FIGHTING DRIVER DISTRACTION – RECENT DEVELOPMENTS 2013 - 2015

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ABSTRACT

Research on driver distraction has a long history and attracts the attention of the scientific community, the public and the authorities. This resulted in a great number of activities. This article will summarize the main developments since the last ESV in 2013 from the perspective of an automotive manufacturer.

Guidelines and standards: In 2013 the National Highway Transport and Safety Agency (NHTSA) published a guideline for visual manual HMI . While basically following the structure of the European Statement of Principles (ESoP) [2] and the AAM guideline [1], the NHTSA guideline is much more restrictive, which means that more functions need to be blocked while driving. So the concern is that drivers will be inclined to use nomadic devices which have no restrictions at all (i.e. smartphones). Thus the overall impact of that guideline on safety may be negative.
The last version of the ESoP was published in 2008. In the framework of the iMobility Forum an HMI group was installed with the objective to check whether any changes, updates or additions are needed. The final report is expected for 2015. Some statements can be expected from the current draft which contains some recommendations and explicitly states to keep the ESoP as a design guideline, based on ISO standards, but not to include overall acceptance criteria. Due to the growing importance of applications that are being developed independently from hardware, another group was established within iMobility Forum, SafeAPP, in order to cover this specific topic.
On international level OICA (Organisation Internationale des Constructeurs d'Automobiles) published a white paper with recommendations for guidelines.

Naturalistic driving studies (NDS): Most experiments in simulators or on test tracks measure driving performance or glance behavior to determine mental workload. For using the telephone they usually report an odd ratio of four (The probability of a crash is four times higher compared to normal driving). It was quite a surprise when the 100 car study in 2013 presented odd ratios below one. Recent data from SHRP 2 give even lower values. NDS seem to be a powerful tool to identify actions and behavior that cause crashes. Detailed methods are under development and handling of great amounts of data is a challenging task.

Tethering: Nomadic devices can cause a problem since neither their displays nor their controls are developed for automotive use. Also they do not block functions that are not intended to be used while driving. One way to overcome this problem is to tether the telephone with the display and the controls of the car. This also makes it possible to apply existing guidelines (AAM, JAMA, ESoP). The Car Connectivity Consortium (CCC) has rephrased the existing guidelines so that they are better understandable by app developers. The CCC also established a process that will be run by certified labs to verify that the applications are in line with the guidelines.
Similar approaches are done be Google (Android auto) and Apple (Car play).

INTRODUCTION

Research on telematics applications started in the eighties. The experts realized already at that time the need for appropriate means to reduce driver distraction. Since then the awareness of the scientific community, the public and the policy maker has ever increased. Two facts are the main driving forces for recent developments. One is the

increased connectivity with smartphones whose computing power compares desktop PC. Drivers increasingly use these devices for some reasons: Some applications are relevant for driving like navigation or warning of speed cameras, some allow some work during commuting time and some allow the driver stay connected with friends and relatives also during the ride. Of course not all of these activities are compatible with driving. This raised great concern in the public and at authorities.

Another driving force are new research activities. In the past a number of measured variables has been used which are assumed to be an indicator of driving safety, like maintaining speed, keeping lane position, biometrical data etc. But the proof was still missing that these parameters describe driving safety, it was just a consensus in the scientific community. This changed with the naturalistic driving studies. This method allows observing the relation between driver behavior and crash risk in real traffic.

GUIDELINES

Based on the research done, 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) published in 2000 and revised in 2006. In Japan, the Japanese Automotive Manufacturers Association (JAMA) [4] 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. In 2013 the National Highway Traffic Safety Agency (NHTSA) in the US published a guideline. Since JAMA and AAM have not been updated in the last two years, the following focuses on ESoP and NHTSA Guideline.

NHTSA Guideline

In 2010 the NHTSA (National Highway Traffic Safety Administration) presented a project to fight driver distraction [5]. One objective was to develop guidelines for visual manual interactions. A draft for public discussion [6] was published in 2012. This draft based to great extent on the AAM Guideline, but introduced very detailed seven methods to assess driver workload [3].

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

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 amount of distraction and hence the probability of an accident.

Beside that there were a number of minor inconsistencies.

In 2013 the final version of the guideline was published. Some inconsistencies have been removed (e.g. 30 letter requirement which came from Japanese writing). The requirements for the test equipment give more

freedom now. However the basic restrictive approach persisted. The possible tests were limited to eye glance measurement and occlusion with slightly modified criteria.

By measuring eye glance time in a driving simulator each of the following criteria has to be met by at least 21 of 24 participants

1) Glance time (85. percentil): < 2sec
2) Mean glance: < 2.0 sec
3) Total glance time:< 12.0

For occlusion testing: 12 sec TSOT (Total shutter open time) for at least participants 21 of 24 has to be reached.

The consequences are demonstrated with the following example: Phoning will be impossible, because dialing will not pass the above criteria. For Total Off-Road Glance Time Mehler et al. reported mean values for selecting a contact from a directory between 12.12 and 16.86 seconds [F]. So this will never meet the above limit of 12 seconds for the 85 percentile.

This means that the above mentioned concerns still exist. If too many functions have to be blocked the driver may be inclined to use handheld devices that have no restrictions of complex functions and no displays and controls appropriate for automotive use. Up to now no automotive OEM is committed to the guideline.

European Statement of Principles

The last version of the ESoP was published in 2008. Due to the changes in HMI technologies and the rapid development of connectivity there was the need to review the guideline. In the framework of the iMobility Forum an HMI group was installed with the objective to check whether any changes, updates or additions are needed. This group started its work in August 2013 and the final report is expected for 2015. Some recommendations can be concluded from the current draft. Most parts of the ESoP have been confirmed after careful review. Proposed changes are:

- Revising the scope
- Taking into account the consequences of automated driving
- The grey area regarding time critical and not time critical warnings should be covered by examples

A special focus of the discussions was the question whether a pass/fail criterion for overall workload should be introduced. This was especially careful examined in the light of the recent NHTSA developments and the JAMA guideline. The conclusion of the group was, to keep the ESoP as a design guideline with reference to ISO standards.

The ESoP should be reviewed at least every three years and approaches in other countries should be monitored. Also there should be an ongoing process of dissemination and publicity since the ESoP addresses multiple stakeholders (e.g. service provider, radio stations) but only the OEM are aware of the ESoP.

Parallel to the HMI group another working group , