FIGHTING DRIVER DISTRACTION - WORLDWIDE APPROACHES

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ABSTRACT

Research on telematics applications started in the eighties. The experts realized already at that time the need for appropriate means to reduce driver distraction. The European project Prometheus was the starting point for standardization activities both on national and international level.

On this basis, guidelines have been developed in Europe, Japan and the US. A team of experts tasked by the European Commission developed the European Statement of Principles (ESoP) which was published in the year 2000 and revised in 2006. In Japan, the Japanese Automotive Manufacturers Association (JAMA) published their guideline in 1990 with revisions in 2000 and 2004. In US the Alliance of Automotive Manufacturers (AAM) developed a guideline which was published in 2003 and revised in 2006. Currently, the National Highway Traffic Safety Agency (NHTSA) in the US is also working on a guideline. The final document is not yet publically available.

All guidelines have similar goals and basic concepts to achieve the limitation of driver workload and to avoid risky behavior. The following are the most prominent: Mounting of displays and controls should not interfere with the primary driving task. Necessary information should be easily perceivable with short glances. Dialogs should have a clear structure that can be easily understood and that does not require timecritical input. Complex operation or information should be disabled while driving.

There are some differences between the regional guidelines. The main difference is the determination of the distraction potential. While the ESoP contains only a verbal description (*visual information not related to driving that is likely to distract the driver significantly)*, the AAM guideline offers different objective methods including measurement of gaze behavior and driving performance. The JAMA guideline requires measurement of glance duration.

All these guidelines are voluntary, but only a part of the industry is committed to the guidelines. The driver workload induced by a telematics system depends on many factors. Different stakeholders are responsible for these factors like car manufacturers, device manufacturers, application developer, radio stations and service provider. The guidelines deal differently with this topic. The ESoP addresses all relevant stakeholders but only the car manufacturers which are represented by ACEA are committed to follow these guidelines. The AAM guideline addresses both OEM and nomadic devices but similar to Europe, only AAM members are committed. The JAMA guideline is binding only for JAMA members.

As mentioned above the guidelines are regularly revised by the respective organizations. Up to now, these guidelines have now been applied for a decade. The number of accidents caused by distraction due to the use of vehicle integrated devices is still small despite the increased use of these systems. This shows the effectiveness of the guidelines. Further improvement is only possible on the basis of new scientific data. Naturalistic driving data are a promising approach.

INTRODUCTION

Developing standards for automotive HMI has a history of decades [3].

It started with PROMETHEUS in 1985. This European project was initiated with the purpose to develop the European traffic scenario of the future with improved safety, environment and efficiency. One of the working groups in PROMETHEUS was created to tackle the Human Factors and HMI questions.

Well into the program, the need for standardisation was realised. Within CEN (Comité Européen de Normalisation) the technical committee CEN TC278 was formed in 1991 for this purpose. One of its working groups, WG10, which was entrusted with the task of using new technologies to solve the problems of human machine interaction.

Discussions of lifting the CEN work to an international, ISO, level started early 1993, since it became clear that it is inefficient to have regional standards in the automotive business. ISO TC 22 SC13 WG8 was formed for this purpose and held its first official meeting in Paris in November of 1994.

Many of the standards developed by this group are referenced in the guidelines that will be described in the next sections:

- Dialog management [4]
- Auditory information [5]
- Measurement of visual behaviuour[6]
- Visual presentation of information [7]
- Priority [9]

A standard for driver response task is currently under development.

THE GUIDELINES

These standards have been augmented by voluntary guidelines. They have been developed by different organization and also different groups are committed to comply with the guidelines (Table 1).

Table 1
Development and compliance with the guidelines

Document	Developed by	Signed by
JAMA Guideline	Japan Automobile Manufacturers Association (JAMA)	JAMA
European Statement of Principles (ESoP)	Expert Group tasked by European Commission	European Automobile Manufacturers' Association (ACEA)
AAM Guideline	Alliance of Automotive Manufacturers (AAM)	AAM

There is also a difference in itemization. While the JAMA guideline has only 15 pages including an appendix, the ESoP has 42 and the AAM Guideline 90.

All these guidelines are voluntary. The automotive industry, as shown in table 1, has signed commitments by their respective organisations to comply with these guidelines. But the driver workload induced by a telematics system depends also on factors influenced by other stakeholders. According to ESoP also the following stakeholders are addressed if their products are intended to be used by the driver while driving:

- After-market systems and service producers
- Prividers of nomadic devices,
- Manufacurers of parts enabling the use of nomadic devices (i.e. cradles, interfaces and connectors)
- Service providers including software providers or broadcasters of information, i.e traffic, travel and navigation information, radio programms with traffic information.

