Chapter 24 - Driver Interface Safety and Usability Standards: An Overview

Paul Green, University of Michigan Transportation Research Institute (UMTRI)

24.1 What is the Goal of This Chapter?

Guidelines and standards provide a collection of the accepted wisdom of an industry, but knowing which guidelines and standards to apply to a particular product is often difficult. The goal of this chapter is to help engineers and others determine which guidelines and standards to consider when designing and evaluating the driver interface for motor vehicle communication and information systems to minimize distraction. Some of the systems of interest are navigation, traffic information, voice communication, text messaging, and entertainment. How much these systems distract drivers from driving depends on the task and its demands, and not on the device, who made it, or how it got into the vehicle. Therefore, there should be no distinction between OEM and aftermarket products, or between installed and carry-in devices, even though some standards reviewed limit the types of devices to which they apply.

Guidelines and standards are expensive and time-consuming to acquire, but the cost of not using them may be greater. Non-complying interfaces can be dangerous to use, a magnet for lawsuits, and undesired by customers. Customers, especially in the U.S., expect motor vehicles to be safe and easy to use. They do not expect to read manuals or take a class to learn how to operate motor vehicle features. In the U.S., the accepted liability benchmark is that products must be designed for reasonable and expected use and misuse. Driver interfaces that are not safe or easy to use may be so because they are distracting, which is the focus of this book.

24.2 What Kinds of Guidelines and Standards Exist?

In common parlance, guidelines refer to how something should be done whereas standards refer to how something must be done. As will become apparent later in the chapter, because some standards are not enforced, they are viewed as guidance, and therefore exist as standards in name only.

Guidelines and standards usually pertain to either product design or performance. Design guidelines and design standards concern physical characteristics, such as tolerances, maximum loads, operating temperatures, etc. Design guidelines and standards are appropriate where a topic has been reasonably well investigated and for which accumulated knowledge is stable, such as requirements for minimum character size to assure legibility or where physical interfaces occur, such as bumper heights (so that bumpers from different vehicles contact one another).

Performance guidelines and performance standards concern how things should be measured and how well they should function, such as time and errors when entering a destination into an in-vehicle navigation system. Performance guidelines and standards are appropriate where there are many methods to achieve a goal or where the underlying technology is rapidly evolving.

Less commonly, guidelines and standards may concern not what is produced, but the process of how it is produced. Such guidelines and standards can cover requirements for the credentials of personnel involved in design and testing, when and how design reviews and tests are done, and how the entire process must be documented.

24.3 Who Develops Motor Vehicle Safety Guidelines and Standards, and How?

Guidelines and standards are developed by professional and trade associations, national and international standards organizations, governments, and others (Schindhelm, Gelau, Keinath, Bengler, Kussmann, Kompfner, Cacciabue, and Martinetto[1]). This section describes the most prominent of these organizations, with Table 24-1 describing the process each organization uses to develop guidelines and standards.

Insert Table 24 - 1 about here

The Society of Automotive Engineers (SAE) is the leading worldwide professional organization of automotive engineers. The development of SAE driver interface standards is the purview of the Intelligent Transportation Systems (ITS) Safety and Human Factors Committee (Society of Automotive Engineers[3]). SAE develops information reports (literature compilations), recommended practices, and standards, all of which are considered to be “standards” by SAE and follow the same development process (Society of Automotive Engineers[4]). Standards are for procedures or specifications that have broad engineering acceptance. Though compliance with SAE recommended practices and standards is voluntary, deviations from them are very difficult to defend in U.S. courts, so suppliers and manufacturers comply with them.

The International Organization for Standardization (ISO) has developed about 12,000 global consensus standards for a wide range of applications as well as a significant number of information reports. ISO driver interface standards are developed primarily by Technical Committee 22/Subcommittee 13 (Road Vehicles/Ergonomics Applicable to Road Vehicles) and, in particular, Working Group 8 (Transport Information and Control Systems on Board – Man-Machine Interface).

