by Congress and stakeholders outside the Department.[82]

[81] A 1997 effort specifically focused on the future of highway safety that has not been updated is the *NHTSA 2020 Report* on trends that could affect highway safety in the year 2020 (see DOT 1997).

[82] DOT also told us that RITA's Bureau of Transportation is revisiting some of its long-term forecasts published in *The Changing Face of Transportation* (DOT 2000a). By incorporating more recent annual data, the bureau is reviewing the accuracy of the previous forecasts and will update trends based on the new data.

Future-Oriented Efforts at DOT Are Not Synthesized for Use by the Congress

We found that while the *DOT 1.0 Fatality Rate Goal* report provided a valuable description of current initiatives and strategies, information from future-oriented or foresight efforts throughout DOT has not been fully captured by this report. Such efforts have produced information to meet planning and other mission-specific needs of various administrations. DOT has not synthesized information from these various documents or presented such a synthesis to the Congress. Table 3 gives examples of DOT future-oriented efforts.

Table 3: Examples of Foresight across DOT

Type of foresight activity	DOT administration and effort	Horizon	Purpose or target	Highway safety addressed?
Vision development	RITA, A Vision for Transportation[a]	2030	Context-setting for DOT transportation research, development, and technology investments	Enunciates principles; highway safety and relevant technology developments described in context of overall transportation system
Trend analysis, scenario development, and operational implications	FMCSA, Motor Carrier Study 2025[b]	2025	FMCSA planning	Addresses highway safety in terms of FMCSA mission and provides detailed analysis of technology and other trends that could affect safety in the motor carrier industry
Use of experts to identify future trends in transportation	FHWA, Advanced Research "Think Tank" Forums[c]	2050 as context	Developing an advanced research plan	Not explicitly; FHWA officials noted that the overall effort prompted subsequent discussion at FHWA on the need for and development of a conceptual framework for highway safety at DOT
Technology scanning[d]	FHWA, International Highway Technology Scanning Program	Ongoing	Disseminate best practices	Addresses various facets of highway safety
Unintended consequences	NHTSA, Human Factors Forum on Advanced Vehicle Safety Technologies[e]	January 2007 workshop	Identify research priorities through interaction with stakeholders	Elicited stakeholders' comments on unintended consequences of crash avoidance technologies and prioritized items for future research

Source: GAO.

Note: DOT told us that another example of a foresight activity is a current BTS effort to revisit its earlier long-term forecasts, review their accuracy, and update them.

[a]DOT 2008c.

[b]Internal report prepared for FMCSA.

[c]These forums are described in Asmeron and McRae 2006.

[d]As defined by FHWA, scanning features the formation of expert teams (managers and specialists in a particular discipline) that travel abroad to consult with foreign counterparts in other countries where advances in transportation relevant to the United States are being made. Scan team members typically represent FHWA, state departments of transportation, local governments, transportation trade and research groups, the private sector, and academia. When a scan is completed, team members evaluate findings and develop a comprehensive report that is circulated throughout the U.S. highway transportation community. The team also develops an implementation plan that summarizes its strategy for implementing the most significant and promising technologies and policies the scan identified. According to FHWA, to accelerate early implementation activities, the scan program supports teams with implementation expertise and funding when they return to the United States.

[e]These issues are discussed in Wochinger and others 2008.

One example, in 2006, was FMCSA's commissioning a study to consider likely forecasts of future industry scenarios in 2025 in order to learn how its current programs, policies, management, and operations could be adjusted to better achieve safety objectives in the next two decades.[83] With historical trends and forecasts providing the basis for scenario development, the resulting study reviewed current FMCSA programs and initiatives to determine whether the administration was well positioned to respond to some of the scenarios. For example, the study assessed the extent to which CSA 2010, a new operational model for FMCSA intended to reduce crashes, fatalities, and injuries related to commercial motor vehicles will affect various scenarios ranging from driver fitness to technology improvement. And after describing a technology-related scenario, the study discussed implications for FMCSA operations, such as human capital and future operational needs and assigned responsibility to FMCSA's Office of Administration in this regard.[84]

Activities such as these are carried out on a one-time basis for a specific purpose and are generally not formally transmitted to the Congress. We did identify some examples in which DOT carried on the development of foresight information in a continuous fashion, but as is the case with the activities we have described, they have not been synthesized for use by the Congress. In addition to FHWA's ongoing development of scans targeting specific issues, NHTSA has developed an ongoing process for eliciting comment on the inclusion of future technologies in NCAP. FHWA's

[83]Internal report prepared for FMCSA.

[84]The report concluded that technological innovation will drive the "next wave of change in the trucking industry." Such innovation includes new vehicle technologies, new driver technologies, system integration, expanded data exchange, and "more sophisticated" statistical analysis of available data. In response, FMCSA should determine whether it has staff possessing the technological knowledge and skills to implement data collection, maintenance, and exchange programs and to develop platforms to support such programs.

International Technology Scanning Program is characterized by an assessment of innovations and practices abroad; it began in the early 1990s. The program has published the results of scans of innovative technologies and practices in other countries that could significantly benefit U.S. highway transportation systems. Such scans could lead to the development of new strategies. For example, after a scan of highway safety information systems in other countries, FHWA safety officials developed a white paper detailing a strategy and steps for further action, including the involvement of multiple stakeholders (FHWA 2006c).

Another scan is intended to survey policy approaches that could improve U.S. roadway safety for older users and, consequently, all road users.[85]

Like FHWA, NHTSA has attempted to stay abreast of international developments, such as those with implications for establishing fatality reduction goals and managing trends related to crash avoidance. For example, in 2007, the director of traffic safety in Sweden and chair of the European New Car Assessment Programme (Euro NCAP) briefed DOT officials on the Swedish approach to fatality reduction known as Vision Zero, as well as trends in Euro NCAP. More generally, officials told us they attend conferences and network with key stakeholders to gain an understanding of technology and behavioral developments relevant to highway safety.[86] NHTSA officials have disseminated results in conference presentations and articles that suggest options for action. In addition, NHTSA has communicated with stakeholders on how it plans to address the trend of in-vehicle crash avoidance. For example, NHTSA developed a January 2007 proposal published in the *Federal Register*, followed by a public hearing that provided the public with the opportunity to comment. The final notice synthesized what was learned and it described NHTSA's final requirements. A similar process will be used before new technologies are included in the future.

[85]Recent FHWA safety-related reports are FHWA 2003; 2005; 2006a; 2006b.

[86]This has ranged from attending technology-oriented meetings, such as those hosted by the Society of Automotive Engineers and ITS America, to the annual Lifesavers Conference, which reports on emerging developments in behavior by members of high-risk groups. (ITS refers to intelligent transportation systems.) A senior NHTSA official responsible for research on behavioral issues described ongoing liaison efforts with groups such as the Governors Highway Safety Association and the Centers for Disease Control and Prevention. NHTSA officials responsible for research on vehicle safety said they network extensively with suppliers and automobile manufacturers, meeting periodically at DOT headquarters to understand the potential of new technology for vehicle safety.

DOT Faces a Foresight Communication Challenge

DOT faces the challenge of conveying the potentially difficult issues posed by high-clockspeed trends and the complexity of forces that could affect highway fatalities in the mid-term and long-term future. Additionally, such information would ideally be provided in a timely fashion for congressional deliberations. Experts we consulted with emphasized the importance of timing and suggested the need to reexamine DOT's capability for producing such information.

We have suggested the value of a systematic, organized approach to guiding the development of information in the area of program evaluation (INTOSAI 2007). In a December 2007 report, we noted also that a set of analytical tools can help policymakers transform government to better meet the demands of the 21st century (GAO 2007). According to that report, the consistent use of these items will help policymakers (1) reach consensus on the outcomes Americans most want their government to achieve, (2) increase transparency and accountability, (3) better prioritize competing demands, (4) make more informed decisions, and (5) modernize federal operations and management. An example of this approach might be adapting GAO's framework for exercising foresight for communications with the Congress.

In addition to conceptual frameworks such as those developed for this report, DOT could consider the value of foresight tools for enhancing communication to the Congress on fast-paced and complex trends that require responses by multiple stakeholders. These could include

> ***Technology and policy roadmaps that describe multiple trends, multiple governance options, and the responsibilities of multiple parties***
>
> The technology roadmap can be used to illustrate the nature, rate, and direction of future science and technology developments related to in-vehicle, vehicle-to-vehicle, and vehicle-road technologies and systems (FURORE 2003). An expanded version could include attention to electronic driver distractions.
>
> A policy-oriented version of the roadmap tool illustrates one model illuminating strategic responses and options for action, as well as communicating organizational responsibilities. DOT's "Hydrogen Roadmap" was developed in 2005 as the guiding document for the DOT Hydrogen Safety Research, Development, Demonstration, and

Deployment programs (DOT 2005). It serves as an outreach document for communication, coordination, and collaboration with other federal agencies, industry, the public, and the Congress.[87]

Foresight methods that inform strategy development by addressing multiple trends

One technique, known as backcasting, generates alternative scenarios for achieving a desired future goal, such as President Kennedy's goal of placing a man on the moon. Backcasting can account for sources of uncertainty and inform deliberations about how to design the most robust strategy for achieving that goal. Another technique is that of technology assessment, which provides a formal analysis of the implications of technology developments and can include an understanding of the unintended consequences of new technologies.

Using foresight methods within an organizationwide capability

The foresight program in the United Kingdom's Government Office for Science uses a model for conducting foresight studies that stresses the importance of an evidence-based approach and includes attention to multiple trends. In addition, stakeholders are involved both during and after a study is conducted. This unit first identifies an emerging development, such as obesity or intelligent infrastructure systems for transportation; describes the range of factors influencing this development and the interaction of such factors; and identifies opportunities for policy intervention. The unit develops scenarios that can then be used to explore the potential effect of different response options. Stakeholders are involved at each stage, from identifying issues to making action plans. They can

[87]The four roads discussed are safety codes, standards, and regulations; infrastructure development and deployment; safety education, outreach, and training; and medium- and heavy-duty vehicle development, demonstration, and deployment. The map for each road includes four areas: anticipated long-term outcomes (11 to 20 years); challenges and requirements; pathways, projects, and products; and timelines.

include local governments, various ministries within the U.K. government, research associations, and industry groups.[88]

Transportation and foresight experts, as well as DOT officials, cited the importance of communicating information on trends and their implications through the reauthorization of funding for surface transportation programs, and they highlighted the importance of timely information for use in this process. Our interviews and review of the foresight literature indicate the importance of identifying which future horizon is appropriate for study; integration with strategic planning and performance measurement processes; developing, testing, and disseminating new methodological approaches so as to inform both action and evidence on emerging trends in the future; providing an ongoing monitoring function; and working with a wide range of stakeholders.[89]

Transportation experts we interviewed, as well as DOT officials, noted the value of reexamining the potential of existing resources within the department for ongoing multimodal or goal-specific trend identification, analysis, and communications. According to DOT, these resources include RITA's Volpe Center and BTS.[90] By better harnessing such resources, as experts noted, DOT and its administrations could enhance their ability to understand and communicate the implications of 21st century trends relevant to highway safety.

Conclusions

High-clockspeed technology trends may shape the future of highway safety, and timely action may be needed to pursue opportunities and counter threats. In instances where data are somewhat limited, DOT has sometimes taken action—for example, incorporating information on lane departure warning and forward-collision avoidance systems on NCAP's new-car labels and pursuing safety applications for vehicle-road communications, such as warnings. But while pursuing the potential

[88]For example, the review of intelligent infrastructure systems resulted in the Minister of State for Transport setting out next steps for stakeholder testing of policies for robustness. The scenarios are used to effectively manage long-term risks while taking advantage of opportunities.

[89]For example, it is key to include an ongoing function and involvement with foresight throughout an organization (Grim and Reif 2008).

[90]DOT told us that BTS's Trending and Forecast Team analyzes long-term and short-term trends on key transportation indicators.

opportunity represented by new crash avoidance technologies, DOT decided that at this time it will not self-initiate (1) empirical research on countermeasures for electronic driver distractions or (2) actions to counter this threat. However, DOT has conducted and sponsored a variety of research studies aimed at understanding the process of distraction and the impact that electronic distractions may have on safety. Appropriate decisions are needed for responses to both opportunities and threats and it is important for decision-making criteria to be clear and transparent, to be well documented, and—in the case of new trends for which definitive safety information is lacking—to address issues of uncertainty. Given the uncertainties that characterize high-clockspeed trends, a number of relevant approaches such as anticipatory risk management (which could consider the risks, for example, of taking no action on a somewhat uncertain but potentially damaging trend) could help avoid situations in which highway safety is improved in one area but deteriorates in another.

Additionally, DOT and others emphasize obtaining high-quality evidence and using this as a basis for decisions, wherever possible. DOT's established methods of collecting high-quality safety data—as well as some innovative, newer methods that DOT has used—may not be sufficiently timely or otherwise suitable for studying the safety impacts of rapidly changing technology-based trends. It remains unclear whether DOT's current data collection systems can adequately track new trends and their impact on highway safety. To enhance safety with informed decision making and the best possible data (data to better establish the size of a new safety problem, for example, or the trajectory of its changing size), new approaches to developing evidence—such as using wireless technology to automatically collect data on crashes or DOT-wide guidance on using data in decision making on highway safety—would help determine when it is appropriate for a DOT administration to undertake action-oriented research, initiate consumer education programs, or take various kinds of actions specific to emerging or evolving trends that affect highway safety.

Finally, DOT's communication with stakeholders, including congressional policy makers, about future highway safety trends might be more comprehensive and timely. In particular, by providing comprehensive and timely information about what is known on trends for which it believes the data are insufficient, DOT could provide the Congress and others with potentially important information they could use in determining how to set national funding and research priorities, especially as the next process for reauthorizing surface transportation funding approaches. Consideration of U.S. and international models for communicating and developing information, as well as frameworks such as the one we have developed, could help DOT determine how to structure information for the Congress, even when data on new safety trends are unclear.

Recommendations for Executive Action

In order to develop an approach to decision making and the development of evidence on high-clockspeed trends affecting highway safety that are characterized by uncertainty, we recommend that the Secretary of Transportation consider and evaluate practices and principles for making decisions under conditions of uncertainty and for using data in such decision making and, on that basis, develop an approach to guide decision making on high-clockspeed trends that, although somewhat uncertain, may affect highway safety. We further recommend that the Secretary of Transportation evaluate whether or not new approaches to data collection are needed to better track new trends related to highway safety.

In addition, in order to improve the information available to the Congress for reauthorization, we recommend that the Secretary of Transportation (1) analyze and report on trends currently anticipated to affect highway safety through 2020 and beyond in a systematic fashion—including information on high-clockspeed trends, discussion of evidence about these and other individual trends, their implications and potential interactions, and DOT responses—and (2) determine, in consultation with relevant congressional committees, schedules for periodic reporting that will be sufficiently frequent to update the Congress on fast-changing trends.

Agency Comments and Our Evaluation

We provided a copy of a draft of this report to the Secretary of Transportation for review and comment. DOT provided written comments (see Appendix X). DOT disagreed with our recommendation that the Secretary develop a new approach to guide decision-making under conditions of uncertainty. Specifically, DOT states that (1) future developments are difficult to foresee; (2) the application of a new decision-making approach that takes account of uncertainty would require extremely large amounts of data, sophisticated analytic tools, skilled practitioners, and significant investment of resources—and would divert substantial resources from ongoing DOT work addressing proven safety problems; and (3) new approaches to decision-making would not provide the rigorous results needed for regulatory action.

We continue to recommend that the Secretary of Transportation develop a new decision-making approach for the following reasons.