The scope of the AAM guideline addresses all suppliers and manufacturers of in vehicle information and communication systems . JAMA referes to OEMs, aftermarket devices are excluded.

Table 2 shows the dates of publication of the guidelines. There are no publications after 2006, despite some discussions about the topic. This is an indication that the guidelines are quite mature and no meaningfull improvement can be done without substantial new scientific data.

Table 2
Publication dates of the guidelines

Document	1. version	2.version	3.version
JAMA Guideline	1990	2000	2004
ESoP	2000	2006	
AAM Guideline	2003	2006	

Table 3 shows a comparison of the guidelines with reference to the respective principles. This list has been developed with colleagues from AAM and CCC (Car Connectivity Consortium) to support HMI developers who have less experience with the requirements of automotive HMI. This seemed to be important because of the upcoming integration of nomadic devices and applications into the vehicle.

It should be noted that some versions of the ESoP use a four digit method of numbering. The numbers used in table 3 are just preceded by 4.3.

Table 3
Comparism of the regional guidelines

	Reference		
Content	**ESoP**	**AAM**	**JAMA**
Correct installation	2.1	1.1	3.1 (4)
Drivers field of view	2.2	1.2	3.1 (2)
Obstruction of displays and controls	2.3 4.5	1.3	3.1 (1)
Driving posture	-	-	3.1 (3)
Close to the drivers line of sight	2.4	1.4	3.2 Annex 1
Glare and reflections	2.5	1.5	3.2
Display at night			4.1 (3)
Short glances	3.1	2.1A	4.2 (1) 4.2 (2) 5(4) Ann. 2.1
Total glance Time	3.1	2.1A	4.2 (1) 4.2 (2) 5 (3) Annex 3
Visual distraction / driving performance		2.1B	-
Symbols	3.2	2.2/1	4.1 (2)
Legibility			
- Contrast	3.2	2.2/2	4.1 (2)
- Size of characters	3.2	2.2/2	4.1 (2)
- Font dimensions	3.2	2.2/2	4.1 (2)
- Blinking	3.2	2.2/2	4.1 (2)
Audibility	3.2		4.1 (2)
Timeliness and accuracy of information	3.3	2.3	-
Prioritization 4)	3.4	-	-
Information which impairs the safety and smooth flow of road traffic	-	-	4.1(1)
No Uncontrollable Sound	3.5 4.6	2.4	4.3 (1) 4.3 (2)
At least one hand on the steering wheel	4.1	3.1	5 (1)
Chunkibility	4.2	3.3	5 (5)
Resumebility	4.3	3.3	5 (6)
Driver paced	4.4	3.4	5 (8)
Handsfree speech		3.2	-
Timely feedback	4.7	3.5	5 (9)
Visual Information can be switched off	4.8	3.6	5 (5)
No TV or scrolling Text	5.1	4.1	4.2 (2) Ann. 2.3 Ann. 2.4
No functional interference	5.2	-	-
Locked during driving	5.3	4.2	4.2 (2) Ann. 2.2 5 (7)
Malfunction notification	5.4	4.3	-

The following chapters show the detailed comparison with differences and common elements:

Correct installation

The system should be located and fitted in accordance with relevant regulations.

While the ESoP focuses on stable mounting and passive safety, the AAM is more general. JAMA regulates the installation of retrofit systems.

Drivers field of view

The system schould not obstruct the drivers view of the road scene.

The content of all guidelines is the same, AAM and ESoP also reference regional standards

Obstruction of displays and controls

The system should not obstruct vehicle controls and displays required for the driving task.

Same content, in ESoP with reference to ISO 4040.

Driving posture

The system shall not cause the driver to be substantially displaced from the driving posture (JAMA only).

Close to the drivers line of sight

This principle limits the downward angle. JAMA defines a value of 30° for the projection of the line between display and JIS eye point on the xz plane. AAM applies additionally a 3D method that allows greater downward angles if the display is mounted on the passenger side. ESoP does not give a defined value for the downward angle.

Glare and Reflections

Visual displays should be designed and installed to reduce glare and reflections.

Table 4
Different aspects of glare and reflections are handled

Topic	ESoP	AAM	JAMA
Display too bright	X	X	X
Reflections on the wind screen	X		X
Reflections on the display (Reduction of contrast)	X	X	
Reference to ISO 15008	X	X	

Display at night

Within JAMA for the night condition not only excessive brightness is considered, but also properties like contrast and colors.

Short glances

The driver should be able to acquire the relevant information with glances that are short enough not to adversely affect driving.

The ESoP declares this an important item which has to be considered while developing the HMI. JAMA additionally mentions limitations for content regarding maps. AAM limits glance time to 2 sec with precise measurement methods.