Similar to compliance with SAE standards, ISO standards are voluntary. However, some countries require “type certification” for vehicles to be sold (which includes compliance with ISO standards). Global manufacturers find that producing ISO-compliant, globally-marketable, vehicles is less costly than producing non-compliant, country-specific, vehicles. Hence, manufacturers comply with them.

The National Highway Traffic Safety Administration (NHTSA), an agency of the U.S.

Department of Transportation (U.S. DOT), is responsible for the Federal Motor Vehicle Safety Standards (National Highway Traffic Safety Adminstration[5]). As the U.S. is currently the largest market for vehicles, these safety standards are particularly important. Furthermore, Canadian standards (Transport Canada[6]) tend to mirror those of the U.S. Failure to comply with U.S. DOT safety standards can result in fines and mandatory recalls. U.S. DOT activity on safety standards depends on which political party holds the presidency and controls Congress. The Republicans favor less government activity (fewer standards or the use of industry/commercial standards). The Democrats favor consumer protection (more federal standards and more rigorous requirements). (For an elaboration, see Joan Claybrook's interview on Frontline [Public Broadcasting System[7]].) The U.S. DOT standards do not address issues of distraction in any substantial way.

A number of highly detailed guidelines were written under contract to the U.S. DOT (e.g., Green, Levison, Paelke and Serafin[8]; Campbell, Carney, and Kantowitz[9]; and see also Chapter 21), but there was no open process for them to be evaluated. The guidelines are interesting and well documented. However, because they are informational and not cited as good practice to be followed by standards development organizations, so there is not much incentive to comply with them.

The Alliance of Automobile Manufacturers (AAM) is the trade association of the U.S. automobile manufacturers. AAM guidelines are voluntary and publicly available, and AAM does not enforce them. The major incentive for manufacturers to comply with the AAM guidelines (in some sense, their own guidelines), is the potential negative outcome of a product liability action. The Japan Automobile Manufacturers Association (JAMA) also has developed guidelines (see Chapter 23). The guidelines were developed specifically to minimize distraction and, although they are theoretically voluntary, as a matter of accepted practice, they are followed by all Japanese original equipment manufacturers (OEMs) and sometimes by aftermarket suppliers. Some of these guidelines are particular to Japan (e.g., concerning very narrow roads).

24.4 Comments on the Guidelines and Standards Development Process

There are differences in how standards development organizations function. Some, such as SAE, ISO, and the U.S. DOT, follow an open process, and for SAE and ISO, consensus is important. Other organizations, such as AAM, are closed to those who are not employees of AAM member companies.

Full participation in standards development requires travel to meetings, which for ISO involves international travel. Only major manufacturers and government agencies have the resources to fund professional time and travel, so such committees have few members from academic organizations or citizen groups. The result is that those with a vested interest in product development have a disproportionate influence on standards development.

Further, although organizational charters require that standards be developed by technical experts, in a few instances participant expertise is weak (for example, they are not full members of the Human Factors and Ergonomics Society or certified by the Board of Certification in Professional Ergonomics).

Finally, guidelines and standards, particularly those of SAE, JAMA, AAM, and ISO, take at least three years to develop. Assembling the relevant information and developing a consensus takes time. Employers are often not willing to provide much support for the background work to aid standards development (such as literature reviews or studies with subjects), especially on short notice, and most committees only meet a few times a year. Thus, design and performance standards are often produced years after the products they affect.

24.4 What Design and Evaluation Standards Exist for Driver Interfaces?

24.4.1 U.S. DOT, EU, AAM, JAMA, and SAE Guidelines and Standards

Table 24-2 summarizes the design and performance guidelines and standards of many organizations, except those of the ISO (described later). Copies of these documents can be retrieved from the University of Michigan Transportation Research Institute (UMTRI) Driver Interface web site (www.umich.edu/~driving), though in some cases final copies are not provided due to copyright protection.

Insert Table 24 - 2 about here

The U.S. DOT effort that funded the previously mentioned UMTRI guidelines (Green et al.[8]) led to a follow-on project, the Battelle guidelines (Campbell et al.[9]). The UMTRI guidelines were intended to supplement standard human factors references such as Military Standard 1472 (U.S. Department of Defense[20]), which is regarded as the human engineering "bible," whereas the Battelle guidelines included information such as required character sizes (see Chapter 22 for an extensive description of the UMTRI and Battelle guidelines). As a follow-on to those efforts, the Virginia Tech Transportation Institute developed a model to predict driver performance (Hankey, Dingus, Hanowski, Wierwille and Andrews[21]). In parallel, the HARDIE guidelines (Ross, Midtland, Fuchs, Pauzie, Engert, Duncan, Vaughan, Vernet, Peters, Burnett, and May[13]) were developed in Europe. There is no data on how much these documents specifically influenced design practice though they did help organize the literature, identify gaps, and indirectly led to efforts to develop SAE and ISO standards.

At about the same time, the European Union (EU) human-machine interface guidelines were developed and later enhanced (Commission of the European Communities[11, 12]). The original EU guidelines were extremely brief, but were expanded and renamed as the European Statement of Principles in 2005 (see Chapter 21). The 1999 EU guidelines also served as the basis for the AAM guidelines (which AAM called principles; Alliance of Automobile Manufacturers[10]) and may have influenced the development of a checklist and guidelines by the Transport Research Laboratory (TRL) (Stevens, Board, Allen, and Quimby[18]; Stevens, Quimby, Board, Kersloot, and Bur[19]). The AAM work is described in greater detail later (and in Chapter 22). Finally, in parallel with all of those efforts, was the development of the JAMA guidelines (Japan Automobile Manufacturers Association[14]; covered in detail in Chapter 23). In a somewhat different direction was the development of two SAE Recommended Practices (Green[22, 23, 24]; Nowakowski and Green[25]; Nowakowski, Utsui and Green[26]; Society of Automotive Engineers[15, 16, 17]), though the SAE efforts (described in detail later) were aware of the prior guidelines and ISO work.

Thus, over a five-year period, a large number of design guidelines were produced, some of which were connected, with the original EU guidelines being the starting point. However, these guidelines and standards differ quite widely in their scope and specificity, with the amount of detail provided increasing over time. Clearly, a guideline that states how far from an intersection a turn message should be presented is readily applied, but in situations without specific guidelines, one must rely on general principles (e.g., "present information consistently"). Experimentally investigating every possible safety and usability design issue is not cost effective, so general principles are often used to make design decisions. Unfortunately, some industry practitioners do not know these guidelines even exist. Furthermore, smaller organizations may have no staff with professional training in human factors, so how those companies would apply the general guidelines is unknown. The lasting contribution of these guidelines could be to spur the development of standards that designers are more likely to follow. Compliance with these guidelines should make driver interfaces safer and easier to use and, in doing so, reduce the extent to which distraction is a problem.

Potentially the AAM principles could have a major impact on driver interface design. Version 2 is the current set with Version 3 reportedly forthcoming (Alliance of Automobile Manufacturers[27, 10]). Although their scope states that the AAM Principles apply only to advanced information and communication systems, these principles should also apply to traditional information or communications systems (e.g., entertainment systems), as the underlying goals (reading displays, pressing buttons, etc.) and method of execution are the same, as is the manner in which tasks distract people from driving.

