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16. Abstract
The issue of driver distraction associated with the use of in-vehicle devices in heavy vehicles was explored through interviews with truck drivers and safety regulators. In order to characterize some of the interface designs and better understand their interaction demands, a sample of commercially available in-vehicle devices was examined. The extent to which these devices conformed to available human factors guidelines and accepted practices was assessed analytically. Industry device design and evaluation practices were also explored via contacts with equipment suppliers and industry Original Equipment Manufactures. Truck driver distraction is perceived by many drivers and safety regulators to be a problem, although it is not generally viewed as a high priority issue. Fleet-based communication devices, which include text-based messaging functions, are widely available and used by the industry. These devices can potentially impose high levels of attentional demand if used while driving since they require numerous inputs and multi-line text displays which have been shown to impair driving performance. Manufacturers of these types of systems tend to provide the capability to restrict driver interactions with these systems while driving (e.g., lock-out the ability to read or send text messages); our interactions with drivers in our sample suggests that many organizations do not necessarily elect to fully implement these restrictions, and there is no uniformly adopted practice for dealing with these types of devices. Product developers and OEMs appear to involve drivers in product development and testing (primarily in order to ensure their products conform to the customers needs); however, objective testing to evaluate the attentional demands of devices may not be widely used.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Previous research and debate on the issue of driver distraction has generally focused on passenger vehicle drivers. Nevertheless, commercial vehicles are generally the first to adopt new technologies, and the trucking industry, in particular, has relied on a variety of widespread fleet management devices which often include in-vehicle displays and complex driver interfaces. It is not known to what extent driver distraction from in-vehicle technologies is a problem for truck drivers or in what manner, if any, this problem differs from that of light vehicle drivers. Truck driver distraction due to in-vehicle technologies may differ from the automobile driver problem because of differences in the types and functions of in-vehicle devices, differences in device placement or design, the truck cab environment, trucking-related tasks, and vehicle control demands, among other aspects. This study provides an important initial step in determining the need for and approach to developing guidelines or standards to limit the exposure of truck drivers to unsafe distractions. It provides greater clarification of the extent and nature of the truck driver distraction problem; critically examines a sample of in-truck devices in terms of human factors requirements; and identifies truck-specific research needs.

Information collected from truck drivers and individuals charged with regulation and fleet safety suggests that distraction from the use of on-board devices may indeed be a problem for truck drivers, but the problem itself is not generally perceived to be great relative to other issues facing the industry (fatigue, unrealistic demands by shippers, lack of rest areas, etc). Many individuals felt truck drivers were less susceptible to distraction compared to passenger vehicle drivers because of their experience and professionalism, and both groups felt that *most* drivers make good decisions about using technology while driving. Drivers tend to feel they can identify situations in which it is safe to use technology and those in which they should avoid using devices while driving, suggesting that drivers differentiate among tasks in terms of their perceived difficulty and risk. Lack of objective data relating the incidence of distraction to commercial vehicle crashes was a moderating factor in how the distraction issue was viewed (many safety regulators were reluctant to speculate on the issue given the lack of objective data). Nevertheless, nearly half of the drivers interviewed (48%) reported experiencing a close call while using a device on-road (e.g., drifting out of the lane while reaching or searching for a device, typing text messages, tuning the radio or CB, or reading text messages). Some close calls were characterized by a reduction in situational awareness leading to slower driver reaction times in response to an external event (e.g., lead vehicle brakes but driver is slow to detect, delayed responses to traffic signals, etc.). Perceived differences between truck and cars included differences in the physical demands of driving the vehicle; the consequences of driving while distracted (tolerance for variation in driving performance and the ability to recover); and the driver’s situational awareness (mental demands of driving).

A survey of commercially available in-vehicle systems found a broad array of devices and functions (fleet management, driver aids and warning, vehicle performance and diagnostics, communication, etc.) used in the industry. The use of multi-functional devices was quite broad; almost all Original Equipment Manufacturers (OEMs) offered at least one multi-functional display in their vehicles. Text messaging and driver communication functions were among the most prevalent with both OEM and aftermarket devices offering these

capabilities. Many systems provide the capability to limited driver interaction with the display/unit while driving, although some flexibility exists regarding the manner in which particular devices can be configured. For example, some text communications systems have a lockout feature to limit driver interaction with the system while the vehicle is moving. Our limited data suggest that these types of lockout features are not necessarily universally applied by fleets, and significant variation appears to exist in terms of how devices, particularly aftermarket systems, are configured and used by drivers. Many companies do have policies regarding the use of devices while driving, but the effectiveness of these types of policies was generally regarded as marginal by many of the safety personnel interviewed.

Interviews with OEMs and suppliers yielded little information regarding device/system evaluation practices (methods, measures, and criteria). Most companies considered information about the specific methods used to evaluate the suitability of system for use while the vehicle is moving to be highly competition sensitive. Companies with human factors specialists on staff were confident that they had knowledge of, and access to, a wide variety of documents from within the broader automotive industry. Nevertheless, human factors expertise may only be accessed when someone takes an initiative either to request assistance (from the product development side) or to provide potentially useful information (from the specialist side). The use of market research techniques (e.g., focus groups, user interviews, and user surveys) is commonly used by OEMs as a means to obtain driver feedback throughout the entire product development process including the testing and evaluation phase. The testing and evaluation phase typically includes actual driving tests by internal company drivers and field-testing by select customers. A general attitude appears to be that since users have so much input into the development of products, specific driver interface testing is not necessary. Nonetheless, some organizations do conduct formal tests for the specific purpose of evaluating the driver interface and usability of a system. Objective methods included the use of workload models where a series of repetitive driving tasks are defined, and driver's skill on those tasks with and without the new system in the vehicle is measured. The secondary task method was also commonly used. In this method, a "secondary" task is defined such as pushing a button in response to a specific buzzer. The driver's willingness and ability to attend to the secondary task is the measured variable.

The information gathered from this effort was used to develop a set of research recommendations intended to outline and define areas of needed research related to commercial vehicle devices and driver distraction. Among the suggested research efforts is to objectively identify the incidence of distraction-related crashes in order to identify and quantify the problem. This can be accomplished via analysis of existing databases, including the Truck Crash Causation database, as well as analysis of individual State databases. Naturalistic studies which demonstrate degradation in truck driving performance resulting from the use of in-vehicle devices are also a valuable tool in assessing the link between device use and safety. Other recommended activities include convening an industry panel or conference to further explore industry practices, evaluation procedures, and criteria for assessing the suitability of a system for use while a vehicle is moving.

INTRODUCTION

The potential hazard of driver distraction through the use of in-vehicle devices has become a major concern in the highway safety field. A number of studies have attempted to characterize and quantitatively relate crashes to distraction, and although associations have varied in magnitude, most comprehensive crash analyses estimate that between 25-30 percent of crashes result as a consequence of driver inattention (Wang, Knipling, & Goodman, 1996; Hendricks, Fell, & Freedman, 2001). There is growing concern that Telematics devices and other in-vehicle devices may add to existing sources of distraction by engaging drivers in complex cognitive tasks and significantly increase exposure though their widespread use. Growing research suggests that cognitive aspects of interacting with in-vehicle technologies can lead to reduced situational awareness (Parkes and Hooimeijer, 2000); attentional narrowing and reduced visual search and mirror sampling (Recarte and Nunes; 2000; Janelle, Singer & Williams, 1999); and increased driver reaction times to roadway events (Lee, Caven, Haake, & Brown, in press). Indeed, these types of innovative technologies may actually increase risk by encouraging more frequent and lengthy use while driving, and enabling designers to expand the capabilities of their systems as well as the range of tasks and functions that can be accessed while driving. Technology trends, therefore, need to be carefully monitored and safety impacts assessed.

Most of the research to date has focused on light passenger vehicles. It is not known to what extent driver distraction from in-vehicle technologies is a problem for truck drivers or in what manner, if any, this problem differs from that of light vehicle drivers. Previous research and debate on driver distraction has particularly focused on cellular phone use, and to a lesser extent, navigation systems. Additional devices and functions are also emerging into the market place, and these devices have the potential to add to existing sources of distraction by engaging drivers in complex cognitive tasks and significantly increasing exposure through their widespread use. A recent inventory of in-vehicle telematics devices sponsored by NHTSA (Llaneras and Singer, 2002) found systems with a number of potentially distracting design elements, including displays that present large amounts of information and incorporate dynamic elements; unrestricted access to complex, multi-step, and demanding tasks while driving; and systems that provide for multiple functions and expanded capabilities. Truck driver distraction due to in-vehicle technologies may differ from the automobile driver problem because of differences in the types and functions of in-vehicle devices, differences in device placement or design, the truck cab environment, trucking-related tasks, vehicle control demands, among other aspects. Therefore, research is required to specifically define the truck driver distraction problem, and building upon applicable light vehicle research, and develop equipment guidelines to minimize the impact of truck driver distraction on safety.

Objective & Scope

The research conducted under this project provides an important initial step in determining the need for and approach to developing guidelines or standards to limit the exposure of truck drivers to unsafe distractions. It seeks to: (a) provide greater clarification of the extent and nature of the truck driver distraction problem; (b) compare and contrast truck driver distraction with light vehicle distraction, through analysis of devices and through focus groups; (c) critically examine selected in-truck devices in terms of human factors requirements; and (d) identify needs for truck-specific research.

Method

Three basic tasks were conducted in support of the project objectives; these included (1) conducting focus groups and interviews with commercial vehicle drivers and industry safety personnel; (2) inventorying and analyzing commercially available devices; and (3) documenting industry system design and evaluation practices. Each task is briefly described in the following sections.

Driver & Fleet Safety Interviews

Interviews (and a focus group) were used to gather insights and information addressing a range of topics related to in-vehicle technology use, including:

- Perceptions of whether distraction associated with the use of in-vehicle devices is currently (or is becoming) a problem for drivers (both truck and passenger vehicle drivers).
- Differences between truck and passenger vehicle demands and perceived risk.
- Factors affecting drivers' willingness to use devices (including job demands, conditions of use, and device designs).
- Suggested potential countermeasures for guarding against distracted driving.

Information was gathered from both truck drivers and individuals in the commercial vehicle industry charged with regulation and fleet safety (e.g., police, fleet managers, etc.). In-person interviews were conducted with drivers recruited at truck stops and rest areas in the greater Washington, D.C. metropolitan area. The sample of 32 truck drivers primarily consisted of long-haul drivers (96%) traveling interstate and cross country. Although both fleet and owner-operators were interviewed, fleet drivers in the sample outnumbered independent owner-operators (65% and 35%, respectively). Vehicles in the sample represented many of the most common makes from manufacturers including Freightliner, Volvo, Kenworth, International, and Peterbilt (model years ranged from 1995 to 2003). Drivers in the sample ranged in age from 30 to 67 years of age (mean of 45 years), and varied in experience from 6 months to 48 years of commercial driving experience (mean of 15 years). Miles traveled per year ranged from 36,000 to 350,000 (mean of 132,434 miles).

A focus group of 11 drivers, recruited from a Maryland-based trucking fleet was also conducted. Drivers in the focus group ranged in age from 34-60 years (mean of 48 years), with an average of 23 years of commercial driving experience (experience ranged from 7-38 years). All drivers were male. The group was primarily composed of long-haul drivers (91%) averaging 111,000 miles per year (range 100,000 to 150,000 miles per year). Fleet vehicles were equipped with CB radios, cruise control, paper maps, and the Qualcomm text messaging system. Many drivers also had access to their personal cellular telephones (not furnished by the fleet). It is also important to note that this trucking fleet represents a very safety conscious organization averaging under 3.1 crashes per million vehicle miles traveled (six times fewer than the industry average). The fleet physically governs the speed of their trucks (65 mph), has stringent hiring practices (recruits only experienced drivers age 25 and older), conducts periodic re-currency training for all drivers, and provides training on in-cab devices (Qualcomm).

Interviews with twelve industry safety and regulatory personnel (e.g., primarily law enforcement officers charged with ensuring commercial vehicle safety) were also conducted in order to supplement the data obtained from drivers. State regulatory and police interviews were conducted via telephone with individuals recruited from the Commercial Vehicle Safety Alliance (CVSA) – a non-profit organization of federal and state government agencies and representatives from private industry in the U.S. dedicated to improving commercial vehicle safety. Members from three CVSA committees were recruited to participate including the Driver Committee, Information Systems Committee, and Intelligent Transportation Systems Committee. Representatives from 12 different state organizations across the country were interviewed (California Highway Patrol, Georgia Department of Motor Vehicles (DMV), Maryland State Police, Michigan State Patrol, New York State Department of Transportation (DOT), Rhode Island State Police, South Carolina Dept. of Public Safety, Tennessee Dept. of Public Safety, Vermont DMV, Virginia State Police, Washington State Patrol, and Wyoming Highway Patrol). The majority of these agencies maintain a database of commercial vehicle crashes (92%) and investigate commercial vehicle related crashes (75%). Individuals in our sample represented a wide array of backgrounds including field officers, crash investigators, commercial carrier supervisors, and passenger and freight safety directors.

A set of common questions were administered to both drivers and safety personnel in order to allow perspectives from both groups to be assessed and compared. Appendix A and B contain the specific questions administered to drivers and safety personnel. Summary data presented in this report draw from all three information sources: driver interviews, driver focus group, and safety/regulatory interviews.

Device Inventory & Analysis

A survey of commercially available in-vehicle systems for the heavy truck market was performed in order to identify the type and range of devices and their interface designs. The main goal of this task was to highlight relevant problem areas and issues related to the design and use of in-vehicle devices (e.g., communications, safety and warning, navigation, multi-function, etc.), rather than focus on describing specific devices. A list of currently available devices was developed, and a sample of devices was targeted for in-depth review. Part of this activity included analytically assessing the extent to which the operation and interface characteristics of devices conform to known or published human factors guidelines and research (e.g., European Commission, 2000; Stevens, et al., 1999; Campbell, Carney, and Kantowitz, 1997; AAMA Driver Focus-Telematics Working Group, 2001).

Text message displays were of particular concern since these types of devices are widely available and research conducted by NHTSA indicates that two and four-line text messages can have substantial deleterious effects on commercial vehicle driver visual allocation and lane keeping performance (Tijerina, Kiger, Rockwell, and Tornow, 1996). A detailed task analysis was conducted on a select number of devices to document the number of operations/steps required to complete a range of tasks, as well as the attention demands associated with device use. This task extended the inventory of commercially available in-vehicle devices by characterizing the nature of task interactions associated with various technologies, and providing a critical analysis and assessment of the usability and safety related features of the devices.

Industry Design & Evaluation Practices

This activity assembled available information on current industry practices as they relate to the design and evaluation of in-vehicle technologies. Manufacturers and suppliers contacted as part of this activity included, among others, Volvo, International, PACCAR, Mack Trucks, Freightliner, Delphi, Bendix, and Qualcomm. The goal was to document design and evaluation practices currently used (or being developed/tested) by each manufacturer or supplier for assessing the safety and suitability of devices for use while driving. Specific information addressed as part of this task included:

- Specific standards and recommended practices used by the industry
- Evaluation procedures, measures, and criteria
- Information relating to the relative success of assessment approaches (and any results of testing they are willing to share)
- Awareness of the availability of passenger vehicle standards; their perceived effectiveness or applicability to the commercial vehicle industry
- Perceived research issues and industry needs (including perceptions of research on the issue of driver distraction and device use.)

Basic findings associated with each of the above tasks are presented and discussed in the sections that follow.

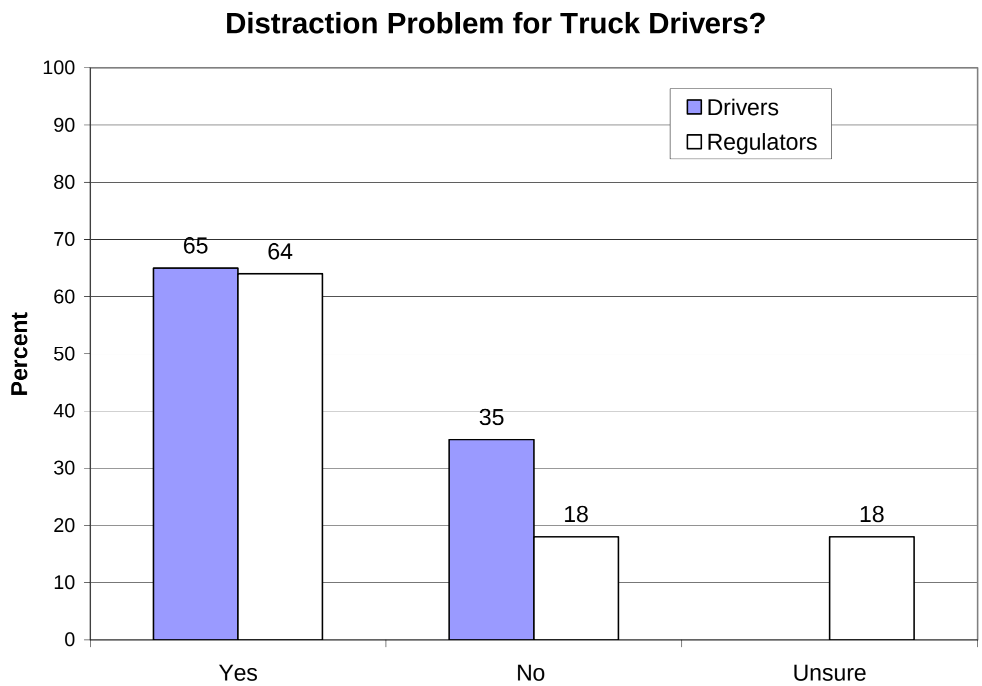
GENERAL PERSPECTIVES ON DISTRACTION

This section presents the results and findings gathered from interviews with drivers and safety personnel (including the focus group). Data for drivers and safety personnel are presented separately, where appropriate, in order to facilitate comparisons between the two groups.

Truck drivers and safety/regulatory personnel show a remarkable level of agreement in their view regarding the current distraction problem for truck and passenger vehicle drivers. As shown in Figure 1 , although many perceived distraction from the use of on-board devices to be a problem for truck drivers (64-65%), nearly all thought that distraction was a problem for passenger car drivers (91%). Several underlying reasons were offered to support this basic perception. Among them was the belief that truck drivers are trained professionals who depend on driving for their livelihood and therefore are more safety conscious than passenger vehicle drivers. Commercial drivers also have much more driving experience than passenger car drivers who tend to travel between 10,000-15,000 miles per year (commercial drivers may drive 10 to 15 times that amount). Commercial vehicle drivers were also thought to abide by more stringent rules and regulations than other drivers, and generally know when it is safe and unsafe to interact with on-board equipment. These beliefs were generally shared by both truck drivers and safety/regulatory personnel.