- Although future developments are difficult to foresee, the decision-making approaches we discuss include strategies that avoid interventions based on a single assumed future course of events. Such strategies do not require foreseeing specific future developments. Rather, they recognize uncertainty—based on limited evidence and the possibility of alternative future developments. For example, in this report we describe strategies that literature and experts have suggested, including (1) developing optional plans, such as "Plan A" and "Plan B," so that either can be used depending on how the future unfolds; and (2) choosing robust solutions that are expected to work reasonably well across multiple possible future developments.

- While DOT pointed to a need for large amounts of data, skilled practitioners, and other requirements, DOT has undertaken foresight efforts in the past despite these challenges. For example, as discussed earlier in this report, DOT reported trend analyses in *The Changing Face of Transportation* (DOT 2000); additionally, DOT's Volpe Center recently applied the "technology roadmap" to identify potential safety issues in the development of new materials for use in automobiles (Brecher 2007). Further, we believe a new decision-making approach would not require DOT to shift significant resources away from current efforts to address established safety problems. Some responses to new or evolving trends may be relatively low cost. For example, a relatively low-cost response to an evolving trend that the states are beginning to address might be a research project that compares levels of success under different programs that have been adopted in various states; the results could then be provided to the states, including those states that are currently considering similar programs.

- We agree that DOT regulatory action requires rigorous evidence and recognize that developing timely, rigorous evidence on new trends may be challenging. However, governance tools other than regulatory action are available for shaping or countering such trends. Conducting exploratory research on how to effectively shape or counter a trend may inform future decision-making at the federal or the state level. (See figures 9, 11, and 13 of this report, which outline a range of governance tools.)

Additionally, DOT notes that it is addressing the older driver trend, as described in a recent GAO report. We agree that DOT is making anticipatory decisions in some cases (and this report describes DOT efforts to shape the development of crash-avoidance technologies). However, we continue to recommend that DOT develop a new approach to guide its decision making on high-clockspeed trends because DOT is currently addressing some trends that affect highway safety and not others, without basing these decisions on criteria designed to take uncertainty in account.

DOT did not specifically comment on our recommendation regarding new methods for developing more timely evidence on high-clockspeed trends or our recommendation for improved communications with Congress and other stakeholders.

DOT disagreed with the wording of our draft conclusion regarding its response to fast-evolving electronic driver distractions. We reworded this conclusion to clarify that DOT has researched the process of driver distraction and the safety impact of electronic distractions, but is not at this time self-initiating empirical research on countermeasures (for example, it is not evaluating the effectiveness of existing countermeasures).

Finally, DOT provided technical comments, which we addressed throughout this report, as appropriate.

We are sending copies of this report to interested congressional committees, the Secretary of Transportation, and the Administrators of NHTSA, RITA, FHWA, and FMCSA. We will also make copies available to others on request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions, please contact Nancy Kingsbury at (202) 512-2700 or kingsburyn@gao.gov or Katherine Siggerud at (202) 512-2834 or siggerudk@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs are on the last page. GAO staff who made contributions to this report are listed in appendix XI.

Sincerely yours,

Nancy R. Kingsbury
Managing Director, Applied Research and Methods

Katherine A. Siggerud
Managing Director, Physical Infrastructure Issues

Appendix I: Exercising Foresight: Three Agency Activities and Related Challenges

Addressing high-clockspeed trends with the purpose of aiding future progress toward basic goals—across a time horizon extending more than 5 years forward—is one way that an agency can exercise foresight.[1] Three agency activities are relevant:

- *Deciding how to respond to trends that can affect important future outcomes.* Statements of the Comptroller General of the United States and foresight literature have urged that current decisions or near-term actions be taken with the purpose of shaping future outcomes (see Walker 2005; Dewar 2006; Rejeski 2003). According to risk management experts and strategic planning literature, goal-achievement efforts should include responses to both opportunities and threats (Harvard Business School 2005, ch. 1).
- *Developing additional evidence on such trends.* The Comptroller General stated that an evidence-based approach to planning for the future is essential to helping policy makers expand their time horizon (Walker 2007). The evidence-based policy perspective emphasizes the development of high-quality evidence and its use in decision making.
- *Communicating with the Congress and others about trends and strategies to address them.* Our recent report on stewardship and 21st challenges emphasizes the need for agencies to communicate with the Congress about developments with implications for the future in a way that is transparent, timely, and useful (GAO 2007).

Foresight literature and experts point to a dynamic process in which earlier decisions about how to respond to a new trend are revised as uncertainty about that trend is reduced—for example, through the development of new evidence on the trend's impact (Younes 2005). Therefore, we view the three activities as part of an ongoing iterative process.

Additionally, literature and experts recognize that as an agency addresses high-clockspeed trends through the activities outlined above, it may encounter challenges, including

[1]Other ways of exercising foresight include, but are not limited to, setting new goals for the future (such as the space program goal set by President Kennedy), exploring potential consequences of a new policy direction, and making quantitative projections of trends that have been tracked over time.

- *A challenge of decision making under conditions of uncertainty.* Uncertainty may characterize various aspects of high-clockspeed or other trends or their future directions (Courtney, Kirkland, and Viguerie 1997; Popper, Lempert, and Bankes 2005).

- *A challenge of developing evidence when existing data systems or analysis methods are not relevant.* Statistical experts told us that data systems and methods that may have worked well in the past may not be suited to studying high-clockspeed or other new trends.

- *A challenge of providing policy-relevant information about the future, such as potential unintended consequences.* The foresight literature highlights the difficulty and importance of identifying such consequences for high-clockspeed trends because there may be little time to anticipate or react to them (Rejeski 2003, 56–57).

Appendix II: Private Sector, University, and Other Experts We Interviewed

In addition to interviewing DOT and TRB officials and staff, and officials from some states, we interviewed the experts listed in this appendix.[1]

Area	Expert	Organization
Automotive and highway safety	Thomas A. Dingus	Virginia Tech Transportation Institute, Blacksburg, Va.
	Clarence M. Ditlow	Center for Auto Safety, Washington, D.C.
	Gerald A. Donaldson, Jacqueline S. Gillan, and Henry M. Jasney	Advocates for Highway Safety, Washington, D.C.
	Mortimer L. Downey III	PB Consult, Washington, D.C.
	James C. Fell	Pacific Institute for Research and Evaluation, Calverton, Md.
	Barry Felrice and David Henry	Chrysler LLC, Auburn Hills, Mich.
	Michael D. Freitas	Ygomi LLC, Washington, D.C.
	Paul M. Horn (retired)	IBM, Armonk, N.Y.
	Anthony R. Kane and Ken F. Kobetsky	American Association of State Highway and Transportation Officials, Washington, D.C.
	Thomas M. Kowalick	Click Incorporated, Southern Pines, N.C.
	Robert C. Lange with Stephen G. Gehring and Stephen E. O'Toole	General Motors Corporation[a]
	Adrian Lund, Anne T. McCartt, and Richard A. Retting	Insurance Institute for Highway Safety, Arlington, Va.
	Robert E. Martinez	Norfolk Southern Corp., Norfolk, Va.
	Carl E. Nash	National Crash Analysis Center, George Washington University, Washington, D.C.
	Priya Prasad	Ford Motor Company, Dearborn, Mich.
	George L. Reagle	George Reagle and Associates, Columbia, Md.
Electronics, communications	Michael F. Altschul and Robert F. Roche	CTIA—The Wireless Association,® Washington, D.C.
	William L. Ball	OnStar™, General Motors Corporation, Detroit, Mich.
	Joseph Brennan	Trinity-Noble LLC, Doylestown, Pa.
	Charles L. Eger	Motorola Inc., Washington, D.C.
	Brian F. Fontes	AT&T, Washington, D.C.
	Arlene Harris	GreatCall Inc., Del Mar, Calif.
	Steve Koenig , J. David Grossman, and Ellen Savage	Consumer Electronics Association, Arlington, Va.
	Tyler C. Messa	Telecommunications Industry Association, Arlington, Va.