Of the AAM principles, principle 2.1 most directly addresses distraction. That principle states, "Systems with visual displays should be designed such that the driver can complete the desired task with sequential glances that are brief enough not to adversely affect driving." There are two alternative verification methods. For alternative A, the criterion is that the 85th percentile of single glance durations should not exceed 2 seconds, and the total glance time for a task should not exceed 20 seconds. There is considerable debate as to what the percentile criterion for a single glance and the maximum task time should be (Go, Morton, Famewo, and Angel[28]), in particular, that the AAM guidelines are too permissive. Compliance can be verified by a visual occlusion procedure (see Chapter 8) or from eye fixation data collected in either a divided attention condition or on-road test (by a camera aimed at the face or an eye fixation monitoring system). (In the visual occlusion procedure subjects wear LCD glasses or in some other manner have their vision to the device periodically interrupted, simulating looking back and forth between the road and the device. In the AAM guidelines the viewing time is 1.5 seconds and the occlusion period 1.0 seconds.)

For alternative B, the criterion is that the number of lane departures does not exceed the number for a reference task such as manual radio tuning (and at the same time car following headway should not degrade). The compliance test involves driving on a real or simulated divided road at 45 mph or less in daylight, on dry pavement, with low to moderate traffic. The AAM principles document provides details concerning the location of the radio, the stations among which to choose, what constitutes a trial, and subject selection. Even though manual tuning seems like a potential benchmark, the range of task times and interface usability varies quite widely among products, making selection of the standard radio-tuning task difficult. In part, this is because radios have evolved from two knobs, five buttons, and a dial to complex multifunction systems with touch screens and menus in which the radio function is embedded. If forced to choose an alternative, the author would choose A because the data are more revealing in terms of when drivers are distracted (which can serve to improve the design) and because the test method and criteria are better defined.

SAE Recommended Practice J2364 (Society of Automotive Engineers[16]) presents two test methods and criteria to determine if visual manual tasks should not be performed while driving. Though the practice scope statement constrains application to navigation-system-related data entry tasks, there is no reason why J2364 should not apply to other visual manual tasks and other systems. The practice does not, and should not, apply to voice interfaces because the task methods are fundamentally different. The idea behind this practice is that the longer an in-vehicle task takes to complete, the greater is the time the driver is distracted from keeping their eyes on the road, and the greater is the probability of a crash.

The static test procedure in J2364 requires 10 test subjects between the ages of 45 and 65 years, which means that the reasonable worst case of elderly drivers is not considered. Each subject completes five practice trials and three test trials of the task in question (e.g., entering a street address) in a parked vehicle, simulator, or laboratory mockup. In the static method, the task is acceptable if the mean task time (actually the antilog of the mean of the logs to reduce the influence of outliers) is less than 15 seconds ("The 15-Second Rule," a duration that has been the subject of considerable discussion). To minimize distraction, the author would recommend 10 seconds. Compliance with the 15-second limit can be estimated using a calculation procedure described in SAE Recommended Practice J2365 (Society of Automotive Engineers[17]) based on task element times (keying, mental operations, etc.) popular in the human-computer interaction literature and adjusted for automotive applications. (See also Pettitt, Burnett, and Karbassioun[29].) In an alternative procedure involving occlusion, the device is visible for 1.5 seconds and occluded for 1 to 2 seconds, with 1.5 seconds being recommended. The criterion (again determined using logs) is 20 seconds. Recently, Pettitt, Burnett, and Stevens[30] have proposed a calculation for estimating compliance.

24.4.2 ISO Standards

Table 24-3 shows the documents developed or being developed by ISO Working Group 8. Most of the documents can be quite general, sometimes not containing the detail found in the Battelle, HARDIE, or UMTRI guidelines. Because reaching agreement is difficult, measurement methods are often presented without acceptance criteria for safety. To promote international harmonization and comply with trade agreements, national standards organizations, technical societies (e.g., SAE), and government organizations (e.g., U.S. DOT) often permit ISO standards to supersede their own standards, so ISO standards are very important.