A significant proportion of individuals in both groups (64-65%) felt that distraction was currently a problem for commercial truck drivers. Among regulators, the problem of truck driver distraction was believed to become increasingly worse over time (82% of regulators interviewed felt driver distraction was becoming an issue). The increasing variety and availability of in-cab technologies was believed to contribute to the potential for distractions while driving. Access to technology while driving, therefore, was one of the main concerns. Figure 2 illustrates the range of available in-vehicle technologies for our sample of drivers, as well as the proportion of drivers who reported using these devices while driving. CB's and radios were present in almost all vehicles (96%), and a majority of trucks possessed the Qualcomm text messaging system[1] (87%) and cellular telephones (70% of drivers indicated having cell phones in their trucks). Many drivers also had access to laptops (26%) and televisions (35%). These percentages merely indicate the presence of a technology, and not necessarily use while driving. Self-reported technology usage (presented in the bottom panel of the figure) suggests that almost all drivers use CB's and radios while driving; furthermore, many drivers are willing to use cell phones while driving. This is consistent with findings from Hanowski et al. (2001) who found that talking on a CB and cell phone are two activities drivers frequently engage in while driving (these two tasks resulted in the largest time exposures among distraction related incidents). Our data also suggest that many drivers interact with the Qualcomm text messaging system while driving; some limit these interactions to simply reading messages (13%), but others (30%) engage in more advanced tasks such as composing and sending e-mails.

[1] The relative availability of the Qualcomm system may reflect the fact that the sample was weighted towards fleet drivers. This system is typically used as a fleet tracking and communications tool.



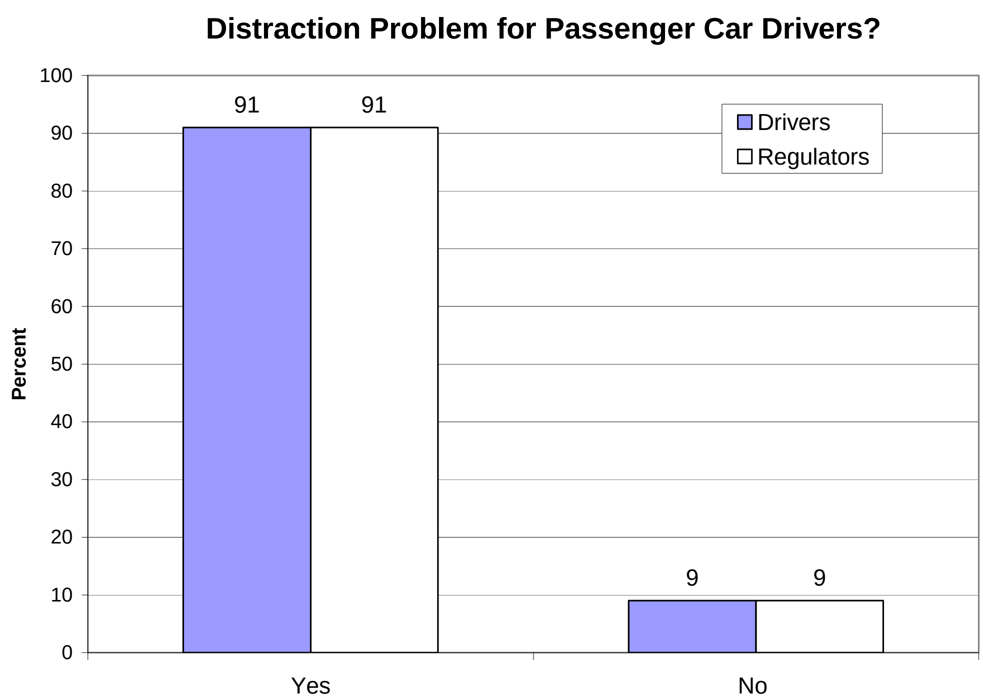
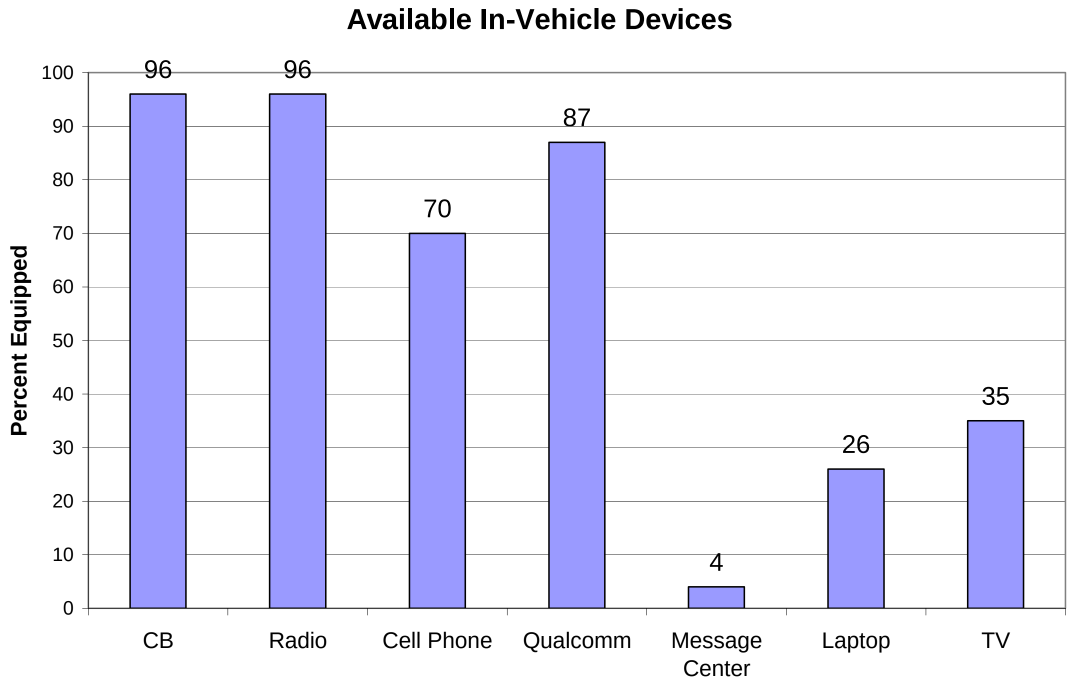


Figure 1. Percentage of Respondents Perceiving Distracted Driving to be a Problem for Truck Drivers and Passenger Vehicle Drivers,



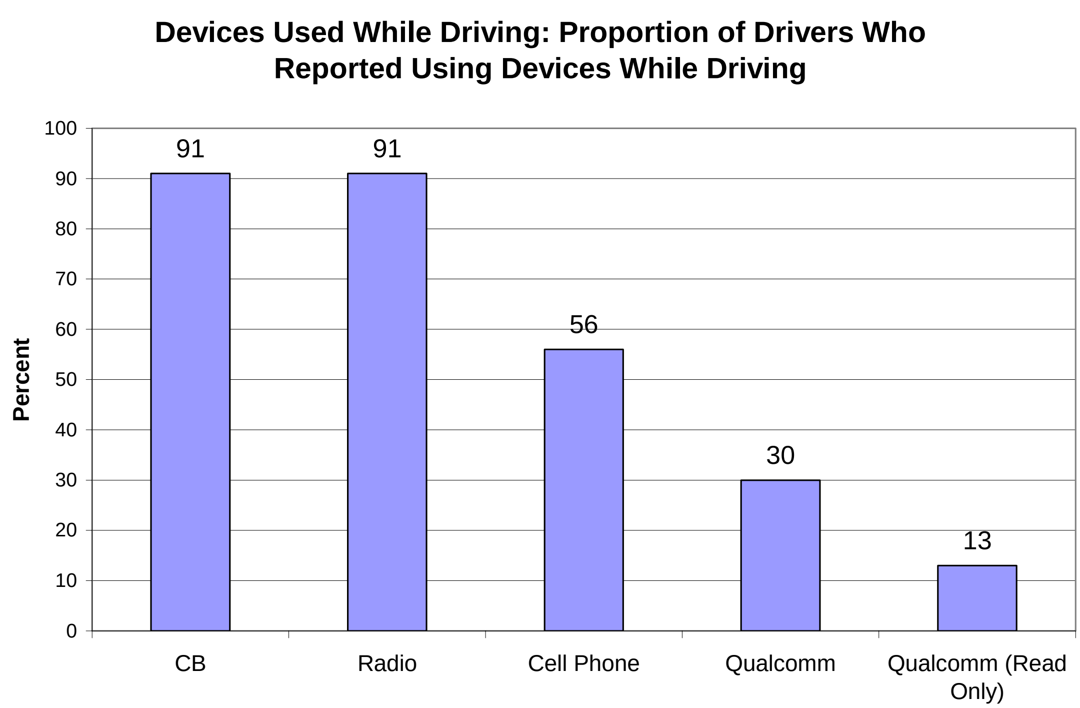


Figure 2. Availability of In-Vehicle Devices and Self-Reported Use While Driving.

Perceptions of Distraction Based on Age and Experience

This section explores driver perceptions of the distraction issue by driver age, experience, and driver type (fleet vs. owner-operators), providing an indication of whether these factors influence driver perceptions. Mean-splits were used to divide drivers along age and experience factors (the mean was used as a division point for age because of the restricted range in age and relatively small sample size). As illustrated in Figure 3, more young drivers (under age 45) tended to believe that driver distraction is currently a problem for the industry than older drivers (over age 45). Differences in magnitude could be due to system usage; young drivers may be more apt to use devices while driving than older drivers. Similarly, more experienced drivers (over 15 years experience) tended to perceive distraction as a problem than inexperienced or novice drivers. This difference could result from the added exposure associated with experience; drivers with more time on the road are likely to have experienced and/or encountered more problems attributed to driver distraction. Also, experienced drivers may more readily recognize the challenges and demands of driving a commercial vehicle and may be more sensitive to the risks of dividing attention to other secondary tasks. Finally, fleet drivers were more apt to perceive distraction to be a problem than owner-operators. Fleet drivers may have a greater number and variety of in-vehicle devices, and/or experience more non-discretionary device interactions (drivers receive more frequent calls from dispatch, and/or feel more pressure to respond immediately). Fleet drivers may also be more sensitive to distraction as a result of safety training and fleet policies governing the use of electronic devices.

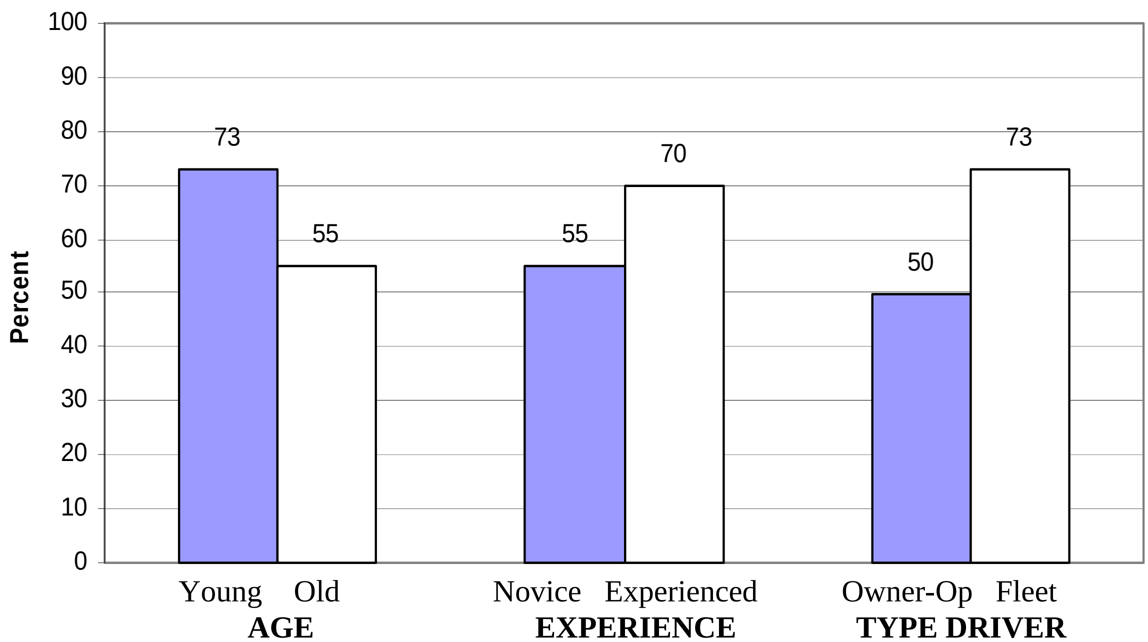


Figure 3. Driver Perception of the Distraction Issue by Age, Experience, and Driver Type. Includes Drivers Who Answered YES to the Question, "Is Distraction a Problem for Truck Drivers?"

Perceived Risk & Conditions of Use

Issues explored in this section address whether truck drivers are aware of the hazards inherent in operating in-vehicle devices while driving, and whether they exercise good judgment regarding use while driving. Specific questions targeted perceptions on device designs, as well as the extent to which drivers exercise good judgment about when it is safe to operate a device while driving (or, conversely, refrain from operating a device).

Simply because a device is installed or used in a vehicle does not necessarily mean that it is intended to be used while driving. The basic issue here is whether truck drivers recognize that some devices may not be designed for use in transit, and whether they understand the possible risks of using on-board devices while driving. As illustrated in Figure 4, most drivers and regulators acknowledge that many devices (including cell phones and the Qualcomm text messaging system) are not specifically designed to be used while driving (some pointed out the warning label on the Qualcomm device itself cautioning against use while driving). Some drivers even suggested design changes to make the Qualcomm unit safer to use while driving[2]. Discussions with the driver focus group also suggest that drivers are more likely to accept the risks associated with using technologies while driving rather than misjudge how difficult a task is to do while driving (e.g., accept the risk rather than misjudge how risky a task is). Thus, many drivers appear to be aware that some devices may not be designed for use while driving, yet accept the risks associated with interacting with devices while driving.

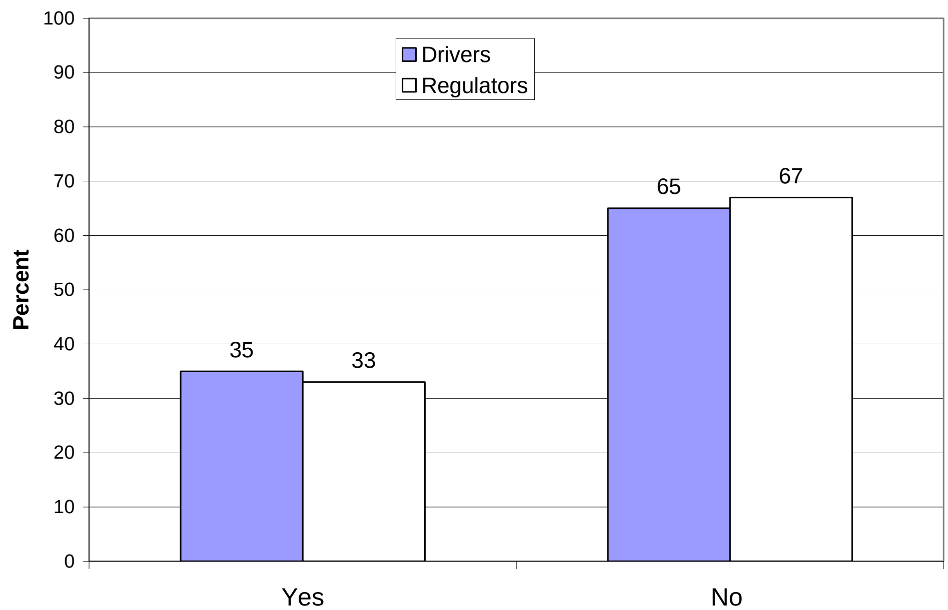


Figure 4. Driver and Regulator Perspective on Device Design:

Are Devices Generally Designed for Use While Driving?

[2] Driver-suggested changes to the Qualcomm included: larger display to limit scrolling, inclusion of a header on incoming text messages, text-to speech, device location, voice activation, a hand-set so they can acknowledge receipt of messages without reaching for the base unit, and canned message responses.

When asked whether truck drivers exercise good judgment about when it is safe or unsafe to use a device while driving, both truck drivers and regulators had similar perceptions. As indicated in Figure 5, both groups felt that *most* truck drivers do in fact make good decisions and exercise good judgment about using technology while driving. Truck drivers felt they can identify situations in which it is safe to use technology and those in which they should avoid using devices while driving. These include poor visibility, bad weather conditions, and heavy traffic; all situations where drivers need to fully concentrate on driving. Some drivers mentioned shedding tasks and turning off potential distractions such as the radio when driving conditions become difficult. Other strategies included pulling off to the side of the road to make cell phone calls or read and send text messages (using the Qualcomm system). Truck drivers also recognized that while most individuals use technology appropriately, there are some individuals who use the technology indiscriminately without regard to road, traffic, or weather conditions. Several mentioned that inexperienced drivers tend to demonstrate poor decision making in this regard; the challenges of driving a large commercial vehicle and operating technology while driving may be too great lacking experience. Many truck drivers also believed that as experience increases, so does a drivers' confidence and ability to timeshare tasks while driving. New drivers need to first learn the dynamics of operating a truck before taking on additional tasks.