[1]We also met with Delegate Jeff Waldstreicher, 18th Legislative District, Montgomery County, Maryland, and we exchanged e-mails with additional persons or groups, including Lisa Lewis of The Partnership for Safe Driving, Washington, D.C.

Area	Expert	Organization
	Paul Nash and Charon Phillips	Verizon Wireless, Washington, D.C.
	T. Russell Shields, Richard Weiland, and Sheryl J. Wilkerson	Ygomi LLC, Oak Brook, Ill., and Washington, D.C.
Public policy, research methods, and foresight	John C. Bailar III	National Academy of Sciences, Washington, D.C., and the University of Chicago, Chicago, Ill.
	Joseph Coates	Consulting Futurist Inc., Washington, D.C.
	Kenneth W. Hunter	Institute for Global Chinese Affairs, University of Maryland, College Park
	Mary Grace Kovar	Consultant, Washington, D.C.
	Rose Marie Martinez	Institute of Medicine, National Academies, Washington, D.C.
	Paul Posner	George Mason University, Fairfax, Va.
	David W. Rejeski	Woodrow Wilson International Center for Scholars, Washington, D.C.
	Fritz J. Scheuren	National Opinion Research Center, University of Chicago, Chicago, Ill.

Source: GAO.

Note: For experts with expertise in more than one category, we selected the category that seemed most relevant.

[a]Robert Lange is in General Motors' Warren, Michigan, office. Stephen O'Toole's and Stephen Gehring's offices are in Washington, D.C.

We met with many automobile manufacturers' and suppliers' representatives in meetings the Alliance of Automobile Manufacturers and Association of International Automobile Manufactures (AIAM) convened.[2]

Finally, we obtained background information on foresight from a number of experts whose work we cite in the report. Others who provided significant background information include Clement Bezold, Institute for Alternative Futures, Alexandria, Va.; Peter C. Bishop, University of Houston, Houston, Texas; Theodore J. Gordon, Millennium Project, World Federation of United Nations Associations, Washington, D.C.; Donna M. Heivilin, formerly with Applied Research and Methods, U.S. Government Accountability Office; Andy Hines, Social Technologies Group Inc., Washington, D.C.; Wendy Schultz of Infinite Futures, Oxford, England; and Edie Weiner of Weiner, Edrich, Brown Inc., New York, N.Y.

[2]Association executives and staff also participated in these meetings. At AIAM this included Michael J. Stanton, President and CEO, and Michael X. Cammisa, Director of Safety. At the Auto Alliance, this included Dave McCurdy, President and CEO, and Robert Strassburger, Vice President, Vehicle Safety and Harmonization.

Appendix III: Review of Studies of Driver Phoning and Highway Safety

For our review of driver phoning and safety risks, we searched (1) all peer-reviewed journals in ProQuest and EconLit and (2) articles listed for the journal of the Transportation Research Board, a peer-reviewed journal in the TRIS database, through October 2007. We also considered the 100-car study and a literature review from the Insurance Institute of Highway Safety. This yielded

- 13 primary studies of driver phoning and crash risks of diverse designs (table 4 summarizes the results, and table 5 gives quality descriptors),[1]
- other primary studies of impacts on driver performance (for example, braking time) without indicating crash risks, and
- three review articles that focused on driver phoning.

Table 4: Impact of Driver Phoning on Crash Risk: 13 Primary Studies

Effect of driver phoning	Number of primary studies and types of design
Increase in crash risk	12 of 13 studies
Estimated size of crash risk	10 of 12 studies estimating crash risk
Quadrupled or quintupled overall risk	4 studies (2 “real world” case-control with record checks conducted in Canada and Australia; 2 U.S. simulator studies)[a]
Doubled or tripled overall risk	3 studies (2 U.S. simulator studies; 1 U.S. self-report survey)[b]
Doubled risk under one condition but limited or no impact for another condition	2 studies (in one, the 100-car study, risk more than doubled when dialing a call; in the other, a study of decisions-made-on-a-track in Canada, risk doubled on wet pavement)
Overall limited or small impact	1 study (self-report survey in Brazil; statistically significant 12% increase)[b]
Amount of increase not specified[c]	2 studies (1 U.S. simulator study; 1 U.S. self-report survey)
No increase in risk	1 study (U.S. simulator study)
Total sampling	13 studies (6 simulator studies, 2 “real world” case-control with record checks, 3 self-report surveys, 1 “decisions on a track” study, and the 100-car study)

Source: GAO analysis of peer-reviewed literature and the 100-car study.

Note: These studies are listed by design category toward the end of this appendix.

[a]One of the simulator studies included regular drivers and airplane pilots, reporting results separately for the two groups. For this table, we considered only results reported for the regular drivers.

[b]The survey documented an association between self-reports of amount of cell phone use while driving and crashes; it excluded reports of crashes occurring while the driver was using the phone.

[c]These studies reported (1) an association between phoning and crashes or (2) an increased risk with amount not specified.

[1]Crash risk estimates are sometimes based on near misses or simulated crashes. Only 1 of the 12 peer-reviewed primary studies included texting and phoning and did not separate the two activities in the analysis; one of the authors told us that texting was not as prevalent as phoning. According to NHTSA, the 100-car study did not include driver texting.

Table 5: Technical Adequacy Descriptors: Primary Studies of Crash Risk by Design Category

	Design category			
	Prospective or controlled	Retrospective		Mixed[a]
Technical adequacy descriptor	**7 driving simulator studies and "decisions on a track"**	**2 case-control studies with record checks**	**3 self-report surveys**	**The 100-car study**
Validity:				
Controlled comparison[b]	Yes, strength	Limited[c]	Limited[c]	Limited[c]
Accurate measures of phoning: e.g., direct observation	Yes, strength	Mixed[d]	Limited	Yes, strength
"Real world" conversations, driving, and crashes	No, weakness[e]	Yes, strength	Yes, strength	Mixed[f]
Free of "reactive effects": e.g., subjects' behavior or statements not biased by knowing they were being studied	No, weakness[g]	Yes, strength	No, weakness	Possibly[h]
Reliability: reproducibility and consistency	Mixed: small samples[i] but negative impact observed for 6 of the 7 studies	Yes, strength: large samples, consistent results for both studies	Yes, strength: large samples, all 3 found some association of phoning with crashes	No, weakness: only 100 cars
Generalizability: to the full U.S. population of drivers, crashes	No, weakness: volunteers from varied population groups	Possibly generalizable but conducted in Canada and Australia	No, weakness: an Internet survey, a college classroom survey, and an intercept survey (conducted in Brazil)	No, weakness: limited to one geographic area, omitted unlicensed drivers

Source: GAO analysis, peer-reviewed literature, and the 100-car study.

Note: These studies are listed by design category toward the end of this appendix.

[a]Mixed design means that the study had elements of prospective and retrospective designs; the 100-car study was prospective in that it set up observations in advance (and subjects knew they were being studied), but driver behavior was not controlled and the analysis was retrospective.

[b]Random assignment, or each subject served as his or her own control.

[c]Retrospective studies, including case-control, surveys, and the 100-car study, do not involve random assignment to comparison groups (such as phoning while driving versus driving only) or other prospective controls to ensure balanced, unbiased comparisons. Statistical controls may be applied but these adjustments are designed to reduce imbalances and do not provide as strong an assurance of equivalence as prospective controls.

[d]These studies checked cell phone records and compared recorded times of crashes and calls, but it has been argued that some calls made after a crash could have been misidentified as precrash calls (because, for example, the recorded time of the crash may not have been exact).

[e]One of the simulator studies featured "naturalistic" conversations; that is, a research assistant talked with subjects in a way intended to be similar to a real-world conversation.

[f]In the 100-car study, the conversations and the driving were real-world, but near misses were the primary basis for estimating crash risks.