Insert Table 24 - 3 about here

ISO standards concern both design (15005 - dialogue management; 15006 - auditory information; 15008 - legibility; 16352 - warnings literature review; 16951 - message priority) and design process issues (17287), as well as performance assessment (15008 - visual behavior; 16673 - occlusion method; 26022 - lane change test). A review of the design standards shows that few have assessment criteria, and most content is quite general. That does not mean, however, they are not useful for addressing distraction.

The lack of performance acceptance criteria in either 16673 or 26022 is particularly noteworthy. Standard 16673 states, “If TSOT is … a criterion then the age of the participants should be taken into account. If R > 1, … participants may be having difficulty in resuming the task ... It is for the users … to determine the exact value to be used as a criterion ....” (TSOT is the total shutter open time, the time a driver interface is visible in an occlusion test. For more extensive descriptions of TSOT and R, see Chapter 8.)

For the lane change test (ISO 26022; see Table 24-3; see also Chapter 9), there is no agreement as to which performance measures to use - the mean delay in missed lane change initiation, number of missed lane changes, mean task completion time, total number of errors, and numerous measures of lane position and path error. In part, this reflects the fact that the test is new and research is ongoing. However, it also reflects the lack of a useful model of how people drive that can predict the effects of performing secondary tasks while driving.

Quite different from all of the other standards is ISO 17287, which describes an ISO 9000-like process to promote safety and usability (and reduce driver distraction). (See Table 24-3.) Though some OEMs and suppliers naturally do some of what is in the standard as good practice, no one seems to pay much attention to complying with it. In part, this is because the administrative burdens are perceived to outweigh the benefits.

24.5 Closing Thoughts

Even after decades of research, the human factors community is not able to predict crash risk from the many test methods proposed (not the occlusion or the lane change test described here, or the peripheral detection task, eyes off the road measures, or other methods; see Part 3 of this volume for a discussion of these methods), though there have been proposals for connecting task time to crashes. Somehow, those connections must to be made, and research on such is of the highest priority. In particular, needed are equations relating performance in various tests to fatalities and injuries likely at that level of performance (although see Young and Angell[41] for some interesting ideas about the relationships between measures). Further, the notion that a single, low-cost, test can assess the interference with driving of a secondary task, regardless of its visual, auditory, cognitive, and psychomotor demands, may need to be abandoned, and that is reflected in ISO's adoption of multiple standards for driver interface assessment.

As described in this chapter, and in Chapters 21, 22, and 23, there are numerous guidelines and standards to assist in designing driver interfaces to enhance safety and ease of use, and reduce distraction, but only a few have performance criteria. Following the design guidelines for ease of use can reduce opportunities for distraction; although performance standards more directly address the distraction problem. Both types of documents, however, are needed.

When selecting a safety or usability guideline or standard, consider the process by which it was developed: the openness of the process (open leads to a greater driver protection); technical expertise of the developers; criterion for safety thresholds (do no harm, be generally safe, is safe unless shown otherwise, etc); the quantity and quality of the supporting data; difficulty of application of the data or process; and relevant application context. These all affect the reliability of the results and the extent to which the standard is biased towards assessing something as safe or unsafe (or distracting or not distracting). In the context of this chapter, should only systems that are flagrantly distracting not be allowed, or those likely to be distracting, or those that are potentially distracting, or should the criterion be something else? What then should a designer do to design a minimally distracting driver interface?

During the initial phases of design, designers should read and apply all of the ISO guidelines that specify the physical characteristics of the driver interface (e.g., 15006, 16951 and especially 15008). They also should read and apply the relevant design guidelines for their intended market: UMTRI, Battelle, and AAM for the U.S., HARDIE for Europe, and JAMA for Japan. For Europe, the ESoP document should also be considered, but because it is so general (as are the AAM principles), those without human factors training will find these documents difficult to apply. However, because all of these guidelines contain good human factors practice, there is no reason why they should not be applied globally.