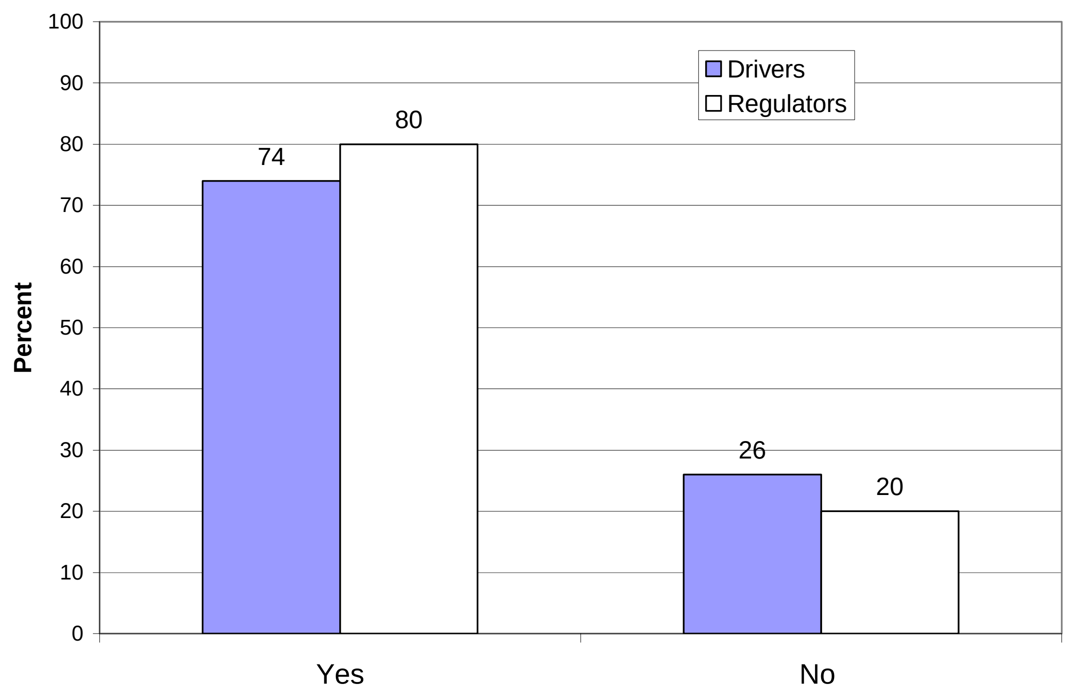


Figure 5. Percentage of Individuals Who Believe Drivers Exercise Good Judgment About When it is Safe to Use an In-Vehicle Device While Driving?

Safety/regulatory personnel tended to share these same viewpoints, however, some felt that many drivers hold misconceptions about when it is safe to use a given technology when driving. Many situations may appear to be safe (clear, dry, open road), but in fact may demand full concentration on the road since unexpected events may occur at anytime. Further, some regulators believed that although drivers may be able to discriminate appropriate from inappropriate situations, the demands and time pressure of the job may force drivers to operate a device while driving. Such pressures may lead drivers to take unnecessary risks or assume tasks that would not otherwise be performed while driving (e.g., accessing e-mail).

Drivers and regulators were asked if they felt drivers can tell if they become distracted while using devices while driving. The overwhelming majority of respondents in both groups (83%) felt that drivers can indeed tell if they become distracted (from the primary task of driving) when using on-board devices. Many commented that truck drivers generally have a heightened sense of awareness relative to passenger cars drivers, and they can cope with some distractions. Follow-up questions suggest that this is not necessarily due to an inherent driver ability or learned skill, but merely that the consequences of distraction are immediately apparent to drivers since any deviation from the lane or steering movements are magnified by the size and weight of the vehicle. Large commercial trucks have much less tolerance for error than smaller passenger vehicles, and performance degradations are quickly apparent to the driver. Thus, drivers may not become aware (or able to compensate for distraction) until they make a driving error. Some drivers commented that they have used the CB to communicate to other distracted truckers, informing them that they are driving erratically.

<u>Close Calls/Crashes</u>

Nearly half of the drivers interviewed (48%) reported experiencing a close call while using a device while driving. The majority of these situations were minor events where the vehicle drifted out of the lane while reaching or searching for a device, typing text messages, tuning the radio or CB, or reading text messages. Some close calls were characterized by a reduction in situational awareness leading to slower driver reaction times in response to an external event (e.g., lead vehicle brakes but driver is slow to detect, delayed responses to traffic signals, etc.). None of the drivers reported (or admitted to) involvement in a crash as a result of technology use while driving. Some drivers reported being aware of other drivers who had distraction related crashes resulting from the use of devices while driving. Nevertheless, a substantial percentage of drivers readily admitted to being distracted while engaged in a secondary task while driving. Several mentioned that they stopped using the Qualcomm and cell phone while driving as a result of a close call.

Use Differences In Cars vs. Commercial Vehicles

As illustrated in Figure 6, respondents in both groups were almost equally divided in their perception of whether there are any real significant differences between technology use while driving in a car versus in a commercial vehicle. Comments seemed to address three basic or underlying dimensions: 1) the physical demands of driving the vehicle, 2) the consequences of driving while distracted (tolerance for variation in driving performance and the ability to recover), and 3) the driver's situational awareness (mental/cognitive demands of driving). Both drivers and regulators tapped into one or more of these aspects. The most obvious difference related to the size of the vehicle and its handling characteristics. Many individuals pointed out that commercial vehicles are much more challenging to drive than cars, and therefore more driver focus is needed. For example, most heavy trucks are equipped with manual transmission and require drivers to use both hands; the majority of passenger cars have automatic transmissions. Commercial vehicles are also larger and heavier vehicles requiring more precise control and much longer stopping distances compared to passenger cars. Cars are smaller, lighter, and more maneuverable than trucks making consequences of a mistake less severe and easier to correct (recovery rate is perceived to be higher for cars than trucks). All these elements suggest that driving a truck requires more focused concentration and any potential distractions can significantly impair a driver's ability to control the vehicle safely.

On the other hand, some drivers felt that devices are easier to use in trucks since their increased size offer truck drivers much better visibility of the road and traffic situation; added visibility translates into greater situational awareness enabling truck drivers to better assess and plan when to use devices, and preview of unfolding traffic events ahead. The added room in the truck cockpit also affords more space for locating and mounting equipment in the truck. Some felt that the added options for placing equipment could make devices easier to use while driving (although, poorly placed items requiring drivers to reach across long distances could be counterproductive). About half of the individuals sampled felt the two were basically the same; drivers in either situation can become distracted and the real issue is with the fundamental limits in a driver's ability to pay attention to multiple things while driving. Many drivers, for example, did not think there was a difference between using technology in their truck versus their own car. These individuals argued that the same basic issues apply in cars and trucks – driver alertness can be sacrificed if distracted while driving.

Although not related to ease of use, some felt that in-vehicle devices are appropriate and purposeful in trucks since they support the driver in their job, whereas such devices represent mere conveniences or toys for the vast majority of passenger vehicles.

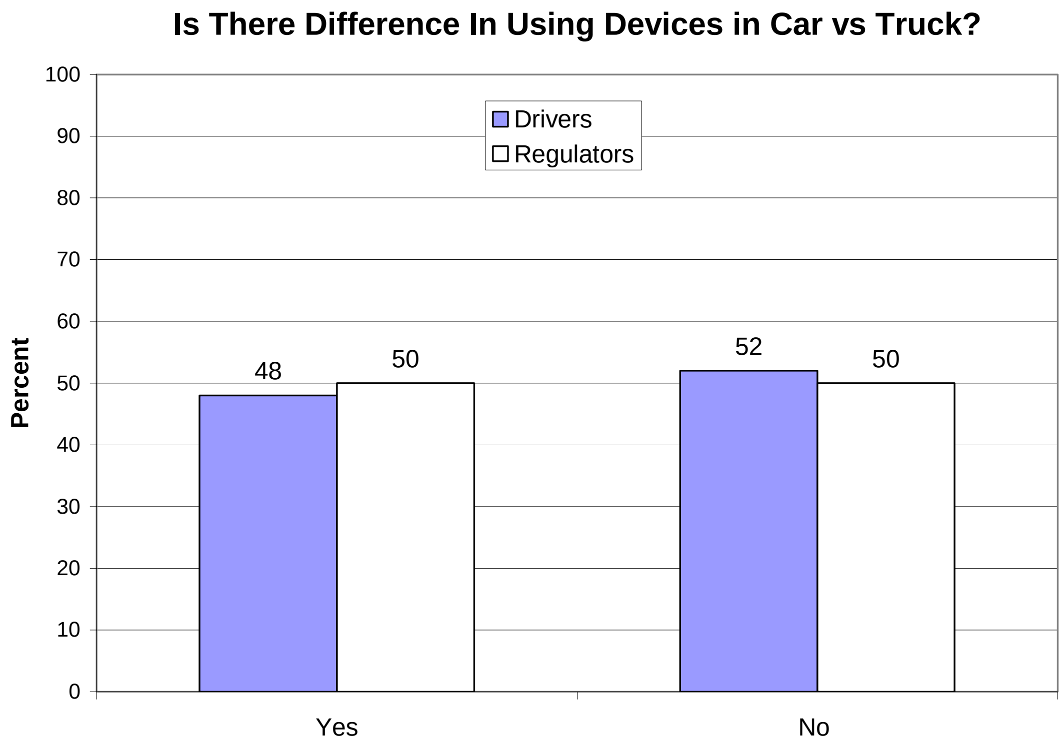


Figure 6. Proportion of Respondents Who Perceive Differences

Between Technology Use in Trucks vs. Cars.

Perceptions of Fleet Safety

Although many drivers believe commercial fleets tend to be safe, they recognize that there is considerable variation across individual companies with respect to their level of safety consciousness. Some companies may sacrifice safety for productivity. Examples of this include pressuring drivers to continue to drive even when drivers are sleepy or fatigued, or creating an atmosphere where drivers are encouraged to exceed their hours of service in order to make a scheduled delivery on time. Similarly, safety personnel also perceived a large amount of variability across fleets in terms of their level of commitment to safety and vehicle maintenance. Industry safety and regulatory personnel were also quick to point out that fleets with poor safety records also tend to have poor vehicle maintenance records. Safe fleets were perceived to have a commitment to driver hiring and training practices, vehicle and equipment maintenance, and knowing and obeying the rules, including operating within the hours of service. Nevertheless, driver distraction was perceived by many to be a driver issue, not limited to a particular fleet or group of drivers. Few individuals interviewed felt that fleets were safer than owner-operators; fleets were perceived to have better equipment, but also a greater variety of equipment.

Impacts of fleet policies were also explored. Some fleets have adopted policies against the use of a technology while driving. For example, one of the fleets interviewed has a policy in place against use of the Qualcomm text messaging system while driving. The fleet even installs the devices in a location to discourage use while driving (on the passenger side). Nevertheless, even individuals in fleet management recognize that the practical reality is that drivers may sometimes access the system to read messages while driving. Some drivers even admitted breaking company policy, believing that reading a text message while driving is safer than stopping along the roadside. The effectiveness of these types of policies was generally regarded as marginal by many of the safety personnel interviewed. As illustrated in Figure 7, many were skeptical or unsure of their effectiveness. Some argued that these policies merely serve as a legal buffer, and are hard to enforce. A slim majority thought policies do work; however, effectiveness was perceived to be tied to enforcement.

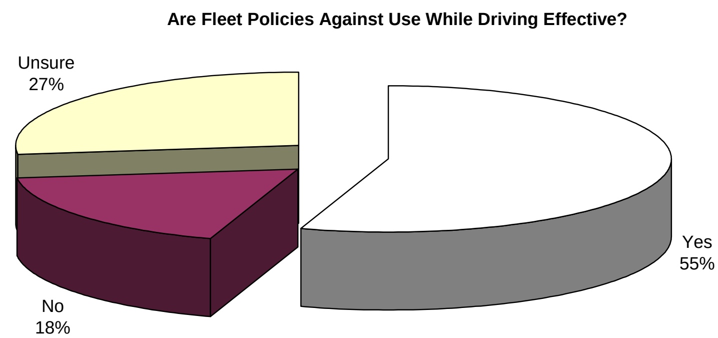


Figure 7. Percentage of Safety/Regulatory Personnel Who Perceive Fleet Policies Against Use While Driving to Be Effective.

DEVICE INVENTORY & ANALYSIS

This task analytically examined a sample of existing truck devices in order to assess their design and provide a basis for determining the following:

- Extent to which device features conform to existing human factors guidelines.
- Extent to which device design parameters are not adequately addressed by available guidelines.
- Similarities and differences between heavy truck and passenger car systems and devices.
- Extent to which existing research methods and metrics can be used to assess the impact of different device features and operations on driver use and performance.
- How multiple devices and systems are being combined in trucks, either as OEM or aftermarket.
- Issues to be resolved through additional research.

A comprehensive list of available devices was developed. This list expanded upon the set of heavy vehicles devices previously identified and compiled by Westat (Llaneras and Singer, 2002). A review of relevant literature, existing human factors guidelines, and truck devices was also performed as part of this activity. This information was used as a basis for analytically assessing the extent to which the display operation and interface characteristics of targeted devices conform to known or published human factors guidelines and research. Truck manufacturers and suppliers were also contacted in order to gather further insights into these devices as well as solicit information on existing evaluation methods and criteria as well as identify perceived needed research.

Summary of Available Devices

Original Equipment Manufacturer's (OEMs) and suppliers were interviewed to obtain basic descriptive information about systems with which the truck driver may interact while driving. The in-vehicle systems included telematic systems, safety and warning devices, navigation, and multi-function systems (e.g., fleet management). A database of fifteen products is contained in Appendix D that includes product descriptions, and industry contact information. Unit pricing was often difficult to define due to vehicle pricing packages, system options, and operation packages.

The following devices are included in the database.

- AutoVue Lane Departure Warning System
- Bendix X-Vision (night vision system)
- Delphi Truck Productivity Computer (multi-functional device, similar to the AutoPC)
- Eaton Vorad and Smart Cruise (Adaptive Cruise Control)
- Freightliner Driver Message Center
- Freightliner Rollover Stability Advisor
- Global T-Fleet communications and tracking system
- Mack VIP display (multi-functional message center)

- MobileMax communications system (text messaging)
- Mobuis TTS Onboard Computer
- PACCAR Driver Message Center
- People Net Wireless Fleet Solutions
- Qualcomm Fleet Advisor & MvPC (text-messaging)
- VDO FM System
- Volvo Driver Information Display & Volvo Link (text messaging)

One common finding is the widespread use of multi-functional devices in the industry. All OEMs interviewed (with the except International) reported offering at least one multi-function display in their vehicles. The purpose of these displays is to provide warnings and diagnostics information, as well as provide a means for integrating other driver/fleet communication functions. Many systems also provided the capability to limited driver interaction with the display/unit while driving, although some flexibility exists regarding the manner in which particular devices can be configured. For example, some text communications systems have a lockout feature to limit driver interaction with the system while the vehicle is moving. For some systems, this feature is standard. More commonly, the systems allow the customer (i.e., a fleet) to select the level of interaction a driver may have with the system while the vehicle is moving. The sensor for the lockout feature is normally activation of the parking brake, but can also be a speed sensor. The selectable level of interaction while the vehicle is moving may range from ‘no restriction’ to ‘full lockout’ while the vehicle is moving. In addition to the lockout feature, the fleet may set the priority on each message that is sent. Usually there are 3 levels of message urgency. Therefore, some organizations may choose to allow the driver to only read emergency messages while driving.

There is one system (Delphi Truck Productivity Computer) on the market that has a voice synthesis capability in order to limit operation while driving. In other words, the system automatically reads a message aloud. This particular system limits driver outbound interactions while driving by only allowing single button pre-programmed messages to be sent while the vehicle is moving. This system is relatively new on the market and it is not yet clear how well the voice synthesis feature will be accepted.

Some technology systems are intended to focus the driver’s attention on a specific driving task. Examples of this type of system are the AutoVue, a lane departure warning system, and the Eaton Vorad, a proximity warning system. These systems are primarily passive, that is they require little or no interaction with the driver while the vehicle is moving except when a warning sounds. These warning systems may help to minimize specific risks associated with driving while distracted. A number of driving aids are also available. The Bendix X-Vision system is in a unique category within this particular study. It provides the driver with a thermal imaging view of the road ahead at night. This can significantly increase the driver’s forward visibility of obstacles. This system is also primarily passive, requiring only that the driver turn the system ON/OFF and adjust the display brightness and contrast.

Device Overviews

Brief descriptions of several of these systems are provided in the sections that follow.

<u>Delphi Truck Productivity Computer</u>

This system was originally developed by Freightliner and is currently being marketed by Pana-Pacific/MobileAria as part of their FleetOutlook system. The basic device is similar in concept to the AutoPC, and integrates multiple functions into a single common in-dash interface unit (e.g., 1-DIN). Functions bundled under FleetOutlook include: Two-way messaging, radio, navigation and routing, driver logs, fuel tax accounting, trailer tracking and monitoring, automated alerts (traffic, weather, truck speed), and productivity metrics. Several design elements have been integrated into the concept in order to reduce distraction; these include, among others:

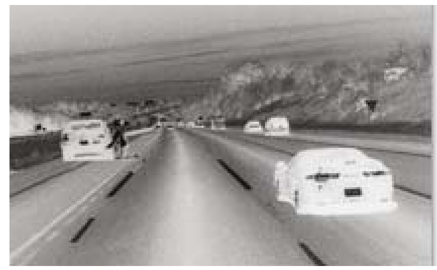
- Text-to-speech
- Integration of functions within a single common interface framework
- Dedicated hard controls for frequently accessed functions
- System status and control input feedback in both visual and auditory forms
- Shallow menu structure

The system features text-to-speech technologies capable of "reading" displayed information and presenting it to drivers over the truck speakers. Messages from dispatch, for example, can be auditorally presented to the driver while the vehicle is moving, reducing the need to glance to the display to read messages. The high contrast electroluminescent monochrome display (320 x 80 pixel) is designed to be easily to read and viewed across a range of lighting conditions. The unit's 18 soft control keys are shape coded and designed to allow for easy operation with a gloved hand. Controls provide sufficient spacing for this purpose with keys spaced between 18-21 mm (between key center-points). Controls include dedicated program access keys which provide quick access to critical or frequently used programs; state dependent keys whose functions vary based on the particular program or application; and fixed function controls such as power, volume, back and eject buttons. The system is also designed to minimize, visual and cognitive load, by controlling the flow of information to drivers. Some programs, for example, can not be accessed while driving; only accessible programs are displayed while driving. System feedback includes simple confirmation of inputs, audio alerts when new information is presented, as well as visual indications when processing delays greater than 1.5 seconds are encountered.

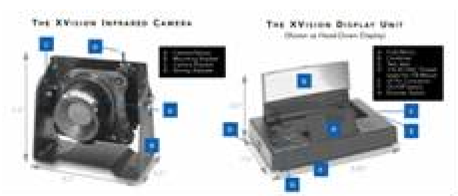
Mack Vehicle Information Profiler (VIP) Display

This OEM furnished system consists of an in-dash display center which provides drivers with vehicle electronics data such as fuel mileage, trip data, and fault alerts. The high-resolution 6" diagonal display (41/2" x 3 3/8") supports information in various formats including text, charts, and diagrams. The system features 10 lighted, dual-function pushbuttons and a main menu with 9 items. Over 50 menu screens are accessible; however, drivers are provided limited access to information while the vehicle is moving (access to all 50 screens is resumed when the vehicle is stopped). No deeper than 3 menu layers are required to access information. The system also provides audible alerts to drivers, warning of potential problems (e.g., engine protection warnings, engine and engine brake overspeed operation, idle shutdown, etc.). Much of the information presented on the trip and sensor display screens is presented both graphically and in text format with precise numeric outputs. This practice tends to result in "busy" displays, but the information is well grouped and by bounding items, drivers may be able to quickly assess system status.