[g]In one simulator study, subjects were told they were testing software for the driving simulator. Thus, although they knew they were being studied, they did not know that the purpose was to evaluate their driving skills.

[h]Drivers in the 100-car study were aware that video cameras and recording devices were installed in the vehicles they were driving, suggesting the potential for reactive effects; however, over time, some—perhaps many—drivers may have become used to these devices and disregarded them.

[i]Range of sample sizes for these 7 studies: 20 to 55 subjects. (One simulator study had 55 regular drivers and 56 airplane pilots; we considered only the results for regular drivers.)

As table 4 shows, 12 of the 13 primary studies indicated at least some increase in risk as a result of driver phoning. Two indicated an increase in risk without estimating the size of the increase. Of the remaining 10 studies (all estimated the size of the increase in risk), one reported an overall small (12 percent) increase, two reported that under some circumstances (that is, dialing a call, driving on wet pavement) there was a doubling of risk or higher impact, and the remaining 7 reported a twofold to fivefold overall increase.

Of the 13 primary studies, 5 compared safety risks for handheld and hands-free phoning.[2] None found any difference. (The 13 primary studies of crash risk and the three reviews of driver phoning studies are listed at the end of this appendix.)

A key feature of the 100-car study was its ability to compare the percentages of crashes and near misses associated with various activities engaged in by participating drivers.[3] Results may not be generalizable but are suggestive. Taken together, dialing and talking on or listening to a handheld device were associated with over 7 percent of observed crashes and near misses. Eating while driving was associated with slightly over 2 percent; applying makeup, less than 2 percent; reaching for a moving object, 1 percent; and drinking from an open container, less than half of 1 percent (Klauer and others 2006, 33).[4]

Other results concerning driver performance are included in some of the studies of crash risk and in other peer-reviewed primary studies that did not examine crash risk. These other results indicate that driving

[2]This included one simulator study, two self-report surveys, and two case-control record-check studies.

[3]The likelihood of a crash or near miss associated with a particular driver behavior reflects a combination of (1) the frequency with which drivers engage in that behavior and (2) the riskiness of the behavior when engaged in.

[4]Additionally, a Brazilian study of crash risk compared smoking, phoning, and the presence of children in the car.

performance is degraded by driver phoning. For example, drivers using a cell phone braked more slowly in response to a lead vehicle's braking. Each of the three review articles concluded that driver phoning increased crash risk or degraded driving performance:

- "there is a growing body of evidence . . . that cell phone use substantially increases crash risk" and that risk is not eliminated by driver use of a "hands-free" phone (McCartt, Helinga, and Bratiman 2006, 102);
- there are "clear costs to driving performance [primarily in terms of reaction time] when drivers [are] engaged in cell phone conversations" (Horrey and Wickens 2006, 196); and
- "using a mobile phone when driving . . . disturbs driving through a diminished field of attention, longer detection times to, e.g., changes in dynamic traffic conditions, longer braking reaction-times . . . and greater lateral deviations on the road . . . [and] complex conversations disturb more than simple conversations" (Svenson and Patten 2005, 195).

Studies of Driver Cell Phone Use

Primary Studies of Crash Risk Identified in GAO Searches by Study Design

Driving Simulator Studies and "Decisions on a Track"

Abdel-Aty, Mohamed. 2003. Investigating the Relationship between Cellular Phone Use and Traffic Safety. Institute of Transportation Engineers. *ITE Journal* 73, no. 10 (October):38–42.

Cooper, Peter J., and Yvonne Zheng. 2002. Turning Gap Acceptance Decision-Making: The Impact of Driver Distraction. *Journal of Safety Research* 33, no. 3 (Fall): 321–35.

Hunton, James, and Jacob M. Rose. 2005. Cellular Telephones and Driving Performance: The Effects of Attentional Demands on Motor Vehicle Crash Risk. *Risk Analysis* (Oxford) 25, no. 4 (August): 855–66.

Rakauskas, Michael E., Leo J. Gugerty, and Nicholas J. Ward. 2004. Effects of Naturalistic Cell Phone Conversations on Driving Performance. *Journal of Safety Research* 35, no. 4:453–64.

Schattler, Kerrie L., and others. 2006. Assessing Driver Distractions from Cell Phone Use While Driving: A Simulator-Based Study. Paper submitted at the 85th Annual Meeting of the Transportation Research Board, Washington, D.C.: January.

Strayer, David L., and Frank Drews. 2004. Profiles in Driver Distraction: Effects of Cell Phone Conversations on Younger and Older Drivers. *Human Factors* 46, no. 4 (Winter):640–49.

Strayer, David L., Frank A. Drews, and Dennis Crouch. 2006. A Comparison of the Cell Phone Driver and the Drunk Driver. *Human Factors* 48, no. 2 (Summer):381–91.

Case Control Studies with Record Checks

McEvoy, Suzanne, and others. 2005. Role of Mobile Phones in Motor Vehicle Crashes Resulting in Hospital Attendance: A Case-Crossover Study. *British Medical Journal* (International Edition: London) 331, no. 7514 (August 20–27):428–30.

Redelmeier, Donald A., and Robert J. Tibshirani. 1997. Association between Cellular-Telephone Calls and Motor Vehicle Collisions. *The New England Journal of Medicine* 336, no. 7 (February 13): 453–58.

Self-Report Surveys

Hahn, Robert W., and James E. Prieger. 2006. The Impact of Driver Cell Phone Use on Accidents. *B. E. Journals in Economic Analysis and Policy: Advances in Economic Analysis and Policy* 6, no. 1:1–37.

Paulo, Loureiro, Adolfo Sachsida, and Tito Moreira. 2004. Traffic Accidents: An Econometric Investigation. *Economics Bulletin* 18, no. 3: 1–7.

Seo, Dong-Chul, and Mohammad R. Torabi. 2004. The Impact of In-Vehicle Cell-Phone Use on Accidents or Near-Accidents among College Students. *Journal of American College Health* 53, no.3 (November/December): 101–07.

The 100-Car Study

Klauer, S. G., and others. 2006. *The Impact of Driver Inattention on Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving*

Study Data. Washington, D.C.: U.S. Department of Transportation, April. DOT HS 810 594,

VTRC (Virginia Transportation Research Council). 2005. *VTRC a Co-sponsor of Groundbreaking Study of Driver Behavior.* Press release, August 15. Accessible at http://vtrc.virginiadot.org/BriefDetails.aspx?Id=19.

Two Review Articles Identified in GAO Searches

Horrey, William J., and Christopher D. Wickens. 2006. Examining the Impact of Cell Phone Conversations on Driving Using Meta-Analytic Techniques. *Human Factors* 48, no.1 (Spring):196–205.

Svenson, Ola, and Christopher J. D. Patten. 2005. Mobile Phones and Driving: A Review of Contemporary Research. *Cognitive Technology Journal* 7:182–97.

Review Article the Insurance Institute of Highway Safety Provided to Us

McCartt, Anne T., Laurie Helinga, and Kel Bratiman. 2006. Cell Phones and Driving: Review of Research. *Traffic Injury Prevention* 7:89–106.

Definition of Technical Adequacy

In this report, we consider technical adequacy to be composed of validity, reliability, and generalizability:

- *Validity* is defined here as unbiased counts or measurement of what one intends to measure—for example, safety outcomes measured by actual crashes or road fatalities rather than by surrogate measures such as near misses (unless the surrogate measures have been shown to be highly correlated with actual crashes or fatalities in a relevant research context).
- *Reliability* is defined here as reproducibility and consistency, or the absence of random error—that is, similar results would be obtained if the study were repeated using the same procedures. In studies in which driver reactions may vary, a key factor contributing to reliability is a sufficiently large study, and a study with few drivers would be likely to yield less reliable results than a study with a much larger sample of drivers.

- *Generalizability* is defined here as the applicability of study results to the population of interest—for example, a study that draws a representative sample from all drivers on U.S. roads would be generalizable in that it could be expected to produce results characterizing that population as a whole.

Appendix IV: Trends for Vulnerable Road-User Groups

Trends for certain vulnerable road-user groups point to heightened safety challenges in the years ahead, and DOT is taking some steps to address these.

- By 2025, the annual number of road fatalities for older drivers may be double what it was in 2005. The main reason for the projected increase is that the first members of the baby boom generation will reach their 65th birthday in 2011, and the number and percentage of Americans older than 65 will steadily increase for several years. In response to this trend, DOT is examining various issues relevant to older drivers (see Band and Perel 2007).

- Motorcycle riders are vulnerable in any type of crash, and the numbers of riders and fatalities have risen in recent years. DOT has anticipated more motorcycles on U.S. roads and has begun taking steps to address related issues—by, for example, examining a broad range of alternative options for reducing motorcycle fatalities (DOT 2007). Most recently, some have speculated that higher than expected increases in motorcycle VMT (or increased scooter use) will occur if fuel prices continue to rise.[1]

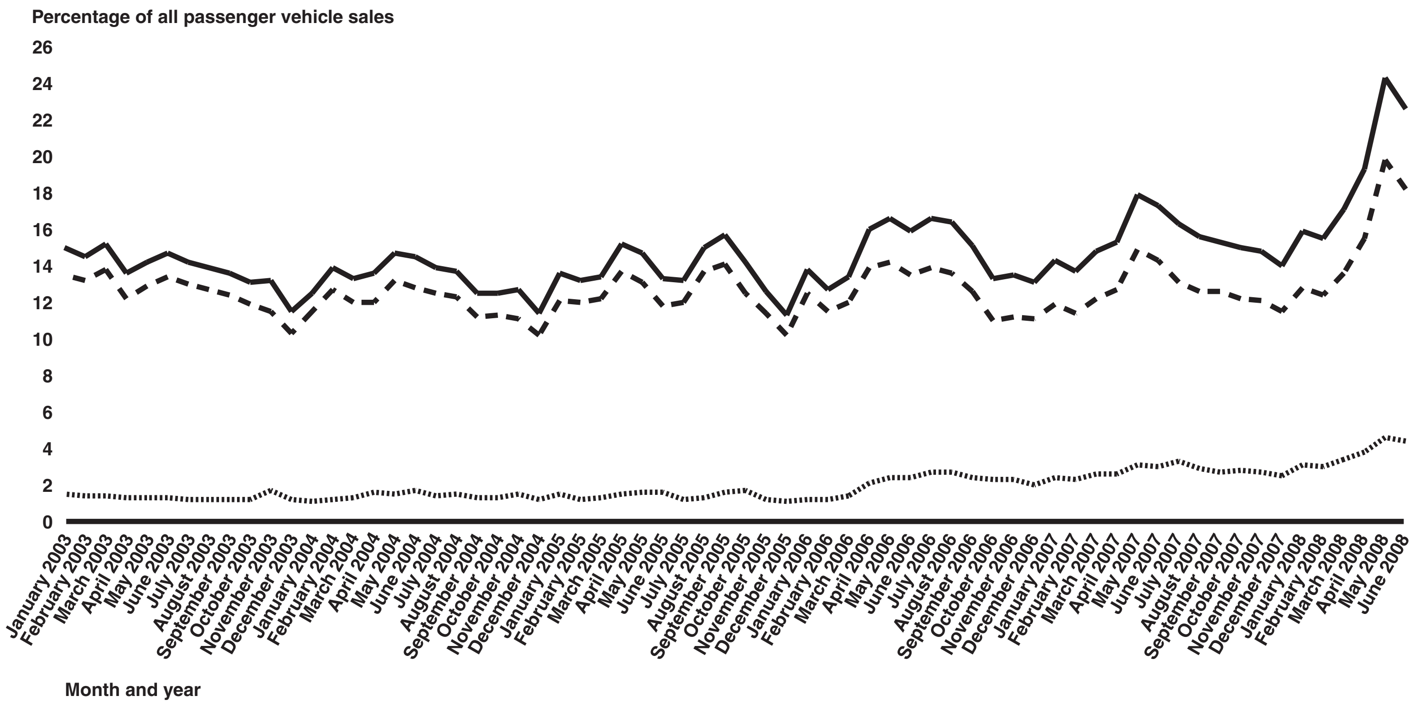
- Occupants of light passenger vehicles in crashes with heavy trucks represent another vulnerable group, and this vulnerability may increase. A recent projection from the Energy Information Administration has suggested that by 2020, VMT for freight trucks weighing over 10,000 pounds will increase by about 30 percent relative to mileage observed in 2006, although the changing economy and rising costs of fuel may limit anticipated increases.

- Occupants of smaller cars are generally vulnerable in crashes.[2] The category with the smallest compact cars or minis (such as the Scion and Aveo) represents a very small percentage of the fleet but may have been growing in recent years, as seen in figure 17. The figure also shows that sales of other small cars recently spiked, possibly as a result of rising fuel prices. At the same time, large sport utility vehicles appear to be declining in popularity.

[1]According to DOT, current measures of VMT underestimate motorcycle use and better measures are needed.

[2]Although improved seat belts, air bags, and other safety features help protect drivers and passengers in smaller cars, they are still likely to be vulnerable in crashes.

Figure 17: Small Cars as a Percentage of Passenger Vehicle Sales, January 2003 to June 2008



All small cars (includes all cars in Ward Automotive Group's "lower small car," "upper small car," and "small specialty car" categories. Ward's defines these categories primarily based on a length of less than 180 inches, but includes other criteria as well, such as height and volume)

Upper small cars (includes all cars in Ward Automotive Group's "upper small car" category and those cars in the "small specialty car" category between 170 and 180 inches long. Examples are such cars as Ford Focus, Nissan Sentra, Toyota Corolla, Volkswagen Jetta, and Volkswagen Rabbit)

Lower small cars (includes all cars in Ward's "lower small car" categopry and cars in the "small specialty car" category less than 170 inches long. Examples are such cars as the Chevrolet Aveo, Honda Fit, Scion xA, Mini Cooper, and Volkswagen Beetle)

Source: GAO analysis of data on new car sales from Ward's Automotive Group, a division of Penton Media Inc.

Appendix V: Illustrations of In-Vehicle Screens for Safety

Examples of in-vehicle screens for safety purposes are shown in figures 18 and 19.

Figure 18: Screen with V2V Icon Warning of a Stopped Vehicle in the Road Ahead

Source: General Motors Corporation.

Figure 19: Backup Camera Screen (Activated When Car Is in Reverse)

Source: GAO.

Appendix VI: Information on Selected NCSA Datasets

Selected datasets maintained by the National Center for Statistics and Analysis, in the National Highway Safety Administration, are outlined in table 6, based on information DOT provided us.

Table 6: Selected NCSA Datasets

	Behavior dataset		Crash dataset		
Feature	**NOPUS**[a]	**MVOSS**[b]	**FARS**[c]	**NASS CDS**[d]	**NMVCCS**[e]
Continuity	Ongoing: annual since 1998	Ongoing: conducted in 1994, 1996, 2001, 2003, and 2007	Ongoing: annual since 1975	Ongoing: annual since 1979	One-time study to be reported in 2008
Coverage	For observations of cell phone use: drivers of passenger vehicles only	Adults 16 and older living in households with landline telephone	Fatal crashes on roadway	Nationally representative sample of motor vehicle traffic crashes (1) reported to police and (2) with light passenger vehicles towed	Nationally representative sample of motor vehicle crashes (1) reported to police, (2) with light passenger vehicles towed, (3) one vehicle on scene at time of researcher arrival, and (4) with emergency medical response
Notable omissions	Pedestrians and bicyclists omitted; for cell phone use, motorcyclists also omitted	Persons in cell-phone-only households or in households without a phone are omitted	Suicides; off road crashes omitted	Pedestrian, motorcycle, and large truck crashes without towed passenger vehicle omitted	Similar to omissions noted for NASS CDS. Also crashes without emergency medical response, crashes with no police accident report filed, etc., are omitted
Approximate sample size	43,000 drivers observed (annual sample)	12,000 persons interviewed (6,000 per questionnaire)[f]	39,000 crashes and 43,000 fatalities (annual census)	4,500 crashes (annual sample)	3,000 crashes (sample for study of crashes in 2005–2006)
Data sources	Trained observers at selected intersections and off-ramps	Telephone interviews using structured questionnaire (landline phones)	Police accident reports, vehicle identification number, and other documents (mostly state-level) such as driver license information[g]	Police accident reports, vehicle identification number[g,h]; field inspection focused on crashworthiness[i]; event data recorder[k]	Police accident reports, vehicle identification number[g,h]; field inspection focused on crash causation[j]; event data recorder[k]

Source: Adapted from information provided by NHTSA's National Center for Statistics and Analysis.