Total glance time

AAM offers two methods to determine total glance time:

- Direct measurement of glance time according to ISO 15007 [6]. The device under test is operated while driving on a road, a test track or in a simulator. Total glance time should not exceed 20 seconds.
- Occlusion testing according to ISO 16673 [8].This method uses a special set of google, where the vision can be blocked by a shutter repeatedly for a defined time. Total Shutter Open Time (TSOT) should not exceed 15 seconds.

JAMA defines 8 seconds for total glance time and 7.5 seconds for TSOT.
ESoP has general design recommendations to reduce total glance time.

Visual distraction / driving performance

AAM also offers a method to determine the influence of visual distraction by measuring the effect on driving quality. The experiment can be performed on the road, on a test track or in a driving simulator. While driving on a highway in a car following scenario the test subject operates the application under test. Lane exceedences and variation of headway are recorded as measures for driving quality. The same procedure is done for manual radio tuning as a reference task. Driving performance for the application must not be significantly worse than the reference task to be allowed while driving.

Symbols

All guidelines request the use of international accepted symbols. ESoP and AAM explicitly refer to ISO 2575 [10].

Legibility

The guidelines themselves have only a very general statement. ESoP and AAM refer to ISO 15008 [7] which has very detailed requirements especially regarding contrast and font size.

Audibility

Regarding audibility ESoP and JAMA refer to existing standards, ESoP with explicit reference to ISO 15006 [5]. .

Timeliness and accuracy of information

Information relevant to the driving task should be accurate and provided in a timely manner.

Mentioned in AAM and ESoP, to be verified by inspection. This principle is mainly relevant for navigation.

Prioritization

Information with higher safety relevance should be given higher priority.

This principle is only within ESoP with a reference to ISO 16951 [9].

Information which impairs the safety and smooth flow of road traffic

A system shall not present information that impairs the safety and the smooth flow of traffic.

This principle exists only in JAMA.

No Uncontrollable Sound

The system should not produce uncontrollable sound liable to mask warnings or to cause distraction.

Same content in all guidelines, in ESop with reference to ISO 15006 [5]

At least one hand on the steering wheel

Same basic content in all guidelines. AAM has additional statements :

- operations where both hands are involved, but both hands are on the steering wheel are allowed
- operations with the need to reach through the openings of the steering wheel are forebidden.

Chunkibility

The system should not require long and uninterruptible manual-visual interactions.

Same content in all guidelines.

Resumebility

The driver should be able resume an interrupted sequence of steps at the point of interruption or at another logical point.

Same content in all guidelines.

Driver paced

The driver should be able to control the pace of interaction with the system. The system should not require time critical responses when providing input to the system.

Same content in all guidelines.

Handsfree speech

This principle within ESoP requires handsfree provisions for using the telephone.

Timely feedback

The system's response following driver input should be timely and clearly perceptible.

Same content in all guidelines. AAM additionally sets a time limit of 2 seconds for the response with reference to ISO 15005 [4].

Visual Information can be switched off

Systems providing non-safety-related dynamic visual information should be capable of a means by which that information is not provided to the driver.

Same basic content in all guidelines.

No TV or scrolling Text

Visual Information not related to driving that is likely to distract the driver significantly (e.g. TV, video, continuously moving images and automatically scrolling text) should be disabled while the vehicle is in motion.

Same basic content in all guidelines. In JAMA also a driver induced scrolling is forbidden.

No functional interference

This principle of ESoP requires that the behavior of the system should not adversely interfere with display or controls required for the primary driving task and for road safety.

Locked during driving

System functions not intended to be used by the driver should be made inaccessible for the purpose of driver interaction while the vehicle is in motion.

Same content in all guidelines.

Malfunction notification

Information about current status, and any detected malfunction, within the system that is likely to have an adverse impact on safety should be presented to the driver.

Same content in ESoP and AAM

NHTSA GUIDELINE

In 2010 the NHTSA (National Highway Traffic Safety Administration) presented a project to fight driver distraction [12]. One objective was to develop guidelines for visual manual interactions. Since the final version is not released until now (01.03.2013) the following is based on the draft document that was the basis for public discussion [13]. The NHTSA guideline is in great detail based on the AAM Guideline, but also discusses very detailed seven methods to assess driver workload. It was indicated

that only two of these methods will be used in the final document.