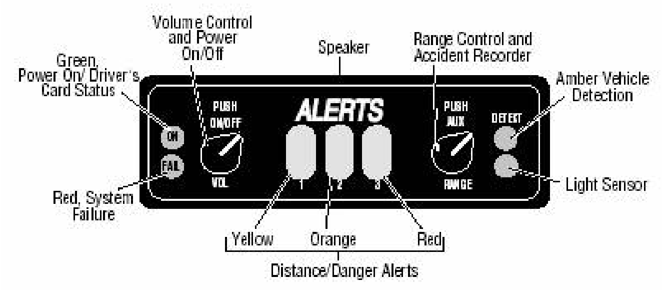
Bendix X-Vision System



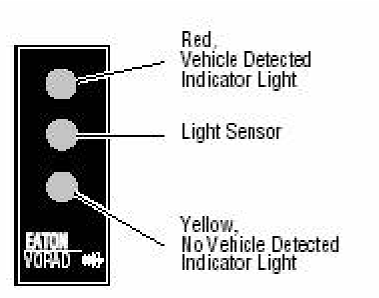
X-Vision is a collision-avoidance aid developed for trucks, buses, and other commercial vehicles. It is very similar to Cadillac's Night Vision System. An infrared camera mounted on the vehicle's exterior captures thermal images of the road up to 1,500 ft ahead, and transmits these images, in real-time, to an in-cab display unit. The display unit is about the size of a rear-view mirror (2" high by 6.5" wide), and can be mounted in two different locations within the drivers cone of vision (above the driver's line of sight, flipping down like a visor, or on the dash, flipping up from the console). Images in the display are depicted proportionally to the images seen through the windshield (system uses a 1:1 viewing ratio). As with the Cadillac system, objects appear as black and white images, and the system has an on/off switch and a dimmer switch to control the brightness of the displayed images. The manufacturer claims that the system can increase a driver's visibility at night between three to five times beyond that provided by the vehicle's headlights alone. The display will also integrate TV cameras and other safety and information systems. XVision was released in December 2001 as a retrofit system following 18-months of product development and testing which included laboratory, test track, and on-road evaluations. Results of a human factors evaluation of the system conducted by Bendix (Bendix, 2002) suggests that the system can provide an additional 11 seconds of driver reaction time, and decreased the time required to detect a pedestrian at 60 mph. The evaluation, conducted on a closed course test track at night, required a sample of 24 drivers to complete 96 laps around the course (approximately 200 miles) and respond to both staged and un-staged events. X-Vision was reported to impose no additional workload, distraction or contribute to driver fatigue; drivers were able to maintain lane position and speed at both 30 and 60 mph while using the system.



Eaton VORAD Collision Warning



The EVT-200 is primarily a radar-based forward and side collision warning system intended to alert drivers to presence of an obstacle either in front of or to the side (or blind-spot) of the cab. The forward collision warning system provides a staged warning strategy providing drivers with distance alerts when the vehicle ahead is within 3, 2, 1, and 0.5 second time-to collision. Drivers can adjust these distance alerts to some extent using a range control knob on the device. Alerts provide both visually and auditorally; the first stage warning (3 sec TTC) is limited to visual only to reduce annoyance. The system is also capable of providing only an imminent crash warning (in essence skipping the first three staged alerts) and does so to warn drivers of stationary objects, or situations where a detected object is within 220ft and moving at least 20% slower than the host vehicle. The optional right-side collision warning sensor is mounted along the side of the cab with the display located to the right side A-pillar inside the truck (consistent with the driver's line of sight to the right side mirror). The system is activated when the vehicle's turn signal is engaged and provides an audible and visual warning to indicate the presence of a vehicle along the right side of the cab (in the driver's blind spot). A left side warning system is also available, and is also limited to objects to the side of the cab.



Although Eaton VORAD does not provide a system to cover the sides or rear of the trailer, we are aware of at least one manufacturer (Transportation Safety Technologies) that has developed an aftermarket system that provides sensor coverage around the sides and rear of the trailer. The Eagle Eye electronic obstacle detection system (www.tst-eagleeye.com) uses seven ultrasonic sensors mounted around the trailer and is intended to warn drivers of obstacles within 10 feet of the trailer when backing and changing lanes.

QualComm Text Messaging System

QualComm provides a variety of mobile communications and fleet management systems, including OmniTracs, OmniExpress, and Fleet Advisor. The company claims that over 2,000 fleets are equipped with their mobile technology, and intercept studies conducted at truck stops and rest areas conducted as part of this project suggests that these devices are indeed widespread within the trucking community. The level of services provided by QualComm can vary from two-way real-time data communications, to optional two-way voice, to automatic GPS vehicle tracking and vehicle sensor and diagnostic information depending on the system and configuration. Some systems can also be integrated with customized or third-party software (i.e., on-board navigation, state fuel tax reports, DOT logs). Three driver display units are available on the market, each with an integrated keyboard and multi-line text display. The Standard Display Unit provides a 4-line by 40-character display (5cm x 13cm display area). The Enhanced Display Unit provides a 6" diagonal, 15-line by 40-character display supporting both text and graphics. The MvPC is the most recently introduced display unit which features a 6.5" diagonal touch screen display with expanded capability (consistent with a mobile computer).

Our experience suggests that many fleets rely on the Qualcomm as the primary fleet communications device (used to provide status information from drivers such as Estimated Time of Arrival, updates, routing information, as well as notify drivers of problems, send information about deliveries such as back hauls – unplanned cargo to bring back, etc). This is usually accomplished via text messages (no voice). Drivers can communicate with fleet dispatch as well as others drivers. Interviews with drivers suggests that the Qualcomm system is perceived to be a very effective tool - drivers drivers, fleet management, and safety personnel all like the Qualcomm. The device was thought to increase driver safety and security, and increase productivity.
The display unit can be mounted in the vehicle cab using a specially designed cradle which is customized to the tractor. In practice, we found a wide range of mounting locations for the device. Some common locations included the center dash, on top of the dash itself (in between the driver and passenger), overhead behind the driver, on the side of the driver's seat, and on the dash nearest to the passenger. Some drivers did not use a mounting holster and placed the unit on the floor of the cab or under the seat. The display can be difficult to see off-angle, but the majority of drivers interviewed tended to remove the device from its cradle when using it (some would position it over the steering wheel). Nevertheless, some trucking companies intentionally mounted the display to discourage drivers from glancing at the display or interacting with the device while driving.

The main menu can be accessed from any screen with a single button press. The text messaging software features 38 pre-formed messages, and is capable of supporting free-form text messaging (38-41 characters per row), as well as text files. Canned or pre-formed messages can vary in terms of their level of complexity; some require very little or no inputs from drivers, while others resemble forms requiring drivers to input a series of items in order to complete the form. Thus, while pre-formed messages may limit the level of driver interaction required to send a message, they do not necessarily completely eliminate the need to input information (some pre-formed messages require significant text entry by drivers).

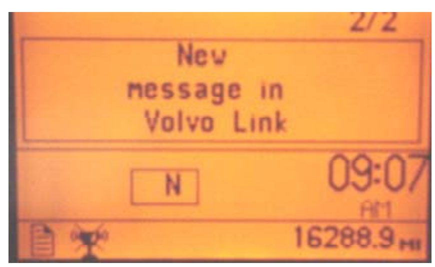
Drivers are alerted to incoming messages via an auditory beep as well as a message waiting LED on the unit which illuminates (steady burn) when a message is received. Dispatch can assign two different priority levels to messages; the message waiting light flashes for high priority messages allowing drivers to distinguish them from standard messages. Messages are presented in tabular form (much like e-mail) with the date, time, label, and status indications (incoming, outgoing, sent, read, etc.).

The QualComm is intended to be used by drivers when the vehicle is stationary, and the system provides some features intended to support this design goal, including lockouts of the display, keyboard, and specific applications (a label warning against use while driving is also stamped onto the unit itself). The MVPc, for example, can be locked (or frozen) into an application mode (e.g., navigation) when the vehicle is moving – drivers can not access other applications until the vehicle is stopped. Similarly, e-mails and other text messages can only be opened and read when the vehicle is stationary. Lockouts, however, are optional and customizable. Again, interviews with drivers suggest that while some companies configure their units to lock out advanced functions while driving, this is certainly not universally implemented. Drivers also seemed to prefer some discretionary use based on demands as opposed to general universal lockouts. Many drivers, for example, felt that reading a message is sometimes safe to do while driving (incidentally, typing messages was not generally perceived to be safe while driving). Drivers, therefore are confident they know when it is safe to read messages, and would like to have the option to perform some tasks while driving if conditions allow. The general perception that reading a text message is safe to do while driving is interesting since research (Tijernia, et al., 1995) suggests that driving performance (visual allocation and lane keeping) can be significantly impaired when reading multi-line text displays, particularly 4-line text displays (Qualcomm unit uses a 4-line text display, and a 15-line text display). Text messages on the display can be difficult to read requiring more time to extract the information. This is because text is presented in uppercase characters, and the system lacks a text wrapping feature which means that words can be broken-up between lines making the physical layout of text messages more complex.

Volvo Link

Volvo Link is an in-vehicle satellite communications system which allows drivers to receive and send e-mail type text messages. Messages are visible through a multi-line graphic display screen embedded within the instrument cluster. Several lines of text are visible in the display at one time (scrolling is required for long messages). The integrated display also serves to access other functions including general vehicle performance data (fuel data, trip time/distance, and gauges information) in addition to the Volvo Link system. Drivers are generally only able to read and send messages when the vehicle is stationary. If drivers attempt to send a message while the vehicle is in motion they will receive a notification indicating, "Stop vehicle to send message." Similarly, if drivers attempt to read an incoming message while driving the display will post the following message, "Stop vehicle to read message." Nevertheless, the system does allow drivers to read and respond to priority messages while driving. Some restrictions apply to reading and sending priority messages. These include the following: the vehicle must be traveling at or below 55 mph (this is the default for viewing priority messages); only the most recent message can be accessed while driving; and drivers can only respond to priority messages while driving using a "Quick Response" which uses a pre-defined message. Standard system messages cannot be read while driving (this includes writing free-form text messages).

Drivers are alerted to the presence of a message and its priority level (normal vs. high priority) through a text message in the display (e.g., "Priority message in Volvo Link"), as well as through a dummy light (INFO lamp) in the vehicle's instrument cluster All four system controls are located on a stalk off the steering wheel column. Menu structures are limited to 3-4 items, and are functionally organized by task (e.g., read message, send message, etc). Drivers can respond with three types of messages: predefined text, breakdown, and free-text messages. Pre-defined text messages (i.e., canned messages) require no additional data entry (some other systems reviewed, used form-like canned messages, requiring some data input from drivers), and are consistent with common needs identified in the industry (e.g., "load picked up", "load delivered", "late arrival: less than 1 h", etc). Breakdown messages are also predefined messages that relate to mechanical problems with the equipment or problems requiring assistance (e.g., "tow truck needed", "tractor tire", etc.). The system also allows for additional text messages (predefined and breakdown) to be tailored or defined by the company/fleet. Drivers can send an e-mail message using the



predefined text or breakdown options with as few as 4 key presses. Most of the messages or responses sent by drivers with this system are available in this predefined message library. Drivers may also choose to write their own messages using the Free Form option. The process for composing Free Form messages is more complex and demanding than pre-defined messages, requiring drivers to scroll through a set of alphanumeric characters and select each item individually to construct words. Sending a similarly worded message using this option can take 15 times more key presses compared to a canned message (see task specific interactions). Given the complexity of this task, free-form messages can only be written when the vehicle is stationary (the system locks-out free-form messages when the vehicle is moving). In all cases, drivers receive confirmation once the message has been sent. The Volvo Link system is available in Volvo 2002+ model year trucks and can be retrofit in trucks as late as 1998 using a smaller display.

Analysis & Task Interactions

This section highlights details for a select sample of commercially available in-vehicle devices regarding their interface design and correspondence to accepted human factors practices. Systems that provide text messaging capabilities were emphasized in our review and analysis since they represent relatively widespread fleet management and communications functions. In-depth reviews and assessments were conducted for the QualComm and Volvo Link systems since they were accessible and provided comparable functions, including reading and sending text messages. Several recent human factors design guidelines and recommended practice documents were used in deriving analytic assessments of these devices, including: guidelines for Advanced Traveler Information Systems (Campbell, et al., 1998: Green et al., 1995); the European Commission Statement of Principals for HMI (Board and Stevens, 2000); Transport Research Laboratory's Safety Checklist for the Assessment of In-Vehicle Information Systems (Stevens, et al., 1999); and the Alliance of Automobile Manufacturers (AAM) Driver Focus-Telematics Working Group statement of principles, criteria and verification procedures on driver interactions with advanced in-vehicle information and communications systems (AAM, 2002). These documents are intended to limit the distraction potential of in-vehicle systems by identifying key Man-Machine Interface issues to be considered in the design and implementation of driver information and communication systems.

Key device design parameters for each text messaging system were documented using an inventory form developed in a previous effort (Llaneras and Singer, 2002); the design parameters captured were based on the HMI elements outlined in the set of guidelines and practice documents outlined earlier . The form captured a range of interface characteristics, features and implementation aspects including the following elements:

- Display and control characteristics (type, location, legibility, number of menus, etc.)
- Type of interaction modes (auditory, visual, haptic, etc.)
- Device interlocks or design restrictions
- Range of device functions/features
- Level of integration (stand-alone versus integrated within and across systems)
- Number of operations required to perform selected tasks
- Use of consumer product use warnings and guidelines

Task interactions with these devices were also quantified and detail the number of steps and key/button presses required to complete some common tasks including sending and reading e-mail messages. Appendix E presents the detailed interface and task interaction data sheets for these systems. In general, the systems were well designed in terms of the physical human factors characteristics associated with the controls and display. One notable exception is the lack of text wrapping with the QualComm system which can make multi-line text messages difficult to read. Truck drivers in our sample were accustomed to reading these displays, but recognized the basic limitation with the display. Since the QualComm system is an aftermarket device, the physical location of the display was not standardized and varied substantially in our experience. Both systems provide mutli-line text displays, and include provisions for limiting driver interactions while driving. The level of interaction required to complete a task using either system varies based on the type of task as well as the input method. As shown in Figure 8, sending an e-mail using the free-form method requires substantially more key/button presses compared to canned or pre-defined text messages. Either system allows drivers to send a basic message in a few key presses with canned e-mail; while composing free-form text messages requires a minimum of 33 key strokes with the QualComm and 59 keystrikes using the Volvo Link. Composing free-form text messages appear to require the same types of demands (in terms of button presses) as destination entry in some navigation systems. Differences in the number of keystrokes between the two systems for sending free-form messages is due to the fact that the QualComm has a physical keyboard while the Volvo Link system presents an electronic character set which requires user to first highlight and then select individual characters. Not surprisingly, both systems restrict the driver from sending free-form messages while the vehicle is moving (fleets must elect this option for the Qualcomm. A warning message, however, is stamped onto the unit indicating not to use while driving). Accessing e-mail messages to be read is accomplished with a minimal number of keystrokes; the issue here of course is the visual demand associated with reading messages. Both devices include the provision for preventing drivers from reading e-mails. In the case of the Volvo Link, drivers can access priority e-mails while driving. Many truck drivers in our sample indicated that they felt comfortable and capable of reading e-mail message while driving.

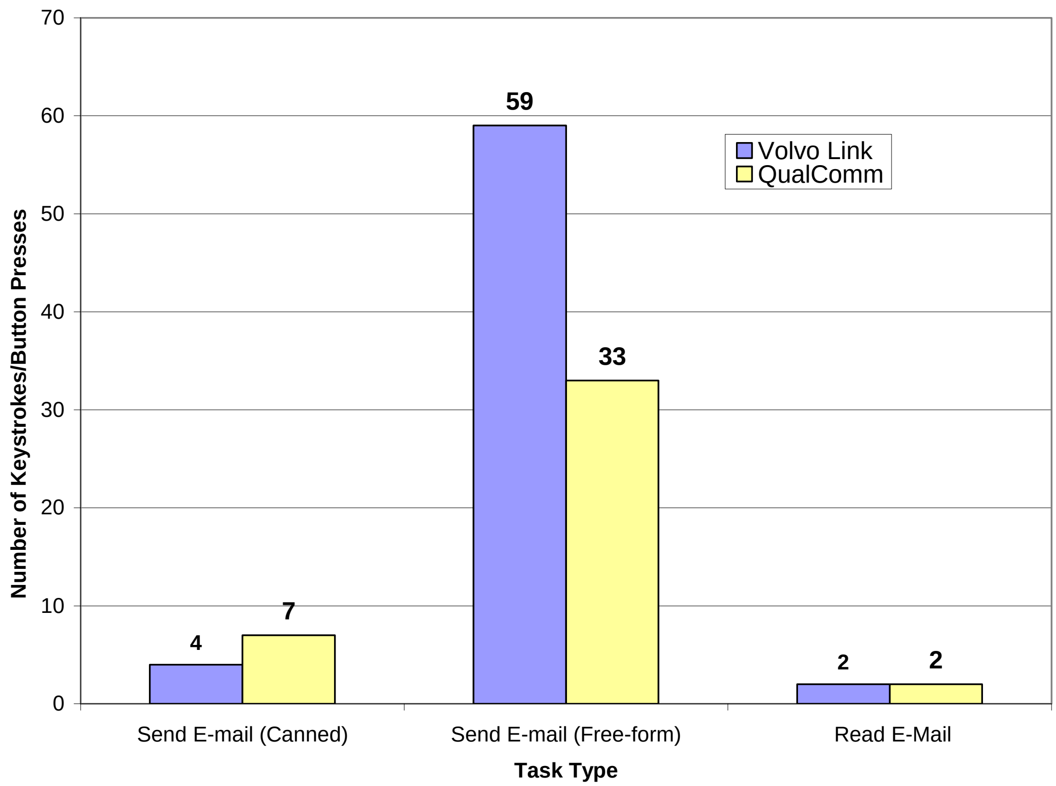


Figure 8. Number of Keystrokes/Button Presses Required to Send and Read E-mail as a Function of Input Method

INDUSTRY DESIGN & EVALUATION PRACTICES

The manufacturers and suppliers of the systems included in the Equipment Survey were asked to participate in a second interview about current industry practices and procedures. The purpose was to assemble available information on current industry practices as they relate to the design and evaluation of in-vehicle technologies. The organizations that elected not to participate did so for a variety of reasons. The most notable reason given was that the information requested was considered competition sensitive. Six organizations agreed to participate in an interview. It is noteworthy that most companies included more than one person in the interview process because of the variety and questions. Some questions were perceived as requiring a technical answer while others were perceived as requiring a managerial or legal response. A list of the interview questions is included in the Appendix C. In general, the questions cover industry standards and recommended practices for device design (including evaluation procedures, measures, and criteria; and information relating to the relative success of assessment approaches), and perceived research issues and industry needs.