However, to minimize distraction, the focus should not be on the physical aspects of the driver interface, but on the tasks the driver performs, especially how often the driver needs to look away from the road and how long the task takes. Accordingly, there should be ongoing calculations of task times and visual demands using the SAE J2365 and Pettitt, Burnett, and Stevens[30] procedures, and modifications of driver tasks to reduce distraction based on those calculations. Those calculations need to occur early in design when the interface is still a paper concept that is easily changed, and continue to be updated as the design evolves. Also needed are measurements of cognitive demand when they are independent of visual demand.

Finally, when a prototype interface is available, its safety/usability/potential for distraction needs to be assessed using the procedures in SAE J2364, ISO 16673 (occlusion), ISO CD 26022 (lane change test) and, for U.S. markets, the AAM principles, most likely 2.1. Of these procedures, the author would suggest checking compliance with SAE J2364 first as it is the easiest of the procedures to complete, especially the static task time procedure. Admittedly, static task time does not capture all of the key characteristics of task interference (Young, Aryal, Muresan, Ding, Oja and Simpson[42]), but it is the only measure for which an accepted standard exists with specific criteria.

It must be kept in mind that compliance with all of these guidelines and standards is voluntary, although concerns of negative outcomes in product liability actions result in OEMs and major suppliers complying with the SAE Recommended Practice in the U.S. and pressure to conform leads to compliance with JAMA guidelines in Japan. ISO design guidelines are used worldwide but, except for the legibility standard (15008), there are no concrete performance criteria, just personal judgments.

In making engineering decisions, hard specifications (e.g., numeric values for operating temperatures or maximum weight) always take precedence over soft specifications (making it "safe," "easy to use," or "not distracting"). The situation is even worse when no specifications or no performance criteria are provided.

If ISO and other organizations are not willing to set numeric performance criteria for safety, safety will be shortchanged, and systems that are distracting to drivers will continue to be produced.

24.6 References

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Table 24-1. Guidelines and Standards Development Processes

Who	Process
SAE	Drafts of SAE standards are developed by working groups who report to committees. Ballots to approve occur at the working group, committee, and the Vehicle Systems Group. At each stage, editing can occur to resolve negative comments, and if the changes are substantial, re-balloting occurs. The approved document receives editorial review (by SAE headquarters) before publication.
ISO	Proposals for ISO standards can originate in national standards organizations of the major vehicle-producing countries such as DIN (Deutsches Institut für Normung) in Germany or from trade and professional associations such as SAE. ISO documents follow a well-defined, six-stage, process involving a series of documents - Preliminary Work Item (PWI), New Work Item (NWI), Working Draft (WD), Committee Draft (CD), Draft International Standard (DIS), Final Draft International Standard (FDIS), and International Standard (IS) - that can take up to three years to develop as a proposal moves from the working group to the subcommittee to the technical committee to the secretariat for review and balloting (ISO[2]). The most important effort comes from the roughly five people on the working group task force that write the first draft. As with the SAE process, there are opportunities for editorial changes after ballots. More informational documents become technical reports instead of standards.
U.S. DOT	These standards are developed following the process described in the Administrative Procedures Act (http://usgovinfo.about.com/library/bills/blapa.htm, retrieved July 15, 2007). The act requires proposed rules (initiated by the U.S. DOT) to be published in the Federal Register, along with listings and responses to public comments, hearings, and the final rule. The "public" includes manufacturers (who provide the most detailed comments), suppliers, consumer organizations and government agencies (including foreign governments), not just individuals.
AAM	Their standards development process is open only to members, and as best the author can tell, AAM produces only guidelines.
JAMA	There is little information on the process in the open literature, though some insights appear in Chapter 23. Some aspects of these standards have been developed as a result of "suggestions" from the National Police Agency.