[a]NOPUS refers to the National Occupant Protection Use Survey, developed to track the use of seat belts, motorcycle helmets, and child restraints.

[b]MVOSS refers to the Motor Vehicle Occupant Safety Survey, developed to obtain a periodic status report of attitudes, knowledge, and self-reported behavior in areas of motor vehicle occupant protection (seat belts, child restraints, air bags, crash injury, and emergency medical response).

[c]FARS refers to the Fatality Analysis Reporting System.

[d]NASS CDS refers to the National Accident Sampling System and the Crashworthiness Data System. The approximately 4,500 crashes in the CDS are selected from a nationally representative probability sample for which police accident reports are collected from the jurisdiction.

[e]NMVCCS (National Motor Vehicle Crash Causation Study) was authorized by SAFETEA-LU in 2003; the first report is planned for release in 2008. The approximately 5,000 crashes in the study were selected from the over 17,000 notifications and on-scene responses to crashes in NASS sample jurisdictions.

[f]MVOSS uses two questionnaires that cover different subject areas, with a small number of shared questions. Each questionnaire is administered to a national sample of approximately 6,000 respondents, the samples are independently drawn, and the same methods are used to draw the samples. Essentially, MVOSS is two surveys.

[g]The vehicle identification number (VIN) indicates new equipment if standard on the make and model; the dataset does not include the full VIN, which is needed to check manufacturers or dealers for optional equipment on the vehicle.

[h]NASS CDS and NMVCSS collect the vehicle identification number from the vehicle inspection or the police accident report.

[i]Field inspection of crash scene, vehicles involved, interviews with involved persons, and medical records for injured occupants.

[j]Field inspection of crash scene, vehicles involved, and interviews with involved persons, focused on factors that led up to the crash.

[k]Event data recorder information is collected when available and permission received.

Appendix VII: In-Vehicle Crash Avoidance Technologies and New NCAP

NHTSA began the New Car Assessment Program (NCAP) in 1978 to provide consumer information to the public. NCAP's goals are to improve occupant safety by providing market incentives for vehicle manufacturers to voluntarily design vehicles with improved crashworthiness and provide independent information to aid consumers in making comparative vehicle purchase decisions. To measure the relative safety of new vehicles, NHTSA developed a series of crash tests that would indicate a vehicle's relative crashworthiness.

For several years, NHTSA used only frontal crash tests and provided data to consumers on the results. Subsequently, to provide information to consumers that would be more easily understood, NHTSA developed the five-star rating program. NHTSA used this rating method first in model year 1994, and it is still in use today. The five-star program gives new vehicles a rating on a one-to-five-star scale representing how well a particular vehicle performed in the crash tests. Beginning in model year 1997, NHTSA implemented side impact crash tests. In model year 2001, NHTSA incorporated rollover crashes into NCAP's testing and ratings.

The Secretary of Transportation credits NCAP with encouraging major safety improvements in the design of new vehicles. According to NHTSA, recent advances in crash avoidance technology offer a new opportunity for NCAP to inform consumers about new systems. In January 2007, NHTSA issued an agency report entitled *The New Car Assessment Program: Suggested Approaches for Future Program Enhancements* and requested comments on options for enhancing NCAP, including information on crash avoidance technologies. The proposal described various options for how to present such information to consumers and indicated that information differentiating the effectiveness of various new technologies might have to wait for future evidence development.

In considering NHTSA's proposal for expanding NCAP, automobile manufacturers and various stakeholders have emphasized the desirability of (1) a rating system reflecting expected safety benefits, (2) efforts to develop better evidence on new technologies, and (3) programs that educate consumers about the nature of these technologies and how they work.

After receiving and evaluating comments through a public hearing and docket submissions, NHTSA issued its final notice in July 2008.[1] The notice

[1] 73 Fed. Reg. 40,016 (July 11, 2008).

summarized the comments received on the agency report and provided the agency's decision on how it would proceed with changes to NCAP. It was decided that for model year 2010, the agency would implement a new crash avoidance program that would communicate whether ESC, FCW, or LDW are standard or optional on vehicles. NHTSA stated that such a rating system should be established for two reasons: (1) to draw a greater distinction for consumers regarding vehicles that are being equipped with ESC during the phase-in period and (2) to provide an incentive for the accelerated deployment of ESC and other new safety technologies that could help drivers prevent severe and frequent crashes. According to NHTSA, ESC, FCW, and LDW are the only technologies mature enough for inclusion in a crash avoidance rating program at this time. All three address a major crash problem, have had safety benefit projections, and have performance tests and procedures available to ensure an acceptable performance level.

NHTSA also notes that the agency will continue to seek public input on the appropriateness of changes to the rating system or technologies, and it anticipates using similar criteria for determining technologies to include in the future.

It is not certain how further information on in-vehicle crash avoidance technologies is to be obtained. NHTSA officials stated that they have yet to determine the details of how they will test each new crash avoidance technology and whether this will be done through an FOT or other research.[2] Similarly, with respect to future generations of existing technologies (for example, improved versions of curve speed warning), NHTSA has not indicated whether or how it might obtain updated evidence on the quantifiable benefits of these technologies. Finally, since many crash avoidance technologies may interact with other safety features, it is not clear how a test would resolve the overall safety impact of a particular technology, such as LDW or curve speed warning.

In terms of consumer awareness of new technologies, the agency has discussed focus group results in which NHTSA noted that "participants may not fully grasp the importance of" new crash avoidance technologies. NHTSA notes its agreement with points made by some commenters in

[2]The method NHTSA used to test ESC—comparisons of actual crashes for cars with and without ESC, across multiple years of data—would be likely to take 5 to 10 years from the time a new technology is introduced in several new models. By then, automakers would be likely to have introduced newer technologies.

support of consumer education materials, a database of nonagency sources of credible vehicle safety information, and suggestions that the agency provide additional information at the point of sale. According to NHTSA, it “continuously investigates ways to improve marketing the NCAP vehicle ratings program . . . and will place the results of…enhanced marketing studies in Docket No. NHTSA-02004-19104, as completed.”

Appendix VIII: Unintended Consequences

When multiple trends converge, the potential future consequences may differ from what was intended or anticipated from considering a single trend in isolation or within the current context (see figure 20). In some cases, future interactions between trends could result in unintended consequences, potentially diluting the impact of positive trends or exacerbating threats.[1]

[1]Another example is that a new development can be viewed as having a positive effect, such as small cars lowering the cost of fuel for consumers. However, their construction could compromise the safety benefits of crashworthiness technologies. When considered in light of the projected volume of commercial trucks on the nation's highways, these interacting trends could lead to more fatalities in the future.

Figure 20: Unintended Consequences of the Interaction of Multiple Trends

Trends	Possible interactions
Crash avoidance + older drivers	Older drivers may be helped by crash avoidance technologies such as backup warning systems illustrated below.  Unintended consequence: Crash avoidance technologies, such as backup warning systems and night vision assistance, may enhance mobility of older drivers, who then travel more miles and, therefore, experience more crashes and fatalities.
Crash avoidance + cell phones	Crash avoidance technologies could mitigate negative effects of drivers using cell phones or other distracting devices.  Unintended consequence: Drivers using a portable touch-screen phone and examining a dashboard screen image at the same time could be further distracted. (Rear view on backup screen, as shown, is activated when car is in reverse.)