Industry Standards and Recommended Practices

Table 1 lists the standards, recommended practices, and documents that are used by the respondents. There is a wide range of familiarity with documents related to driver distraction. Some companies only mentioned using standards related to the physical aspects of product design. These companies indicated a vague awareness of papers and articles that have been published on the subject in general, but did not consider them as useful for the product development process. Some companies considered a list of documents beyond well-known standards to be competitive sensitive information.

Even those companies that were not willing to share a specific list of documents were willing to discuss the issue in general terms. Some of these companies have human factors specialists on staff. In general, those companies were confident that they had knowledge of, and access to, a wide variety of documents from within the broader automotive industry. A key piece of information is that the human factors specialists are sometimes located in a separate part of the organization from the engineers designing truck products. In practical terms, this means any information that is considered specialized is only accessed when someone takes an initiative either to request assistance (from the product development side) or to provide potentially useful information (from the specialist side).

Table 1. List of Standards, Guidelines and Recommended Practices Referenced by OEM's

Area/Source	Standards, Recommended Practices and Guidelines	Other Documents
Outside the Trucking Industry Note: Some military standards apply directly to the development of military trucks, but most of the respondents also considered them to be reference material for commercial product development.	DOD-HDBK-743 Anthropometry of U.S. Military Personnel MIL-HDBK-759 Human Factors Engineering Design for Army Materiel MIL-HDBK-761 Human Engineering Guidelines for Management Information Systems DOD-HDBK-763 Human Engineering Procedures Guide MIL-STD-1295 Human Factors Engineering Design Criteria for Helicopter Cockpit Electro-Optical Display Symbology MIL-STD-1472 Human Engineering Design Criteria for Military Systems, Equipment and Facilities MIL-STD-1478 Task Performance Analysis MIL-STD-1794 Human Factors Engineering Program for Intercontinental Ballistic Missile Systems MIL-STD-1908 Definitions of Human Factors Terms MIL-HDBK-46855 Human Engineering Requirements for Military Systems Equipment and Facilities	
Passenger Vehicle Industry		HASTE project in Europe, an ongoing project "Strategies for Reducing Driver Distraction from In-Vehicle Telematics Devices: A Discussion Document", Transport Canada, June 2003 Statement of Principles on Human Machine Interface (HMI) for In-Vehicle Information and Communication Systems (DRAFT) Dec 2000, Alliance of Automobile Manufacturers
Truck Industry	J951 J1100 J1516 J1517 J1520 J1521 J1750 FHWA-RD-98-057 Human Factors Design Guidelines for ATIS/CVO Internal Corporate Guidelines (unique to individual companies, not available to public)	

Evaluation Procedures, Measures, and Criteria

Industry contacts were queried about their procedures for assessing and evaluating the acceptance and safety impacts of their systems and features. The use of market research techniques, such as focus groups, user interviews, and user surveys, was the most frequent response to this question. The use of market research in the product development process is highly developed in the trucking industry. Many companies use these techniques to obtain driver feedback throughout the entire product development process including the testing and evaluation phase. As an example, focus groups are often conducted to assist a company in determining the system requirements prior to product development. They may be used again to select between multiple proposed design solutions. They may be used in later stages to confirm the final solution. The testing and evaluation phase typically includes actual driving tests by internal company drivers and field-testing by select customers. Depending on the company, the drivers will be surveyed for feedback on the system. Depending on the company, the driver evaluations may be formal or informal and may or may not be filtered through a fleet manager.

A general attitude appears to be that since users have so much input into the development of products, specific driver interface testing is not necessary. Nonetheless, formal tests conducted for the specific purpose of evaluating the driver interface and usability of a system are conducted in addition to the market research methods in some companies. It appears that objective testing methods are becoming more common.

All companies considered information about the specific methods used to evaluate the suitability of system for use while the vehicle is moving to be highly competition sensitive. Although Bendix was willing to provide a written summary of their study for the X-Vision system, the summary does not include details. Their method can be generally described as using a workload model. They defined a series of repetitive driving tasks, such as steering wheel inputs, and measured the driver’s skill on those tasks with and without the new system in the vehicle. Another method mentioned during the interviews was also a common workload evaluation method: the secondary task method. In this method, an unnecessary task is defined such as pushing a button in response to a specific buzzer. The driver’s willingness and ability to attend to the unnecessary task is the measured variable. Not too surprisingly, no one was willing to discuss specific criteria for any method.

Limited use of simulators was mentioned, but in general was not considered a viable option for most organizations. The cost of leasing time and expertise to use the National Advanced Driving Simulator, for example, was specifically mentioned as prohibitive for the normal product development testing and evaluation cycle in terms of both time and money.

There were very few comments in these interviews regarding the relative success of the various evaluation procedures, methods, and criteria. The most interesting comment related to the use of the secondary task method. They commented that even if a secondary task method is used on two different studies, the secondary task must be adjusted. This may be a change in the hardware location to accommodate different systems or vehicles or it may be a change in the task. As an example, the use of a buzzer and button task might not be appropriate if the system is to be used in a very noisy environment.

All companies were willing to consider participating in some type of industry discussion on the subject of evaluating and measuring driver distraction or the broader subject of evaluating the suitability of a system for use while a vehicle is moving. Forums that might be acceptable included a specific industry/government exchange meeting or a standing industry meeting such as SAE Truck & Bus.

RECOMMENDED RESEARCH

This section synthesizes the information gathered from each of the preceding project tasks to develop a set of research recommendations intended to outline and define areas of needed research related to commercial vehicle devices and driver distraction. The research statements provided outline basic problem areas and scope with supporting rationale, as well as highlight alternative approaches to examine and investigate problem areas. The recommendations are intended to focus on collecting data to further advance the development of guidelines, performance requirements, and criteria to minimize the impact of truck in-vehicle information, Telematics, and safety warning devices on driver distraction and workload.

Perceived Research Issues and Industry Needs

Table 2 summarizes the areas perceived to be the biggest problems/safety issues facing the commercial vehicle industry (data were gathered from focus groups and interviews with drivers and safety personnel). Responses are not presented in any particular order, and are broken out individually for drivers and safety personnel. Both groups were remarkably similar in their assessment of safety-related problems in the industry, identifying numerous common safety issues. Items in common include, among others: driver fatigue, unrealistic demands by shippers, speed differentials between cars and trucks, poor truck driver training, and lack of rest areas. Several of these safety issues are interrelated. Lack of rest areas and pressure to deliver on time was thought to significantly contribute to driver fatigue; addressing one or both of these contributory factors could help to alleviate the driver fatigue problem. Few, if any of the respondents brought up the issue of driver distraction – it is possible that they assumed we were asking for additional problems aside from driver distraction. Alternatively, individuals may not have perceived driver distraction to be among the top safety issues or concerns in the commercial driving industry.

Table 2. Perceived Important Safety Issues

DRIVERS		SAFETY PERSONNEL
• Driver fatigue and lack of sleep/rest. • Lack of rest areas and parking. • Unrealistic demands by shippers. • Pressure to deliver on-time • Dual speed limits for trucks and cars. • Truck roll-overs at ramps due to excessive speeds. • Poor training for young/new truck drivers. • Lack of education on the part of car drivers about trucks.		• Driver fatigue. • Fitness for duty (better measures) • Availability and number of rest strops • Unreasonable demands by shippers/management. No responsibility to uphold Hours Of Service • Speed differential between cars and trucks • Excessive speed • Truck driver training and

• Truck inspections. State DOTs need more freedom to be able to take problem trucks off the road • Lane restrictions (e.g., "No Trucks Left Lane"). • Better roads • Tire recaps		education • Lack of professionalism • Driver compensation • Equipment & maintenance problems

Perceived Solutions to Distraction Problem

Those in enforcement and safety were hesitant to introduce any technology bans outlawing device use while driving for a variety of reasons. Some felt that it was too late to practically implement any technology bans given that many devices are already on the market and being used by drivers. Bans were also perceived by some to be difficult to enforce and much better left to the industry itself to self-regulate and police (in the form of fleet policies, for example). Others felt that a strong case, supported by crash evidence, would need to be made before bans should be considered. Making this case on the basis of crash data was believed to be a very challenging task (proving device use led to a crash can be difficult). Some proactive solutions to the issue of distraction (proposed by safety personnel) included the following:

- Development of enhanced designs allowing drivers to safely interact with devices while driving (e.g., hands-free and voice recognition technology).
- Incorporation of device restrictions and physical lockouts which prevent drivers from accessing functions and tasks that are too risky to be performed while driving.
- Integration of devices with on-board equipment furnished by the manufacturers; eliminate the proliferation of multiple (different) device interfaces.
- Locate devices out of the driver's reach so they cannot be accessed while driving.
- Reduce the urgency of communications (e.g., tag information with priority levels, automate process, etc.).
- Allow insurance companies to self-police the industry. Insurance rates will increase if a widespread problem emerges. Higher costs will necessitate actions by industry since it is a profit motivated endeavor.

Research Statements & Suggested Recommendations

- <u>Collect & analyze commercial vehicle crash data to identify relative contributions of distraction associated with device use to crashes</u>. The relative contribution of distracted driving (and distraction associated with in-vehicle devices) is not well understood or known. Despite the availability of a wide number of crash databases (e.g., Fatality Analysis Reporting System, Trucks in Fatal Accidents, General Estimates System, Motor Carrier Management Information System Crash File), no nationally representative data on large truck crash causes currently exists. NASS-GES data gathered from police accident reports does include driver distraction associated with the use of in-vehicle technology, but additional heavy truck crash data is needed. The Federal Motor Carrier Safety

Administration (FMCSA) and NHTSA are jointly addressing this problem by developing and compiling nationally representative data containing information describing the causes or contributing factors associated with large truck crashes (trucks over 10,000 pounds gross weight). The database (hereto referred to as the Large Truck Crash Causation Database) samples large truck crashes resulting in serious injury or fatalities, with information collected by trained investigators from NHTSA's National Automotive Sampling System. Data collection forms include narrative descriptions and catalog pre-crash events leading up to the crash as well as assessments of crash causation, including driver factors such as distraction and technology use (e.g., dialing phone; adjusting radio/CD; conversing on CB, phone, or with passenger, etc.). This database is expected to serve as a rich information repository for understanding the relative contribution of distraction in large truck crashes. Many individual States also maintain records of truck crashes, and could serve as an alternative or supplemental information source. Specific activities conducted in support of this research should include review of the data collection forms and coding schemes, as well as familiarization with the structure and content of the statistical database and associated data analysis tools. The analysis should provide insights into the basic relationships between truck crashes and distraction as well as:

- Identify and characterize crash types and situations,
- Identify, classify, and quantify distraction sources contributing to crashes,
- Identify types of trucks (straight, combination, delivery, etc.) and roadways involved in distraction related crashes,
- Relate specific types of distraction to crash profiles,
- Contrast distraction-related crashes to non-distraction crashes,
- Identify systems or devices known to have contributed to truck crashes, and
- Provide a basis for comparing results to light vehicle distraction related crashes.

- <u>Conduct naturalistic studies of commercial vehicle drivers to characterize impacts of device use while driving</u>. Crash data is difficult to obtain and may be limited in terms of providing direct information about the relative crash contributions of distraction associated with device use as it relates to NASS-GES, individual State data, and the Large Truck Crash Causation Database. Surrogate safety measures can be defined and obtained under naturalistic driving conditions using instrumented vehicles. Vehicle performance data and safety surrogate measures can be used to assess the impacts of device use on safety under a range of real-world environments, operating conditions, and across a variety of drivers. The sample would need to consist of fleets or trucking companies equipped with a range of devices, and who would be willing to cooperate in an instrumented vehicle study using their own trucks (preferable) or a truck furnished by the organization conducting the study. Text-messaging systems are widely used and available and would serve as a good representative candidate technology to investigate. Systems with alternative interface designs should be included in the study in order to assess the impacts of various designs (e.g., display size, text-to-speech, etc.). In order to maximize opportunities to capture meaningful data, the sample should consist of fleets which are not only equipped with the technology, but routinely use the systems as part of their normal course of business with no policies against use while driving. Drivers recruited for participation should also be frequent or routine users of the technology. The results of the study would help to identify the potential safety impacts of these devices on driving performance, and could serve to stimulate the industry towards standardization (e.g., increase the consistency of lockouts, or other practices). Feedback from drivers and information gathered from the study would also be useful to system designers.

- Support collaborative truck-based research efforts intended to foster standardization and use of common metrics and procedures. Due to the cost associated with conducting formal evaluation-types studies, some companies indicated that collaboration among organizations to accomplish defined research of common interest to all would be welcome (as well as more common in the future). Some respondents indicated that studies including three or more participants might become typical in order to spread the cost. The inclusion of multiple participants in a study was given as one reason some standardization in the evaluation methods is needed in the industry. For example, defining a standard set of repetitive driving tasks and measures would reduce the preparation time for tests. This was particularly desirable to suppliers who currently may have to conduct multiple tests for the same system with different measures in order to satisfy different vehicle manufacturers. A similar effort for the light vehicle industry is under development (i.e., CAMP). However, based upon OEM interviews, most trucking manufacturers do not readily accept automobile based studies as applicable to the truck industry due to differences in driver experience, skill, judgment and motivation. This suggests that research should be conducted and guidelines should be developed that are unique to the trucking industry. Alternatively, studies allowing direct comparisons between light and heavy vehicle drivers would need to be developed in order to demonstrate differences and similarities across the two environments (e.g., demonstrate whether commercial truck drivers are indeed able to identify significant driver distraction situations and avoid them better than non-commercial automobile drivers). The issue of whether common detection or assessment methods and criteria can be used across vehicle platforms is still an important open issue.

- Convene an industry panel or conference to help raise awareness and propose countermeasures. Such a conference should include individuals from the insurance field. The meeting should discuss various incentives for safe driving and better device designs. Tax incentives or regulatory incentives for purchasing equipment that could mitigate the effects of driver distraction by refocusing the driver’s attention on a lapse in their driving task may also be beneficial to the industry, and their role should be discussed.

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SUMMARY & CONCLUSIONS

This project set out to determine the need for and approach to developing guidelines or standards to limit the exposure of truck drivers to unsafe distractions resulting from the use of in-vehicle devices. Perceptions on the issue of driving while distracted were gathered using focus groups and in-person interviews with both truck drivers and safety regulators. The availability of in-vehicle devices and range of interface designs were also documented in order to better understand the range of tasks and demands imposed by these devices. Industry design and evaluation practices were also solicited in order to assess the extent to which new guidelines or standards may be required.

Results of interview with drivers, safety regulators and equipment developers suggest that distracted driving is an issue for all drivers, not just truck drivers. The general consensus is that driving distractions are less of a problem for truck drivers because of a higher level of skill, experience, and judgment among truck drivers than among automobile drivers. An assumption that truck drivers are completely focused on business and do not tolerate distractions was mentioned repeatedly. In part, this assumption is based on the input companies have received repeatedly in their market research studies over many years. There is also an assumption that truck drivers have a stronger motivation to stay focused on the driving task because it is their livelihood. One respondent succinctly stated that the truck driver's primary task is to drive the vehicle and that all other tasks are secondary. However, it is obvious that drivers have been and continue to successfully accomplish these secondary tasks without incident most of the time. Key findings and highlights are presented below.

<u>Perceptions on Distraction</u>

- Although a majority of drivers and safety personnel (about 65%) felt distraction was currently a problem, it did not appear to rank highly among other problems facing the industry. Driver distraction was perceived by many to be a driver issue and not limited to a particular fleet or group of drivers. Perceptions among drivers varied considerably by age, experience, and type of driver (fleet vs. owner-operator). Young, experienced, and fleet drivers were more likely to perceive the existence of a problem.

- Many individuals felt truck drivers were less susceptible to distraction than passenger vehicle drivers because of their experience and professionalism. Truck drivers were also perceived to generally exercise good judgment about the safe and appropriate use of in-vehicle devices while driving. Nevertheless, a significant number of truck drivers and safety personnel felt distraction is a problem for the trucking industry.

- Many safety and regulatory personnel felt that the issue of truck driver distraction would become increasingly important as the number and variety of in-vehicle technologies proliferate in the market. They do generally recognize, however, that most drivers exercise good judgment about using these devices while driving. There were some concerns that drivers may hold misconceptions about when it is safe to use a device while driving.

- Drivers are generally aware of the risks associated with the use of in-vehicle devices while driving. Over two-thirds of the drivers recognize that many devices are not intended or designed for use while driving, and nearly half of the drivers interviewed reported experiencing a close call while using a device when driving. Thus, drivers tend to either consider the risk to be minimal or accept the risk. Job demands and pressures may also contribute to device use under less than optimal conditions.

- Aside from the consequences of a crash or incident, many drivers felt there was no difference between using technologies in a truck versus a car – the driver is the limiting factor. In-vehicle devices in trucks were viewed as purposeful since they aid the drivers in accomplishing their task; not so with the majority of devices found in passenger vehicles. Nevertheless, the demands associated with controlling a large commercial vehicle makes the issue of distraction an important issue for commercial vehicles (Due to their size, trucks require more precise control, and the consequences of a crash resulting from lapses in attention caused by distraction can be substantial).

- Fleet policies against using devices while driving were seen by many as marginally effective. The level of effectiveness was believed to depend on enforcement and punitive consequences. Some drivers readily admitted "stretching" company policy on occasions.

- Banning technology use while driving was not seen to be practical or warranted on the basis of evidence (or lack thereof). Development of enhanced device designs and restrictions and lockouts were suggested, among others, as possible solutions to the driver distraction issue.

<u>Device Designs</u>

- Text-based communication systems are widely available and used in the industry. These are primarily used as fleet management tools. Most systems rely on multi-line visual displays to present e-mail type text messages to drivers (although the use of text-to-speech to read messages to drivers is also available). Most systems include the capability to limit interactions when the vehicle is moving (e.g., lock-out the ability to read or write messages); however, lockouts are not necessarily universally applied by fleets.