Table 24 - 2. Major non-ISO telematics guidelines and recommended practices

Common Name	Authors & Year	Pages	Comments
Alliance guidelines, version 3	Alliance of Automobile Manufacturers (AAM) (2003)[10]	67	This elaboration of original EU principles contains a rationale, criteria, verification procedures, and examples for each guideline. These guidelines are likely to be used by U.S. OEMs. Key sections are principles 2.1 and 2.2, which concern visual demand and are still in need of refinement.
Battelle guidelines	Campbell, Carney, and Kantowitz (1997)[9]	261	These guidelines emphasize heavy vehicles with chapters concerning navigation (3), warning systems, in-vehicle signs, trucks, and other topics. The guidelines include physical ergonomics (e.g., control sizes). Each guideline is accompanied by the rationale, application notes, references, and a four-star rating of the supporting evidence. Example: Chapter 5 (routing and navigation guidelines): *"Road segments should be color coded (green, yellow, red) to indicate the mean speed of the traffic flow."*
EU guidelines	Commission of the European Communities (1999)[11]	2	These 24 very brief guidelines are mostly "motherhood" statements concerning overall system design, installation, information presentation, interaction with controls and displays, system behavior, and other topics. Example: Section 4 (overall design): *"The system should be designed to support the driver and should not give rise to potentially hazardous behaviour by the driver or other road users."*
European Statement of Principles (ESoP)	Commission of the European Communities (2005)[12]	59	This expansion of original EU guidelines (renamed as a statement of principles) contains the now 35 re-worded guidelines with added explanations. Example: 1.3 Design Goal III: *"The system does not distract or visually entertain the driver… The goal … is to ensure that the driver is not distracted …such that their ability to be in full control … is not compromised…Visual entertainment may occur by visually displaying images which are attractive…"*
HARDIE guidelines	Ross, Midtland, Fuchs, Pauzie, et al. (1996)[13]	480	These European guidelines contain chapters on road and traffic information, navigation, collision avoidance, adaptive cruise control, and variable message signs. They contain less data than UMTRI or Battelle guidelines but are broader as they consider driver assistance systems. Obtaining a copy of this handbook is very difficult.

JAMA guidelines	Japan Automobile Manufacturers Association (2004)[14]	15	Although these guidelines are brief, they contain several very specific requirements concerning display location (not permitted 30 degrees or more below the driver's viewing plane) and constraints on what can be shown in a moving vehicle (e.g., no broadcast TV, no descriptions for hotels and restaurants, 30 characters or less of traffic information).
SAE J2364 ("15-second rule")	Society of Automotive Engineers (2004)[15, 16]	13	This recommended practice specifies the maximum allowable task time and test procedures for navigation system tasks performed while driving for systems with visual displays and manual controls. It also describes an interrupted vision (visual occlusion) method. Designers will find SAE J2678, the rationale for SAE J2364, helpful in understanding when and how to apply SAE J2364.
SAE J2365 (SAE calculations)	Society of Automotive Engineers (2002)[17]	23	This document describes a method to compute total task time for visual-manual tasks not involving voice and is used early in design to estimate compliance with SAE J2364 and other purposes. The method utilizes time estimates for mental operations, keying, searching, and so forth.
TRL checklist	Stevens, Board, Allen, and Quimby (1999) [18]	18	Simple check list. Example: Controls, item C1: *"Are the IVIS controls easily reached by the user when driving?* ** All controls needed when driving can be reached from the normal driving position..."*
TRL guidelines	Stevens, Quimby, Board, Kersloot, and Bur (2002)[19]	70	These design guidelines focus on how to design and assess for safety. There are sections concerning compliance with regulations, packaging and instructions, installation, driver input, visual displays and information presentation, auditory information presentation, information comprehension, menus, and temporal information.
UMTRI guidelines	Green, Levison, Paelke, and Serafin (1993)[8]	111	This first set of U.S. guidelines includes principles, general guidelines and specific design criteria with chapters on manual controls, speech, visual displays, auditory displays (4), navigation interfaces (3), traffic information, phones, vehicle monitoring, and warning systems. For every guideline the supporting literature is described. Example: Guideline 7.14: *"For expressway ramps, give both the route name and direction, and a city locator. For example, the display should show "I-275 North" and "Flint." The names should be on separate lines, so … makes in-vehicle displays compatible with signs."*