Sources: AAA Foundation for Traffic Safety and GAO.

Appendix IX: Literature Review's Suggestion: Evaluating State Laws

The congressional conference report that led DOT to conduct a literature review on distracted driving suggested that the results of that review might help "focus the federal research effort."[1] The resulting review indicated one direction for research that focuses specifically on countermeasures: "evaluation of the effectiveness of State distraction-related laws" (Ranney 2008, 22).[2] Elsewhere, the review stated that while most efforts to control driver behaviors might have limited effectiveness for driver lifestyle choices such as using a cell phone while driving, a key exception might be state GDL programs banning cell phone use for new drivers, which include teens 16 to 17 years old.[3]

A recent evaluation of a single state's GDL cell ban (not conducted by DOT) indicates that the ban did not change teen driver behavior in the state studied (Foss and others 2008). The literature review's suggestion that DOT evaluate state laws—and the possible focus on GDL laws—is still relevant in that neither the literature review nor the recent GDL evaluation discussed whether different states (1) may have implemented GDL cell bans in different ways or (2) are considering new approaches to GDL implementation in the near future.

- Thus far, according to NHTSA, 19 states and the District of Columbia have implemented GDL cell bans. The literature review did not indicate whether some states currently (1) enforce the cell phone ban by, for example, focusing on areas near high schools; (2) aim publicity about the law at teens and parents; or (3) sponsor related programs to encourage teen compliance or parental oversight.[4] (According to the report on the one state that was evaluated, that state did not emphasize such approaches.)

[1]H.R. Rep. No.109-307, at 181–182 (2005).

[2]The literature review also mentioned in-vehicle systems for information and entertainment; it did not suggest evaluations of these technologies as a possible research direction. Systems built into new cars include OnStar™ and Sync™, among others. OnStar™ has reported that driver calls made with its hands-free technology do "not increase the risk of collision as compared to normal driving" (Lange 2007).

[3]Most states now have GDL programs, which have generally proven effective (see NHTSA 2008b and Baker, Chen, and Li 2007).

[4]However, high-visibility enforcement has been used in other areas of safety (see GAO 2008c, 24 and 26).

- As we have documented throughout this report, fast-changing new technologies are affecting highway safety. One objective of further research could be to describe whether states with GDL cell bans are using, encouraging, or considering for new technologies the future, such as devices that could help police detect ongoing calls in passing cars or in-car equipment to track, record, and report—to either parents or police—*driver* use of portable phone use.[5]

- A researcher in this area told us that no "poll" of states has described how they are implementing GDL programs.

Thus, it is possible that some states are implementing or considering the implementation of GDL cell bans differently from the state that was tested. Research to evaluate the different ways that such bans are implemented would be relevant to the suggestion in the literature review.

[5]Related technology is discussed in Brennan, Adi, and Campbell (2008). DriveCam video-recording and other systems for oversight of drivers can be used by parents of teens (see *http://www.drivecam.com*).

Appendix X: Comments from the Department of Transportation

U.S. Department of Transportation

Office of the Secretary of Transportation

Assistant Secretary for Administration

1200 New Jersey Avenue, SE
Washington, DC 20590

September 26, 2008

Ms. Katherine Siggerud
Managing Director, Physical Infrastructure

Ms. Nancy Kingsbury
Managing Director, Applied Research and Methods
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Ms. Siggerud and Ms. Kingsbury:

The Government Accountability Office's (GAO) draft report on foresight issues facing the Department of Transportation presents an interesting theoretical approach, which attempts to extrapolate trends and identify early intervention points to improve long term outcomes 20 or more years hence. While these methods have laudable intent, they suffer from several shortcomings. Implementing these approaches to long term issues would require the diversion of substantial resources from ongoing efforts with proven outcomes in an attempt to anticipate and define future trends that may, or may not, develop. The National Highway Traffic Safety Administration (NHTSA), for example, has honed a data-driven, performance-oriented approach to addressing the issues most in need of attention now and for the foreseeable future. These include increasing the use of passenger restraint systems, reducing impaired driving through behavioral and technological improvements, reducing motorcycle fatalities, enhancing vehicle crash avoidance and crashworthiness systems, and increasing consumer information to provide for knowledgeable choices when purchasing a vehicle. These are the primary actions that reflect NHTSA's focus on those areas that pose the greatest risk on the Nation's highways and require continued and increasingly effective action. While the Department is not unconcerned about the issues that may emerge over the next 20 years, it must, in a resource-constrained environment, focus its attention on evidence-based strategies to improve safety.

The anticipatory mechanisms discussed in the draft report suffer from methodological problems as well. First and foremost is their inability to effectively contend with discontinuities that inevitably occur within the extended timeframe during which they are intended to operate. It is indeed the proverbial bus that you do not see coming that poses the greatest danger of collision. There will certainly be numerous discontinuities over the next 20 years, e.g., world events and unanticipated technologies that will pose substantial and unpredictable influence over what will

2

become future key transportation safety issues. For example the oil shocks of the 1970's were unanticipated and resulted in substantial changes to the Nation's rolling stock as well as new safety issues which could not have been anticipated 20 years prior. In addition to these shortcomings, these techniques also require massive amounts of data, sophisticated technical analytical tools, skilled practitioners, and a significant investment of resources. Further, these tools do not at this time appear to produce results with the rigor necessary to form the basis of regulatory action by the Department. These methods may well merit additional attention and development in academia, which may be most adept at developing the methods to their full potential.

The Department is looking towards the future to anticipate and address major safety issues. The Federal Highway Administration and NHTSA's actions to address the special needs of older drivers are a case in point. While the methodology may differ from that offered in the GAO draft report, the Department has initiated, together with its state partners, actions intended to address the increasing population of older drivers. The Department's efforts to meet this challenge were recognized in GAO's recent report on the topic.[1] That report describes both Federal efforts to implement safety measures to address the special needs of older drivers and the difficulty states face in committing scarce resources in anticipation of, rather than in response to, significant safety concerns.

Finally, the GAO report is inaccurate in its conclusion that DOT has not initiated research or action to counter the threat of electronic driver distractions. NHTSA continues to amass a body of knowledge regarding driver distractions, most recently issuing *"Driver Distraction: A Review of the Current State-of-Knowledge"* in April, and *"Driver Strategies for Engaging in Distracting Tasks Using In-Vehicle Technologies"* in March. These are just the latest of many research studies listed on NHTSA's internet website that are focused on the topic of driver distraction. These are all part of NHTSA's efforts to determine the nature and extent of the safety problem as well as intervention strategies.

We appreciate the opportunity to offer comments on the draft report. In addition to this statement for inclusion in the report, we have separately provided a number of technical comments for GAO's consideration in finalizing the document. Please contact Martin Gertel, Director of Audit Relations, on 202-366-5145 with any questions.

Sincerely,

Linda J. Washington

Linda J. Washington

[1] *"Older Driver Safety: Knowledge Sharing Should Help States prepare for Increase in Older Driver Population,"* GAO-07-413, April 2007

Appendix XI: GAO Contacts and Staff Acknowledgments

GAO Contacts

Nancy R. Kingsbury, Managing Director, Applied Research and Methods, (202) 512-2700 or kingsburyn@gao.gov. Katherine A. Siggerud, Managing Director, Physical Infrastructure Issues, (202) 512-2834 or siggerudk@gao.gov.

Staff Acknowledgments

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[1] The following individuals contributed to this report during the summer internship program with GAO: Grace E. Cho, Griffin Glatt-Dowd, and Richard M. Todaro. Additionally, Charity J. Goodman, formerly with GAO, contributed to an early phase of this study.

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