- The demands imposed by text messaging systems (as measured by the number of steps and button presses) can vary significantly based on the task and input method. Driver communications using 'pre-defined" or "canned" text messages can generally be accomplished easily requiring a few button or key presses. However, the process of sending e-mail type messages using free-form methods are considerably more complex requiring dozens of button or key presses. Writing e-mails using free-form methods can resemble the manual/visual demands associated with destination entry tasks for a navigation system. Most devices are designed to restrict the drivers from writing free-form messages while the vehicle is in motion.

- On-board devices tend to integrate several functions within a single device. Both systems provided by Original Equipment Manufacturers and available aftermarket vendors tend to include multiple functions, including GPS for vehicle tracking, driver messaging, vehicle diagnostics and performance data, and driver logs. Many devices provide the capability to expand functionality and level of services by integrating customized or third-party applications. Integration of functions within a single common interface framework is likely to increase ease-of-use and efficiency. However, merely using a common architecture does not necessarily guarantee that different applications will provide a consistent, usable interface.

<u>Industry Design & Evaluation Practices</u>

- There is a wide range of familiarity with documents related to driver distraction. Most manufacturers are very familiar with existing standards and recommended practices related to the physical workspace aspects of design, but less so with those addressing cognitive and attentional demands.

- Many companies were very reluctant to discuss specific methods and techniques used to evaluate systems and devices. Some general strategies included workload measurements using secondary task techniques and on-road test track studies. The industry tends to rely on market research and focus groups in early design stages, and field testing by customers during later design stages. Many would be willing to participate in some type of industry discussion on the subject of evaluating and measuring driver distraction.

The authors' impression formulated based on this activity is that truck driver distraction appears to rank low as a safety issue among both drivers and safety/regulatory personnel. This is largely based on truck driver and safety personnel perceptions; the lack of objective data was a concern. Many agencies contacted as part of this work maintain crash records (92%) and investigate truck crashes (75%), yet individuals within these organizations were frequently equivocal about the role distraction plays in commercial vehicle safety and crashes. One could speculate, therefore, that distraction resulting from the use of in-vehicle devices while driving is not currently a major problem (nor a problem that is readily apparent). Many individuals were hesitant to speculate about the degree to which distraction is involved in commercial vehicle crashes without objective crash data relating distraction to crashes. Data from the Large Truck Crash Causation Study (being conducted by the National Center for Statistics and Analysis) could provide objective evidence as to the existence of a problem. The subjective perceptions gathered as part of this effort would seem to suggest that the issue of driver distraction is not presently perceived to be a major problem for the industry. Drivers and safety/regulatory personnel both recognize, however, that the issue of driver distraction could emerge as a significant concern as devices become more widely available and used. Good device designs, proactive testing, and use policies are critical steps the industry should be exercising to ensure safety.

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APPENDIX A: TRUCK DRIVER INTERVIEW QUESTIONS

Demographics

- Owner-Operator or Fleet Driver?
- Years of commercial driving experience.
- Type of driving (long-haul, local, etc.)
- Miles driven per year.
- Age.
- Make and year of Truck.

Devices & On-Board Equiment

- What electronic devices do you have in your cab?
- Which do you use while driving?
- Do you think they are generally designed to be used while driving?

Perception on Distraction

- In your opinion, is distraction a problem for commercial vehicle drivers? Why/Why Not?
- Is distraction a problem for passenger vehicle drivers? Why/Why Not?
- Is distraction associated with the use of in-vehicle devices becoming a problem?
- Do you think drivers can tell when they are distracted?

Conditions of Use

- Do you think other truck drivers exercise good judgement about when it is safe to use while driving?
- What situation would you chose not to use a device?
- Do you think there is any difference between using these types of devices in a truck versus a car?

Close Calls

- Have you had any close calls related to the use of a device while driving?
- Are you aware of other drivers who have had close calls?

Other

- Does experience in using a device change the way drivers use it? How?

Final Comments or Questions

- In your opinion, what differentiates a safe driver (or fleet) from an unsafe one?
- What are the top 3 problem areas in the industry?
- Any last comments on any of these issues?

Thanks very much for your time. If you are interested, we can arrange to send you a copy of our report to NHSTA and FMCSA. The full report should be completed by end of the year (involves other work looking a devices, etc).

APPENDIX B: TELEPHONE INTERVIEW SCRIPT FOR SAFETY AND REGULATORY CONTACTS

Lead-In (Introduction)

- My Name is XXXX, I'm with Westat (a research company in MD). We are working with the National Highway Traffic Safety Administration (NHTSA) and the Federal Motor Carrier Safety Admin (FMCSA)
- I got your name from Steve Keppler with the Commercial Vehicle Safety Alliance.
- He thought you might be able to help us out in gathering some information on the issue of truck driver distraction.
- I'd like to ask you a few questions about this issue. Is this a good time, or should I call back at a more convenient time (should take about 15 minutes).

Purpose of Today's Interview

- Growing in-vehicle device market (Electronic devices)
- Maximize performance benefits, minimize distraction
- Distraction/Inattention big issue with passenger car drivers
- Discuss your impressions of this issue in commercial driving industry
    - Specifically use of devices while driving

Demographic Information

- Before we start, I need to get some basic information:
- Name; (write-in before hand)
- Organization (write-in before hand)
- Title (Responsibility)
- Years at Organization
- Years at Position
- Does your agency..
    - maintain crash database?
    - Investigate commercial vehicle crashes?

Perceptions on Distracted Driving Problem (NOW)

- In your opinion, is distraction associated with in-vehicle devices a problem in the commercial vehicle industry?(cell phones, in-vehicle PC's, text messaging, navigation & routing, data recorders, etc.)
- Why/Why Not
- How big a problem do you think it is
    - Rate how big a problem you think distraction is for truck drivers on a scale of 1 to 10 (where 10 is huge problem, 1 = no problem).
- What percentage of truck crashes would you estimate are due to distracted driving?
- Would you say the problem is isolated to a few specific drivers or fleets, or is it more widespread?

Perceptions on Distracted Driving (Becoming Problem?)

- Is distraction associated with the use of electronic in-vehicle devices becoming a problem?
- Why do you think it is or is not?
- Is distraction a bigger problem for passenger car drivers?
- Why/why not?

Fleets vs. Owner Operators

- Are trucking fleets generally safer (as a whole) than Owner-Operators?
- What distinguishes safe from unsafe fleet?
- Which fleets tend to have poor safety records
- Are there differences in the types of in-vehicle devices between fleets and owner-operators.
- If so, what?

Devices

- What would you say are some of the more common technologies used by Truckers today?
- (CB's,Radios,Cell Phones, Text-Messaging (QualComm)
- What are some other types of technology you've seen drivers use (while driving)? Laptops, Faxes, TV's

Usage Patterns

- Have you noticed an increase (in the past few years) in the amount of in-vehicle technologies in trucks?
- Do you think drivers exercise good judgment about when it is safe to use (make a cell phone call, read an e-mail message)?
- Do you think drivers can tell when they are distracted?
- Do you think devices are designed to be used while driving?
- Which ones are are/not?
- Are there specific situations in which you think drivers tend to
    - Use these devices.
    - Avoid the use of these devices.
- Do you think there is any difference between using these types of devices in a truck versus a car? Why?

Incidents

- Are you aware of any crashes or mishaps resulting from a driver being distracted from use of in-vehicle technology?
    - What were the circumstances and outcome
    - Technology used
- In your opinion, what types of activities are more likely to lead to problems when driving?

Reducing Risk

- Some fleets have policies against using devices while driving.
  - Do you think these policies are effective? Why/Why Not?
- What do you think should be done to address this problem (distraction from in-vehicle device use)?
- Does experience using a device change the way drivers use it? Why/How?
- Could training help to improve safety?

Final Comments or Questions

- In your opinion, what differentiates a safe driver (or fleet) from an unsafe one?

- What are the top 3 problem areas in the industry?

- Any last comments on any of these issues?

Thanks very much for your time. If you are interested, we can arrange to send you a copy of our report to NHSTA and FMCSA. The full report should be completed by end of the year (involves other work looking a devices, etc).

APPENDIX C: ORIGINAL EQUIPMENT MANUFACTURER INTERVIEW QUESTIONS

1.a. Please list any standards, recommended practices, or other types of documents from non-automotive industries of which you are aware that are related to practices and procedures for assessing the safety and suitability of devices for use while a commercial truck driver is driving. (This may include aerospace or any other industry.) For each one, answer the following questions:
1.b. Do you perceive it to be applicable to the truck industry? Why or why not?
1.c. Do you perceive it to be effective for the truck industry? Why or why not?

2.a. Please list any passenger vehicle standards, recommended practices, or other types of documents of which you are aware that are related to practices and procedures for assessing the safety and suitability of devices for use while a commercial truck driver is driving. For each one, answer the following questions:
2.b. Do you perceive it to be applicable to the truck industry? Why or why not?
2.c. Do you perceive it to be effective for the truck industry? Why or why not?

3.a. Please list any medium or heavy-duty truck standards, recommended practices, or other types of documents of which you are aware that are related to practices and procedures for assessing the safety and suitability of devices for use while a commercial truck driver is driving.
For each one, answer the following questions:
3.b. Do you perceive it to be applicable to the truck industry? Why or why not?
3.c. Do you perceive it to be effective for the truck industry? Why or why not?

4. Please indicate the evaluation procedures, measures, and criteria that you have used or currently use for assessing the safety and suitability of devices for use while a commercial truck driver is driving.

5. In your opinion, are there methods you have tried for assessing driver distractibility or usability that were not successful? Would you be willing to share information and/or results from those tests with NHTSA?

6. From your perspective, is distracted driving a problem for commercial truck drivers? If so, what do you suggest should be done about the problem? (This question is not limited to NHTSA activities.)

7. What is your perception of current research on the issue of driver distraction and the use of in-cab devices? How well do you think it applies to the truck industry?

8. From your perspective, what are the research issues and truck industry needs in the area of assessing the safety and suitability of devices that drivers use while driving?

APPENDIX D: TELEMATIC PRODUCT & CONTACT INFORMATION

Telematic Product and Contact Information

Product	AutoVue
Description	a lane departure warning system that warns drivers if they are drifting out of their lanes unintentionally, utilizes a small, integrated platform consisting of a camera, onboard computer, and software that easily attaches to the vehicle.
Unit Price	
Date Introduced	9/1/2002
Years On Market	0
MarketPenetration	0.00%
User Manual Available?	☑
Location of Manual	Contact Bill
First Name	Bill
Last Name	Patrolia
Contact Title	Director of Sales for the Truck Market
Work Phone	(801) 475-4008
Work Extension	
Mobile Phone	
Fax Number	(801) 475-4011
Email Address	wjp@iteris.com
Company Name	Iteris, Inc.
Department	Sales & Marketing
Address	1910 Mohawk Lane
City	Ogden
State/Province	UT
Postal Code	84403-

Notes

"display" is only audio and is a small box that is attached to the camera by a ribbon cable.
Introduced into Europe in June of 2000. Have sold 4000 units in Europe.

Unit Price $ 1100-1500

Send an email to Bill Patriola before contacting customers below.
John.pope@cgor.com 8284593200 Cargo Transporters, on Freightliners
Tom Rule tom.rule @logexcorp.com 9086845613, on international trucks

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Product	Bendix X-Vision
Description	Infrared thermal imaging camera to allow detection of obstacles at distances greater than the standard headlamps It provides operatorsadvancedwarning in the road at night. Viewing distances can be >1500ft.
Unit Price	$3,995.00
Date Introduced	12/1/2001
Years On Market	2
MarketPenetration	0.00%
User Manual Available?	☐
Location of Manual	No manual required
First Name	Dennis
Last Name	Losh
Contact Title	Engineering Director for New Business D
Work Phone	(440) 329-9421
Company Name	Benidx Commercial Vehicle LLC
Department	New Business Development and New Ve

Work Extension		Address	901 Cleveland St.
Mobile Phone		City	Elyria
Fax Number	(440) 329-9607	State/Province	Ohio
Email Address	dennis.losh@bendix.com	Postal Code	44035-

Notes

Both a head-up and a head down display (LCD) are available.
Purchase price is aftermarket, with HUD, camera, all hardware, and video instructions.
Other than installation, only controls are the video controls which self-evident (ON,OFF, Brightness, Contrast), so no manual is included with the system.

Product	Delphi Truck Productivity Center	Unit Price	
Description	Currently does exactly what the driver message center does, but is able to be used by third party software. Capable of speech recognition and has speech synthesis for reading email. Monochrome display. Open architecture hardware system for Windows CE.	Date Introduced	1/1/2002
		Years On Market	1
		MarketPenetration	0.00%
		User Manual Available?	✔
First Name	Dan	Location of Manual	via contact
Last Name	Harris		
Contact Title	Product Sales Manager, Truck PC and Te	Company Name	Delphi Delco Electronics Systems
Work Phone	(765) 451-0198	Department	
Work Extension		Address	
Mobile Phone		City	
Fax Number		State/Province	
Email Address	j.dan.harris@delphi.com	Postal Code	

Notes

Tied to parking brake. Certain functions are locked out when parking brake is not engaged, e.g. typing messages. PanaPacific sells the system and Mobilearia is the operations provider (MountainView, CA). They have a standard set of applications as well as an optional set of applications. Vehicle diagnostics is a typical application. Single DIN size.

$1800-2200 base system price

PanaPacific
John Trenberth - President
408-874-4813
Debbie Cameron @ Panapacific 615-566-1007

Product	Eaton Vorad and Smart Cruise	Unit Price	

Description	Vorad is a collision avoidance system and smart cruise is an optional system that locks onto a vehcle in front of you and maintains a following distance. Driver display has lights and audible tones as well as side sensor displays in A-pilllar (s).
Date Introduced	1/1/1994
Years On Market	0
MarketPenetration	0.00%
User Manual Available?	☑
Location of Manual	on website www.roadran
First Name	Tom
Last Name	Mattox
Contact Title	
Work Phone	(269) 342-3064
Work Extension	
Mobile Phone	(215) 327-1667
Fax Number	(215) 860-7370
Email Address	kennethmciarlone@eaton.com
Company Name	Roadranger
Department	
Address	21 Victoria Court
City	Holand
State/Province	PA
Postal Code	18966-

Notes

Smart cruise ON/OFF is indicated by a light that says SC. Driver may have a log on-card, Vehicle Information System) that can act both to record vehicle performance and to act as a "black box" in case of an accident.

Freightliner intgrates these into the driver message center using a text and graphic symbol with an audible alert.

Eaton with single side sensor, forward sensor, accident reconstruction capable and event capable (EVIMS) approx $2100. Smart cruise would add about $300. Smart cruise is currenlty only available as original equipment. Has a failure mode with an indicator also.

Product	Freightliner Driver Message Center
Description	messages and information on command such as trip , fuel economy, etc. Also presents infromation on warnings and advisories
Unit Price	
Date Introduced	
Years On Market	0
MarketPenetration	0.00%
User Manual Available?	☐
Location of Manual	
First Name	Tim
Last Name	Blubaugh
Contact Title	
Work Phone	
Work Extension	
Mobile Phone	
Fax Number	
Email Address	
Company Name	
Department	
Address	
City	
State/Province	
Postal Code	

Notes

Product: Freightliner Rollover Stability Advisor

Description: roll advisor and control system. Info presented via the message center. Intended to teach driver new behaviors

Unit Price:

Date Introduced:

Years On Market: 0

MarketPenetration: 0.00%

User Manual Available? ☐

Location of Manual:

First Name: Tim

Last Name: Blubaugh

Contact Title:

Work Phone:

Work Extension:

Mobile Phone:

Fax Number:

Email Address:

Company Name:

Department:

Address:

City:

State/Province:

Postal Code:

Notes: When the driver has undergone a rollover risk situation, after the event the system communicates to the driver that there was some degree of risk of rollover. It gives the level of risk cia a tone and a text message and tells them by how much they need to reduce their speed in order to minimize the risk. Once a certain level of lateral accelerations is detected, the Roll stability control can actively engage the engine brake system to reduce speed

Product: Global T-Fleet

Description: a nationwide communications and tracking system for the long-haul trucking industry; uses an on-board Driver Terminal to transmit DHF signals and receive FM sub-carrier data; has a full keyboard, numeric keypad, special function keys, and an LCD display.

Unit Price: $1,000.00

Date Introduced: 1/1/2003

Years On Market: 0

MarketPenetration: 0.00%

User Manual Available? ☑

Location of Manual: from contact

First Name: Jim

Last Name: Graf

Contact Title: National Sales Manger
Work Phone: (800) 220-5174
Work Extension: 216
Mobile Phone:
Fax Number: (239) 642-9283
Email Address: jimgraf@global2way.com

Company Name: Global T-Fleet
Department: Sales Management
Address: 678 Bald Eagle Drive
City: Marco Island
State/Province: FL
Postal Code: 34145-

Notes: Introduction date is for the current version. Driver interface goes back to Terion which was introduced in 1998(?)

According to website, Messages arrive to driver in one of three priorities (verified):
Normal: light blinks on terminal
Important: light blinks on terminal and beeps once
Emergency: light blinks rapidly on terminal and a shrill tone beeps once per minute until the driver responds.
Terminal is mounted on a clip typically on the passenger side of the vehicle. Pigtailed to vehicle. Can be used on his lap or on the steering wheel. Driver or dispatcher can place system in "Lock-down" mode. If the vehicle moves 1/10 mile, system automatically sends signal to a pre-defined emergency number. How the system is placed into "lock-down" mode depends on the fleet to some extent. The fleet can define lock-down" mode as anytime the engine is turned off for more than X minutes or it can require the driver

---

Product: Mack Vehicle Information Profiler (VIP) Display

Description: 1/4 vga electroluminescent display device includes trip info., messaging from any 1587 protocol system or the Mack telematic device, & maint. Most menu items are locked-out while driiving. Only 2 screens, sensor info. and a driver selected favorite

Unit Price:
Date Introduced: 3/1/2000
Years On Market: 3
MarketPenetration: 0.00%
User Manual Available?: ☑
Location of Manual: contact Wayne or John

First Name: John
Last Name: Bernosky

Contact Title: Sr. Staff Engineer
Work Phone: (610) 351-8404
Work Extension:
Mobile Phone:
Fax Number: (610) 351-8466
Email Address: john.bernosky@volvo.com

Company Name: Mack Trucks
Department: Product Development
Address: 2402 Leihigh Pkwy South
POB 1907
City: Allentown
State/Province: PA
Postal Code: 18105-1907

Notes	A fault code may also be seen while driving. An audible alarm plus the display indicates a fault. A fault that occurs while driving must be acknowledged by pressing a button. The device has 10 pre-defined buttons. Driver manual is separate from regular driver manual. Obtain marketing information from Wayne Wissinger 301-790-5831 Product Market Strategy Send Task 2 Questions to Jon via email.