Table 24 – 3. ISO Standards

Document, Reference	Short Title	Pages	Comment
Std 15005: 2002(E) (ISO[31])	Dialogue management principles and compliance procedures	15	This standard provides high-level ergonomic principles (compatibility with driving, consistency, simplicity, etc) to help design driver and in-vehicle system interactions in moving vehicles. Compliance is determined mostly by observation. Example: *"5.2.4.2.4 Individual TICS dialogues shall be designed to guide the driver in giving a priority to the information displayed. Example 1: A collision-avoidance system will rapidly attract the driver's attention (but without startling the driver) when a collision is imminent…"*
Std 15006:2004 (ISO[32])	Specifications & compliance procedures for auditory presentation	18	This standard provides requirements for in-vehicle auditory messages including signal levels, appropriateness, coding, etc., along with compliance test procedures. In a suggested procedure for tone discernment, the standard suggests 90% correct (out of 10 trials for 10 subjects) as an acceptance criterion.
Std 15007-1:2002(E) (ISO[33])	Visual behavior measurement 1: Definitions & parameters	8	This standard defines common terms related to driver eye glances and shows areas of interest in the vehicle. Examples: *"direction of gaze - target to which the eyes are directed"* *"dwell time - sum of consecutive individual fixation and saccade times to a target in a single glance"*
TS 15007-2:2001 (ISO[34])	Visual behavior measurement 2: Equipment & procedures	14	This trial standard describes video-based equipment (cameras, recording procedures, etc.) and procedures (subject descriptions, experiment design parameters, tasks, performance measures, etc.) used to measure driver visual behavior.
Std 15008:2003 (ISO[35])	Legibility (Visual presentation of information)	24	Example specifications include character size (20 arc minutes recommended), contrast (5:1 for night, 3:1 for twilight and diffuse daylight, 2:1 for direct sunlight), width-to-height ratio (0.08 to 0.16), ISO 2575 symbol resolution (32x32 if 1 bit, 24x24 if gray scale), as well as how character dimensions are measured.
TR 16352:2005 (ISO[36])	Warnings literature review	137	In 17 chapters this circa 2004 review of warning systems ergonomics covers topics such as alarm theories, the design of visual, auditory, and tactile warnings, and redundancy. The report contains 188 references.

TS 16951:2004 (ISO[37])	Message priority	35	This trial standard describes how to determine a priority index for in-vehicle messages (e.g., navigation turn instruction, collision warning) presented to drivers. It includes evaluator and scenario selection, message content, and analysis. Priority is based on two four-point scales, criticality (the likelihood of injury or vehicle damage if the event occurs), and urgency (required response time).
Std 17287:2002 (ISO[38])	Suitability of interfaces while driving	38	This standard describes a process to assess if a driver interface is suitable for use while driving using hierarchical task analysis, and encourages the use of driver performance tests. It considers the user's task, context of use, assessment, and documentation. The approach is extremely general and contains no performance criteria.
Std 16673:2007 (ISO[39])	Occlusion method to assess distraction	19	This standard describes a test to assess the visual demand of a display by periodically blocking (occluding) the driver's view of the display (1.5 s visible, 1.5 s occluded). It includes requirements for 10 subjects and their training, their age (at least 2 over 50), test hardware, and two performance measures (total shutter open time, resumability).
CD 26022 (ISO[40])	Lane change test to assess distraction	34	This committee draft standard describes a PC-based driving simulator test of the demand of a driver interface. Subjects drive and, when signaled by signs, change lanes. Some of those changes occur while using an in-vehicle device. The desired performance metrics are still being discussed, though several are proposed. The procedure contains considerable detail, such as instructions to subjects.