EGDS	Eye glance testing
OCC	Occlusion testing
STEP	Step counting
DS-BM	Driving test protocol with benchmark
DS-FC	Driving test protocol with fixed acceptance criteria
DFD-BM	Dynamic following and detection protocol with benchmark
DFD-FC	Dynamic following and detection protocol with fixed acceptance criteria

Table 5
Assessment methods for driver workload within NHTSA Guideline

Method	Description	Acceptance criterion
EGDS	Measuring Eye Glance time in a driving simulator	1) Glance time (85 percentil): < 2sec for any participants 2) Mean glance: < 2.0 sec for 21 of 24 participants 3) Total glance time:< 12.0 sec for 21 of 24 participants
OCC	Occlusion Testing	9 sec TSOT
STEP	Step counting	6 steps
DS-BM	Driving performance in a simulator (lane excceedences and standard deviations of headway)	Not significantly greater than he reference task (radio tuning)
DS-FC	Driving per-formance in a simulator (lane excceedences and standard deviations of headway)	Lane exceedance: 0.06 per second Standard deviation of headway: 0.35 seconds
DFD-BM	Eye glance criteria **PLUS** Visual detection task Reference task: Navigation input	1) Glance time (85 percentil): < 2sec for 85% of the participants 2) Mean glance: < 2.0 sec for 21 of 24 participants 3) Total glance time:< 12.0 sec for 21 of 24 participants **AND** 3 of the 4 following: 1) Standard deviation of lane position significantly less than reference task 2) Car following delay significantly less than for the reference task 3) Percentage of correctly detected events significantly higher than for the reference task 4) Response time is significantly less than for the reference task
DFD-FC	Eye glance criteria **PLUS** Visual detection task	1) Glance time (85 percentil): < 2sec for 85% of the participants 2) Mean glance: < 2.0 sec for 21 of 24 participants 3) Total glance time:< 12.0 sec for 21 of 24 participants **AND** 3 of the 4 following: 1) Standard deviation of lane position significantly less than 1.0 feet 2) Car following delay significantly less than 4.6 sec. 3) Percentage of correctly detected events significantly higher than 80 %. 4) Response time is significantly less than 1.0 sec

After publication of the draft NHTSA faced strong opposition from the automotive industry. The main concerns were:

- NHTSA tightens the criteria very much without a basis of scientific data.
- If, as a consequence of these restrictions, functions of integrated devices are further restricted, users will be inclined to use handheld devices that do not have a user interface developed for use while driving and thus increase the probability of an accident.

Beside these major points there are a number of other concerns. They are not justified from scientific evidence.

- The 30 character rule was taken from the JAMA guideline, ignoring the fact, that a Kanji character is much more difficult to read

than a Latin character because it contains the information of a whole word.
- Moving maps, related to the position of the vehicle, are forbidden. Instead of these quasi-static maps are recommended, that jump every few seconds. Obviously that is more distracting than a smooth scrolling map

Other additional requirements on test subjects, test setup and equipment make the measurement of glance behavior and driving performance more complicated than appropriate without a rationale:
- A vehicle cab is demanded by NHTSA for the test setup. OEMs need to test for all their car types, so a flexible mock up is more useful.
- Definitions of age groups is too detailed
- Requirement for mileage of test subjects (7000 m/a) is too high
- The request that automakers employees are not allowed as test persons is not appropriate. Regarding innovative telematics applications OEM employees are not more knowable about advanced applications than the typical user of innovative applications

Some functions are excluded without a precise definition. As an example social media are mentioned. These applications include features not relevant for driving like general messages and pictures on the 'wall', but others give access to addresses and telephone numbers which can be automatically forwarded to telephone or navigation system and will reduce driver distraction.

CONCLUSION AND FUTURE DEVELOPMENT

History has shown that despite of the concerns in the past there is no increase of accidents due to the use of integrated devices. Current standards and guidelines stand on the solid ground of scientific evidence and are regularly reviewed. New input for these standards is especially expected from naturalistic driving data. For instance, it was surprising that hands free phoning showed an Odd Ratio of 0.5[13] . I.e. it had only half the accident rate of just driving. Data like these can give a deeper inside into realistic driver behavior than simulator experiments. Current guidelines do not consider the frequency of use of a specific application. While texting may occur during the whole travel time, destination input will probably be used only once every second trip.

In contrast to the use of integrated devices the danger of handheld devices is obvious. This holds especially for entering text, a functionality that is generally blocked with OEM installed devices. With nomadic devices there is technically no way to block functions while driving unless the user has installed a special software. This also requires monitoring by e.g. parents or employers. So the main factors to reduce texting while driving is education and enforcement. In addition to that industry can offer save and attractive alternatives for a reasonable price. One approach is the Mirrorlink project. The automotive industry together with the phone companies are spending a big effort in the Car Connectivity Consortium (CCC) to develop a concept where the application runs on a smartphone but uses the large display of the car. By this integration it is also possible to apply all the guidelines described above and block certain functions while driving. This seems to be the next big step to reduce driver distraction.

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