Product	MobileMax	Unit Price	
Description	2-way communications system. Includes large message screen with a full alpha numeric keyboard (less than PC keyboard). Primarily menu driven. Fleet can set & change the ability of the driver (or cab occupant) to operate the system.	Date Introduced	10/1/1994
		Years On Market	0
		MarketPenetration	0.00%
		User Manual Available?	✔
First Name	Tom	Location of Manual	contact Tom
Last Name	Cuthbertson		
Contact Title	Director of Customer Implementation	Company Name	Aether Systems
Work Phone	(571) 633-5874	Department	
Work Extension		Address	8401 Greensboro Dr.
Mobile Phone	(703) 801-2419	City	McClean
Fax Number		State/Province	VA
Email Address	tcuthbertson@aethersystems.com	Postal Code	22102-

Notes	$2100. Includes 2 modems (earth & satelite), engine interface, keyboard, tranceiver, cabling. Operating cost = 25,000 characters = $35/month. Minimum commitment is about 36 months. User manual is a quick reference card. Also has some prompts built into the system. The company has a customer advisory group to provide feedback on the system in the real world. Requested to review a copy of report with their comments included prior to release. Aether Corporate Headquarters 11460 Cronridge Drive Owings Mills, Maryland 21117

Product	Mobius TTS	Unit Price	
Description	Mobius TTS is a Mobile Logistics Management System. Uses a graphical LCD touch screen as the driver interface. Driver may receive audible messages while the vehicle is in motion, but cannot interact while the vehicle is moving.	Date Introduced	3/1/2000
		Years On Market	3
		MarketPenetration	0.00%
		User Manual Available?	✔
First Name	Karen	Location of Manual	

Last Name: Hilyard

Contact Title	Marketing Manger, Mobius TTS	Company Name	Cadec Corporation
Work Phone	(603) 668-1010	Department	
Work Extension		Address	8 E Perimeter Road
Mobile Phone		City	Londonderry
Fax Number		State/Province	NH
Email Address		Postal Code	03053-

Notes:

Featuring an advanced modular design, Mobius TTS provides a high-powered onboard computer running on the Microsoft® Windows® CE platform that offers: Timely route information Instantaneous event notification, Detailed driver and vehicle information, Reliable safety and compliance data, Accurate delivery and pickup tracking, Integrated onboard data with back-office enterprise.
May receive audible messages while the vehicle is moving.
Will not give out prices due to variables. Cannot provide market penetration unless the market is defined.

Main Office Address:
Cadec Corporation
8 E Perimeter Road

Product	PACCAR Driver Message Center	Unit Price	$550.00
Description	trip computer information, fuel data, clock, Has 2 levels of information. Steve believes that maintenance functions are in the second level and cannot be accessed while the vehicle is moving.	Date Introduced	6/1/1997
		Years On Market	0
		MarketPenetration	0.00%
		User Manual Available?	✔
First Name	Steve	Location of Manual	PACCAR Parts or Dealer
Last Name	Jahns		

Contact Title	Sr. Project Engineer, Ergonomics Group	Company Name	PACCAR Technical Center
Work Phone	(360) 757-5267	Department	
Work Extension		Address	1261 Farm To Market Road
Mobile Phone		City	Mt. Vernon
Fax Number	(360) 757-5370	State/Province	WA
Email Address	Steve.Jahns@PACCAR.com	Postal Code	98273-

Notes: There is an SAE Paper by Louis Rodriquez, Steve Jahns, Rick Bertlan describing the system in fairly great detail. 1997 or 1998.

Product	PeopleNet Mobile Fleet Solutions
Description	A modular telematics communications system. Includes tracking, communications, taxes, email, vehicle performance, elog book, and voice communications.
Unit Price	$1,000.00
Date Introduced	1/1/1996
Years On Market	7
MarketPenetration	0.00%
User Manual Available?	✔
Location of Manual	web and/or paper
First Name	Brian
Last Name	McLaughlin
Contact Title	VP of marketing
Work Phone	(888) 346-3486
Work Extension	211
Mobile Phone	
Fax Number	(952) 368-9320
Email Address	bmclaughlin@peoplenetonline.com
Company Name	PeopleNet Communications
Department	Marketing
Address	1107 Hazeltine Blvd, Suite 350
City	Chaska
State/Province	MN
Postal Code	55318-

Notes: Driver interface options include a voice handset with handsfree mode, keyboard, small message display, and a specially designed handheld computer and cradle.
Basic elements are onboard computer, GPS, office/web software. This part of the system does not have a driver interface.
Message display has 5 buttons on it.
Administrators have ability to configure rights of applications and features to individuals and drivers.
Less than 5% of customers do tracking only. They are generally not transportation companies.
Unit price is keyboard and message display.

Company held a "Users Conference" in July 2003. Gained a lot of information about how customers are usiing their systems via discussions. People wanted more time, so they will definitely do another User's conference next year.

Product	Qualcomm Fleet Advisor
Description	
Unit Price	
Date Introduced	
Years On Market	0
MarketPenetration	0.00%
User Manual Available?	✔
Location of Manual	
First Name	Jeff

Last Name	Waterstreet

Contact Title		Company Name	Qualcomm
Work Phone	(800) 348-7227	Department	
Work Extension		Address	
Mobile Phone		City	
Fax Number		State/Province	
Email Address	jeffw@qualcomm.com	Postal Code	

Notes

Product	Qualcomm MvPC	Unit Price	
Description	Wireless fleet managemet and mutifunctional device. Three different driver interface units are available.	Date Introduced	
		Years On Market	0
		MarketPenetration	0.00%
		User Manual Available?	☑
First Name	Alice	Location of Manual	
Last Name	Tornquest		

Contact Title	Director, Government Affairs	Company Name	Qualcomm
Work Phone	(202) 263-0024	Department	
Work Extension		Address	2000 K Street, N.W. Suite 375
Mobile Phone		City	Washington DC
Fax Number	(202) 263-0010	State/Province	
Email Address	alicet@qualcomm.com	Postal Code	20006-

Notes

Product: VDO FM System

Description: Modular system which may provide tracking, communications, navigation, regulatory and vehicle data for the fleet. Audio buzzer tells the driver he has exceeded pre-set driving limits. 2 different driver interfaces are available (both optional) for input.

Unit Price: $1,000.00

Date Introduced: 1/1/1998

Years On Market: 5

MarketPenetration: 0.00%

User Manual Available? ✔

Location of Manual: From contact via CD or

First Name: Tony

Last Name: Reynolds

Contact Title: Fleet Sales Manager - NAFTA Region

Work Phone: (540) 955-9051

Work Extension:

Mobile Phone: (443) 421-0427

Fax Number: (540) 955-9052

Email Address: www.irdinc.com

Company Name: International Road Dynamics

Department:

Address: 2885 Springsbury Rd

City: Berryville

State/Province: VA

Postal Code: 22611-3917

Notes: According to the VDO website:
"Colour monitors are available in a range of sizes. Key information is presented clearly at all times for minimum distraction on the road." and "The integrated hands-free facility and intuitive user interface ensure minimum distraction while driving." [Later statement is for the FM Skylink Handheld.]

Siemens VDO Automotive Corp.
North American/Trading & Aftermarket
Westfield Corporate Center
4905 Tilghman Street, Suite 120
PA 18104 Allentown

Product: Volvo Driver Information Display

Description: displays sensor informaiton on the display within the cluster. Can be set with a "favorite" prior to driving. Driver can also select different sensors to display while driving. Maintenance functions can be accessed while stopped only.

Unit Price:

Date Introduced: 9/1/1996

Years On Market: 8

MarketPenetration: 0.00%

User Manual Available? ✔

Location of Manual: In Driver's Manual with e

First Name: John

Last Name	Bolchalk		
Contact Title	Sr. Group Leader for Telematics	Company Name	Volvo Trucks North America
Work Phone	(336) 393-2767	Department	Telematics Department
Work Extension		Address	7900 National Service Road
Mobile Phone		City	Greensboro
Fax Number	(336) 393-2773	State/Province	NC
Email Address	john.bolchalk@volvo.com	Postal Code	27402-6115

Notes: Currently standard with the vehicle, but will become a standard with a delete option later this year.
There may be occaissional updates that require the addition of pages

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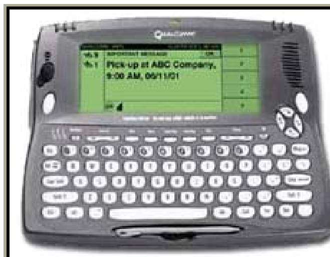
Product	Volvo Link	Unit Price	
Description	Volvo Link utilizes satellites and the Internet to locate trucks and provide two-way communication between terminals and drivers. Volvo Link can be built into the truck during its manufacture or retrofitted. Drivers use the DID to send & receive messages.	Date Introduced	3/1/2002
		Years On Market	1
		MarketPenetration	0.00%
		User Manual Available?	☑
First Name	John	Location of Manual	Purchase or obtain from
Last Name	Bolchalk		
Contact Title	Sr. Group Leader, Telematics	Company Name	Volvo Trucks North America
Work Phone	(336) 393-2767	Department	Telematics Department
Work Extension		Address	7900 National Service Road
Mobile Phone		City	Greensboro
Fax Number		State/Province	NC
Email Address	john.bolchalk@volvo.com	Postal Code	27402-6115

Notes	Only urgent messages can be accessed while the vehicle is moving. Approximately $1200.00 as an aftermarket purchase, slightly less ($1050.00) for optional purchase with a new truck. To see a more complete description of the system go to www.volvotrucks.us.com; select "Service", then select "Volvo Link". Ask Don Philya for customer contacts 363-2234. Customer input began at early field testing with customers. Feedback from customers resulted in minor improvements in usability. Some testing was done on the vehicle cluster overall, but do not know whether the Volvo Link was included. Will have to ask someone in the cab department about this. John's department does not deal with human factors. SAE STD viewing angles ,etc. From ATIS/CVO group. Available on-line. John will send link. Finds it very applicable.

APPENDIX E: TASK ANALYSIS DATA SHEETS

In-Vehicle Device Inventory

Basic Information



Device Name: QualComm MvPC
Model:
Manufacturer: QualComm
Availability: Aftermarket
Device Class: Fleet Management
Device Dimensions: 10x8x1.5
Number Functions: 6
Cost: 0
Primary Functions: E-mail, Pager, Aid Request, Vehicle Diagnostics & Performance, Navigation
Platform: Truck

Description: An in-vehicle computer and mobile communications system for fleet management. Runs custom or third party applications in addition to standard on-board application s(text messaging). Basic product has been on the market for over 12 years. Three different driver interfaces available, MvPC represents newest introduction.

DeviceNum: 1

- [x] Manual Available
- Number Pages: 0
- [x] Training Course/Class
- [ ] Internal System Demo
- [x] Reference/Instruction Card
- [ ] Training Video/CD
- [x] Designed for In-Vehicle Use
- [ ] Carry-In Device

Interface Characteristics

Mounting Position Unit: 8
Mounting Position Display: 8
Horizontal Viewing Angle: 0
Vertical Viewing Angle: 0

- [ ] Adjustible Position
- [ ] Fixed
- [ ] Recommended Position
- [x] Hand-Held
- [x] Holster/Docking Port/Cradle
- [ ] Pedestal
- [ ] Obstructed View
  - [ ] Direct Road View
  - [ ] Mirrors
  - [ ] Other Controls/Displays

Controls

Number Hard Controls: 78

- [x] Push Button
- [ ] Rotary Knob
- [ ] Rocker Switch
- [ ] Joystick
- [ ] Lever
- [x] Hard Keyboard
  - [x] QWERTY
- [ ] Toggle Switch
- [ ] Pull Knob
- [ ] Thumb-Wheel
- [ ] Bezel
- [x] Stylus
- [ ] Soft Keyboard
  - [ ] QWERTY
- [ ] Touch Screen
- [ ] Hand-Held Remote

Remote: Height Width
Main Control: Pushbutton
Smallest: Height 0.4 Width 0.7
Largest: Height 1.8 Width 1.2
Min Control Spacing: 1.4
Min Gap Spacing: 0.4

- [ ] Multifunction
- [ ] Grouping
- [ ] Steering Mounted
- [x] Illuminated

[x] Visual Displays

DisplayType: 640x240 VGA LCD
Size: 0 Height: 0 Width: 0

- [x] Integrated Display/Controls

DisplayLegibility: Fair-Good
Character Height 0 Width 0
Font Size: 0 Rows: 0
Char/Row: 38 Words/Row: 0

- [x] Graphics
- [x] Icons
- [x] Text
- [x] Tables
- [x] Paragraphs
- [x] Grouping
- [ ] Color Coding.
- [x] Night/Day

[x] Auditory Interface

- [ ] Voice Recognition

Command Funct In Library: 0

- [ ] Synonyms
- [x] Auditory Output

Auditory Format:

- [ ] Synthesized Speech
- [x] Digitized Speech
- [x] Tones/Beeps
- [ ] Text to Speech
- [ ] Guidance with Street Names
  - [ ] Limited Road Name Output
  - [ ] Complete Road Name Output

Max Message Length: 0
Clarity:

- [ ] Repeat Messages
- [ ] Mutes Other Outputs
- [ ] Automatic Volume Control
- [ ] Ear-Phone Access

Interface Comments: Features a 6.5" touchscreen display. Can be mounted in various locations within the cab. Other displays include a 4-line and 15-line text display (both represent older and less capable versions of the system, but are widely available). No text wrapping capability with older versions.

Safety Features

- [x] Warning Against Use While Driving
  - [x] Warning in Manual
  - [x] Warning Labels on Device
  - [ ] Warning Start-up Screen
  - [ ] Warning When Operating
- [ ] Hands-Free
- [ ] Voice Activated Controls
- [ ] Can be Operated with 1 Hand
- [ ] Auto Re-Routing

- [ ] Manages Info Flow to Driver (Adaptive System)
- [ ] Non-Adaptive
- [x] Locks Out Functions While Driving
- [x] Optional Locks
  - [ ] View Maps
  - [ ] Destination Entry
  - [ ] Map Scrolling
  - [ ] Destination Selection
  - [ ] Modify Route/Detour
  - [x] Display Blank While Driving

Other Locked-Out Functions: Can lock-out keyboard and freeze display on a screen

Comments: Lockouts are optional and customizable

General Interaction Dimensions

- [x] Control Activation Feedback
  - [x] Auditory Feedback
  - [x] Visual Feedback
- [x] System Status Feedback
- [x] Interaction by Passenger
- [ ] Restricts Input Options

Max Depth Menus: 0

Max Number Items in Menu: 0

- [ ] Alert Tone
- [x] Self-Paced
- [x] Scrolling List
- [ ] Smart Spelling
- [ ] SR Compatibility
- [ ] Auto Fill-In
- [x] Highlighting

- [ ] Prompts Response
- [ ] Time Out 0 Seconds
- [ ] Confirmation of Speech Commands
- [ ] Presence of Ads/Distracting Items
- [ ] Dynamic Elements
  - [ ] Moving Map
  - [ ] Flashing Items

Other Items:

Comments:

System Architecture

Operating System: Windows CE

- [ ] Blue Tooth (Wireless Comm)
- [ ] Add-On Capability

Type:

System Specific Data

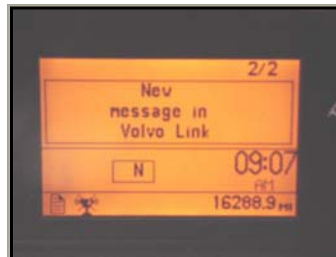
- [ ] Combined Views

Default View:

General Comments

In-Vehicle Device Inventory

Basic Information



Device Name: Volvo Link System
Model:
Manufacturer: Volvo Trucks
Availability: Fleet/OEM
Device Class: Communication
Device Dimensions:
Number Functions: 4
Cost:
Primary Functions: E-Mail, Vehicle Status (performance), GPS, Emergency Roadside Assistance
Platform: Truck

Description: A satellite communications system between driver and fleet. Driver can received and send e-mail type messages. Uses graphic display on the vehicle's instrument cluster. Packaged within larger driver information system providing vehicle operations data (e.g., fuel data, trip data, etc.).

DeviceNum: 2

- [x] Manual Available
  - Number Pages: 12
- [ ] Training Course/Class
- [ ] Internal System Demo
- [ ] Reference/Instruction Card
- [ ] Training Video/CD
- [x] Designed for In-Vehicle Use
- [ ] Carry-In Device

Interface Characteristics

Mounting Position Unit: 4
Mounting Position Display: 4
Horizontal Viewing Angle: 0
Vertical Viewing Angle: 0

- [ ] Adjustible Position
- [x] Fixed
- [ ] Recommended Position
- [ ] Hand-Held
- [ ] Holster/Docking Port/Cradle
- [ ] Pedestal
- [ ] Obstructed View
  - [ ] Direct Road View
  - [ ] Mirrors
  - [ ] Other Controls/Displays

Controls

Number Hard Controls: 4

- [x] Push Button
- [ ] Rotary Knob
- [x] Rocker Switch
- [ ] Joystick
- [ ] Lever
- [ ] Hard Keyboard
  - [ ] QWERTY
- [ ] Toggle Switch
- [ ] Pull Knob
- [ ] Thumb-Wheel
- [ ] Bezel
- [ ] Stylus
- [ ] Soft Keyboard
  - [ ] QWERTY
- [ ] Touch Screen
- [ ] Hand-Held Remote

Remote: Height Width
Main Control:
Smallest:
Height 0 Width 0
Largest:
Height 0 Width 0
Min Control Spacing: 0
Min Gap Spacing: 0

- [x] Multifunction
- [ ] Grouping
- [ ] Steering Mounted
- [ ] Illuminated

[x] Visual Displays

DisplayType: LCD
Size: 0 Height: 0 Width: 0

- [ ] Integrated Display/Controls

DisplayLegibility:
Character Height 0 Width 0
Font Size: 0 Rows: 0
Char/Row: 22 Words/Row: 4

- [x] Graphics
- [x] Text
- [ ] Paragraphs
- [x] Icons
- [ ] Tables
- [x] Grouping
- [ ] Color Coding.
- [ ] Night/Day

[ ] Auditory Interface

- [ ] Voice Recognition

Command Funct In Library: 0

- [ ] Synonyms
- [ ] Auditory Output

Auditory Format:

- [ ] Synthesized Speech
- [ ] Digitized Speech
- [ ] Tones/Beeps
- [ ] Text to Speech
- [ ] Guidance with Street Names
  - [ ] Limited Road Name Output
  - [ ] Complete Road Name Output

Max Message Length: 0
Clarity:

- [ ] Repeat Messages
- [ ] Mutes Other Outputs
- [ ] Automatic Volume Control
- [ ] Ear-Phone Access

Interface Comments: Controls mounted on stalk off of steering wheel (same location as wiper). Visual display mounted in Instrument Panel cluster. Volvo Link menu item is the first on the display llist; single button press to launch application. Only "Quick Response" using pre-defined text can be used while driving.

Safety Features

- [x] Warning Against Use While Driving
  - [x] Warning in Manual
  - [ ] Warning Labels on Device
  - [ ] Warning Start-up Screen
  - [x] Warning When Operating
- [ ] Hands-Free
- [ ] Voice Activated Controls
- [x] Can be Operated with 1 Hand
- [ ] Auto Re-Routing

- [x] Manages Info Flow to Driver (Adaptive System)
- [x] Non-Adaptive
  - [x] Locks Out Functions While Driving
  - [ ] Optional Locks
    - [ ] View Maps
    - [ ] Destination Entry
    - [ ] Map Scrolling
    - [ ] Destination Selection
    - [ ] Modify Route/Detour
    - [ ] Display Blank While Driving

Other Locked-Out Functions: Read and write messages

Comments: Incoming messages coded for priority. Only priority messages can be read while driving (at 55 mph or below is the default); and only the last received. Responding to messages also limited to priority messages and then limited to a quick response with 3 canned options. Systems notifies driver to "stop vehicle to read message" if they attempt to access standard message while driving.

General Interaction Dimensions

- [x] Control Activation Feedback
  - [ ] Auditory Feedback
  - [x] Visual Feedback
- [x] System Status Feedback
- [ ] Interaction by Passenger
- [x] Restricts Input Options

Max Depth Menus: 2

Max Number Items in Menu: 4

- [ ] Alert Tone
- [x] Self-Paced
- [ ] Scrolling List
- [ ] Smart Spelling
- [ ] SR Compatibility
- [ ] Auto Fill-In
- [x] Highlighting

- [ ] Prompts Response
- [ ] Time Out 0 Seconds
- [ ] Confirmation of Speech Commands
- [ ] Presence of Ads/Distracting Items
- [ ] Dynamic Elements
  - [ ] Moving Map
  - [ ] Flashing Items

Other Items:

Comments: Driver notified of incoming message via text message and info lamp icon on display (visual display, no tone). Driver can send 3 types of messages (pre-defined text, breakdown and free text); two represent canned messages. Driver uses control button and alphanumeric display to type-in messages; one character entered at a time. Confirmation of message "sent" is provided.

System Architecture

Operating System:

- [ ] Blue Tooth (Wireless Comm)
- [ ] Add-On Capability

Type

System Specific Data

- [ ] Combined Views

Default View:

General Comments

System clearly demonstrates design for the driving context. Display limited in the amount of information presented, and menu options and levels are shallow. System includes provisions to restrict drivers from attempting to read and/or write messages while driving. Only pre-scritped responses to messages availbale while driving. Free-text typing is only avialble when the vehicle is stationary. Messages longer than several lines can be read by scrolling. No dynamic elements to attract attention.

Task Specific Interaction

Device Name: Qualcomm   Device Number: 1   TaskNum: 4

TASK

Sample Task: Reply to Message

Method: Canned or Free Form Response

Min Steps: 4   Max Steps: 4   Min Keystrokes: 4   Max Keystrokes: 4

Type Control: Keyboard

Step 1: Select to Reply to the Message

Notes Step 1: Press the Replay hard key. Assumes that the driver just finished reading a displayed message (1 button press)

Step 2: Create Message Using Canned Form

Notes Step 2: A message should automatically appear once the creat message screen opens. Complete the message form. Data entry varies based on form, assume simple form requires Yes/No response (e.g., Available for a Load?). Enter Y/N (1 button press)

Step 3: Request to Send Message

Notes Step 3: Press "Send" hard key to send message (1 button press)

Step 4: Confirm Before Sending

Notes Step 4: System asks driver to confirm command to send. Press Y/N key (1 button press)

Step 5:

Notes Step 5:

Step 6:

Notes Step 6:

Step 7:

Notes Step 7:

Step 8:

Notes Step 8:

Step 9:

Notes Step 9:

Step 10:

Notes Step 10:

Step 11:

Notes Step 11:

- [ ] Multiple Methods (Shortcuts)
- [ ] Error Prevention
- [ ] Resume Without Interruption
- [ ] Error Recovery

Comment: Assume that the driver has accessed and read a message and has chosen to reply using canned response (message). The steps for sending free-form messages are identical, button presses will vary. Max keystrokes assumes the canned response requires a single button press, can vary.

Task Specific Interaction

Device Name: Qualcomm   Device Number: 1   TaskNum: 1

TASK   Sample Task: Read E-Mail

Method:

Min Steps: 4   Max Steps: 5   Min Keystrokes: 2   Max Keystrokes: 3

Type Control: Keyboard

Step 1: Detect Message Received

Notes Step 1: Unit includes a message waiting light which illuminates when a message has been received; also issues a tone/beep. Some companies also install a separate light on the dash to indicate when an urgent message has been sent. (0 button presses)

Step 2: Access Messages

Notes Step 2: Enter Read Next hardkey to display first message. Messages are stored with most recent messages first. (1 button press)

Step 3: Read Message

Notes Step 3: If message is l;arger than a single page or display screen, then the driver will need to scroll down using arrow keys. One button press equals one line of text. Assume no scolling needed (0 button press)

Step 4: Read Next Message

Notes Step 4: Advance to next message in the memory by pressing the read next hard key. (1 button press)

Step 5: Return to Main Screen

Notes Step 5: Return to the main view status menu by pressing the view status hard key (1 button press)

Step 6:

Notes Step 6:

Step 7:

Notes Step 7:

Step 8:

Notes Step 8:

Step 9:

Notes Step 9:

Step 10:

Notes Step 10:

Step 11:

Notes Step 11:

☐ Multiple Methods (Shortcuts)   ☐ Error Prevention

☐ Resume Without Interruption   ☐ Error Recovery

Comment: Unit displays the number of messages received on the main view status menu. The number of button presses may increase based on the length of the message - driver may need to scroll down a message.

Task Specific Interaction

Device Name: Qualcomm | Device Number: 1 | TaskNum: 2

TASK

Sample Task: Send E-Mail

Method: Canned Message

Min Steps: 5 | Max Steps: 10 | Min Keystrokes: 7 | Max Keystrokes: 30

Type Control: keyboard

Step 1: Press Create Message Key

Notes Step 1: Accesses the screen used to compose messages, both canned and free-form. (1 button press)

Step 2: Select Canned Message

Notes Step 2: Up to 63 messages availble. Must select from list by scrolling, or entering the messages number (recalled from driver's memory). Assume recalled (2 button presses for the two digit number). Hot enter key (3 button preses total)

Step 3: Fill-in Canned Message Form

Notes Step 3: Each form is unique with different amounts of info to be entered. Assume driver sending message ablout load status. Steps 4-6 detail message steps.

Step 4: Enter Date & Time

Notes Step 4: Date entered using month and date, then pressing enter (5 button presses). Time using military (5 button presses). (Total 10 button presses)

Step 5: Enter Trailer Number

Notes Step 5: Unique trailer ID. Enter 5-6 numbers typical (Total 6 button presses)

Step 6: Enter License Number

Notes Step 6: Driver Licesnse number Enter 5-6 numbers (Total 6 button presses)

Step 7: Need Directions?

Notes Step 7: Indicate Y/N to this question. (1 Button press)

Step 8: Have Trailer?

Notes Step 8: Indicate Y/N to this question. (1 Button press)

Step 9: Request to Send Message

Notes Step 9: Press "Send" hard key to send message. (1 button press)

Step 10: Confirm Message Before Sending

Notes Step 10: System asks driver to confirm command to send. Press Y/N key. (1 button press)

Step 11:

Notes Step 11:

- [x] Multiple Methods (Shortcuts)
- [ ] Error Prevention
- [ ] Resume Without Interruption
- [ ] Error Recovery

Comment: Canned Messages reduce but does not eliminate data entry. Minimum Steps and Key strokes above assumes that the canned message being selected required no data entry (just driver entering the return key, single button press). Max strokes and steps may be larger based on the canned form (we used the load status message). Task as written assumes the driver enters the canned message number rather than scroll thru the list of avialable messages. Also assume the unit is already turned on.

Task Specific Interaction

Device Name: Qualcomm | Device Number: 1 | TaskNum: 3

TASK

Sample Task: Send E-Mail

Method: Free-Text

Min Steps: 5 | Max Steps: 5 | Min Keystrokes: 28 | Max Keystrokes: 54

Type Control: Keyboard

Step 1: Press Create Message Key

Notes Step 1: Accesses the screen used to compose messages, both canned and free-form. (1 button press)

Step 2: Use the Free Form Message Option

Notes Step 2: Simply press the enter key and the cursor moves into the text field or message area. (1 button press)

Step 3: Type in the Message

Notes Step 3: Number of button presses will vary based on message length. Assume two messages 1) a 4 word message is entered " Trucks In Shop Till 2300" (24 button presses), and 2) 8 word message "Truck fixed and loaded, resuming

Step 4: Request to Send the Message

Notes Step 4: Press "send" hard key to send message (1 button press)

Step 5: Confirm Message before Sending

Notes Step 5: System asks driver to confirm command to send. Press Y/N key (1 button press)

Step 6:

Notes Step 6:

Step 7:

Notes Step 7:

Step 8:

Notes Step 8:

Step 9:

Notes Step 9:

Step 10:

Notes Step 10:

Step 11:

Notes Step 11:

- [ ] Multiple Methods (Shortcuts)
- [ ] Error Prevention
- [ ] Resume Without Interruption
- [ ] Error Recovery

Comment: Two different message lenghts are assumed - 4 word and an 8 word message, "Trucks in shop till 2300", and "Truck fixed and loaded, resuming trip after fueling" Even short word messages require many button presses. Number of keystrokes can be substantially larger than reflected here, but basic number of steps is unchanged.

Task Specific Interaction

Device Name: Qualcomm | Device Number: 1 | TaskNum: 5

TASK

Sample Task: Send E-Mail

Method: Free Form Text

Min Steps: 5 | Max Steps: 5 | Min Keystrokes: 33 | Max Keystrokes: 33

Type Control:

Step 1:	Press Create Message Key
Notes Step 1:	Accesses the screen used to compose messages, both canned and free-form (1 button press)
Step 2:	Use the free-form Message Option
Notes Step 2:	Press the enter key and the cursor movves into the field or message area (1 button press)
Step 3:	Type in the message
Notes Step 3:	Number button presses will vary based on message length. Assume the folllowing message " Late arrival: Less than 1 h" (29 button presses)
Step 4:	Request to send message
Notes Step 4:	Press Send hard key to send message (1 button press)
Step 5:	Confirm Message Before Sending
Notes Step 5:	System asks driver to confirm command to send. Press Y/N key (1 button press)
Step 6:	
Notes Step 6:	
Step 7:	
Notes Step 7:	
Step 8:	
Notes Step 8:	
Step 9:	
Notes Step 9:	
Step 10:	
Notes Step 10:	
Step 11:	
Notes Step 11:	

- [ ] Multiple Methods (Shortcuts)
- [ ] Error Prevention
- [ ] Resume Without Interruption
- [ ] Error Recovery

Comment

Task Specific Interaction

Device Name: Volvo Link   Device Number: 2   TaskNum: 1

TASK

Sample Task: Send E-Mail

Method: Canned Message (Pre defined text)

Min Steps: 4   Max Steps: 4   Min Keystrokes: 4   Max Keystrokes: 9

Type Control:

Step 1: Access Volvo Link System

Notes Step 1: Press the "Enter" control to access system. Volvo Link is the first menu item and should already be highlighted; if not, the Vovlo Link menu item will need to be highlighted using the cursor. Min 1 keypress, Max 3 keypress.

Step 2: Select Message Type

Notes Step 2: The Pre-defined text message type is the first item in the menu and should be highlighted. Press "Enter" to select. Brings up a list of pre-defined messages. Min 1 kepress

Step 3: Select Canned Message

Notes Step 3: Scroll down list to highlight desired message. Late arrival: less than 1 hr, takes two scrolls. Press "Enter" to select message. Min 1 keypress, Max 4 (max could be more as number messages increase)

Step 4: Send the Message

Notes Step 4: After selecting the message, the display directs the driver to either send the message or return to the menu. Press "Enter" to send. A confirmation screen will indicate that the message was sent. Min/Max 1 kepress.

Step 5:

Notes Step 5:

Step 6:

Notes Step 6:

Step 7:

Notes Step 7:

Step 8:

Notes Step 8:

Step 9:

Notes Step 9:

Step 10:

Notes Step 10:

Step 11:

Notes Step 11:

- [x] Multiple Methods (Shortcuts)
- [ ] Error Prevention
- [ ] Resume Without Interruption
- [x] Error Recovery

Comment: Send a pre-defined text message, "Late arrival: less than 1 h". Pre-defined option allows drivers to select among exisiting canned messages. No data entry needed. The number of pre-defined messages will impact the amount of scrolling needed to highlight a message. Common messages come standard, system allows additional company defined messages to be defined. One of the least demanding methods of sending messages.

Task Specific Interaction

Device Name:	Volvo Link
Device Number:	2
TaskNum:	2

TASK

Sample Task:	Send E-Mail
Method:	Free Form Text
Min Steps:	4
Max Steps:	4
Min Keystrokes:	59
Max Keystrokes:	63
Type Control:	

Step 1:	Access Volvo Link System
Notes Step 1:	Press the "Enter" control to access system. Volvo Link is the first menu item and should already be highlighted; if not, the Volvo Link menu item will ned to be highlighted using he cursor. Min 1 keypress Max 3 keypress.
Step 2:	Select Message Type
Notes Step 2:	The "Free text" message option is the last item in the menu; scroll down twice to highight. Press "Enter" to select option and bring-up the free text display. Min/Max 3 keypress
Step 3:	Compose Message
Notes Step 3:	Use the scroll control to position the cursor to the desired characters, select the item using the "Enter" control. To type in the message, "Late arrival: less than 1 h" requires 27 scrolls each with a keypress (additional 27
Step 4:	Send Message
Notes Step 4:	Press and hold the "Enter" control for 3 seconds OR select the "X" character. Display issues a confirmation, "Message sent." Min 1 kepress, Max 2 keypress
Step 5:	
Notes Step 5:	
Step 6:	
Notes Step 6:	
Step 7:	
Notes Step 7:	
Step 8:	
Notes Step 8:	
Step 9:	
Notes Step 9:	
Step 10:	
Notes Step 10:	
Step 11:	
Notes Step 11:	

- [ ] Multiple Methods (Shortcuts)
- [ ] Error Prevention
- [ ] Resume Without Interruption
- [x] Error Recovery

Comment: The message sent in this example is the same one used in the canned message example ("Late arrival: Less than 1 h").

Task Specific Interaction

Device Name: Volvo Link Device Number: 2 TaskNum: 3

TASK Sample Task: Read E-Mail & Respond

Method: New Icoming Message

Min Steps: 3 Max Steps: 3 Min Keystrokes: 4 Max Keystrokes: 5

Type Control:

Step 1: Acknowledge Message Notification

Notes Step 1: Driver is notified of an incoming message by a notification message on the display and the INFO lamp which illuminates. Driver acknowledges message notification by pressing the "Ecs" button. Min/Max 1 keypress

Step 2: Read Message

Notes Step 2: Once the driver aknowledges the receipt of the message as outlined in Step 1, the message is automatically displayed (assuming the vehicle is not moving, or a priority message is incoming). Min/Max 0 keypress

Step 3: Respond to Message

Notes Step 3: Press "Enter" while message is displayed; brings up quick reponse menu with predefined reponses (1 keypress). Scroll to highlight appropriate response option(Min 1, Max 2); select option and send using "Enter" (1 keypress)

Step 4:

Notes Step 4:

Step 5:

Notes Step 5:

Step 6:

Notes Step 6:

Step 7:

Notes Step 7:

Step 8:

Notes Step 8:

Step 9:

Notes Step 9:

Step 10:

Notes Step 10:

Step 11:

Notes Step 11:

- [x] Multiple Methods (Shortcuts)
- [ ] Error Prevention
- [ ] Resume Without Interruption
- [ ] Error Recovery

Comment: Assume truck ignition is on, and a new incomng message has been sent from dispatch/fleet (vehicle is either stopped, or priority message when driving). The Volvo Link system menu does not necessarily need to be accessed in order to receive a message. Drivers can read and respond using quick response to messages while driving. Driver can only send quick response to the most recent message; quick response uses pre-defines text.

Task Specific Interaction

Device Name: Volvo Link

Device Number: 2 TaskNum: 4

TASK

Sample Task: Read Stored Unread Message

Method: Assume Reading 2nd Message in Queue

Min Steps: 2 Max Steps: 4 Min Keystrokes: 2 Max Keystrokes: 7

Type Control:

Step 1: Access Volvo Link System

Notes Step 1: Press the "Enter" control to access system (Volvo link is 1st menu item, and should be highlighted). Min 1 keypress, Max 3 keypress

Step 2: Select Read Messages

Notes Step 2: From the Volvo Link menu, select read messages menu item (first menu item of three, and should be highlighted). Brings up first message in queue. Min 1 keypress, Max 2 keypress

Step 3: Access 2nd Messages in Queue

Notes Step 3: Press "Enter" to bring up the 2nd message in the queue. Min/Max 1 keypress

Step 4: Scroll to Read Lenghty Message

Notes Step 4: If the message text does not fit in the visible screen area, scroll down to reveal additonal lines of text. Assume 1 scroll needed to read entire message. Min/Max 1 keypress

Step 5:

Notes Step 5:

Step 6:

Notes Step 6:

Step 7:

Notes Step 7:

Step 8:

Notes Step 8:

Step 9:

Notes Step 9:

Step 10:

Notes Step 10:

Step 11:

Notes Step 11:

- [ ] Multiple Methods (Shortcuts)
- [ ] Error Prevention
- [ ] Resume Without Interruption
- [ ] Error Recovery

Comment: Number of unread messages in queue are displayed to the driver once the read message screen appears along with the text for the first message.

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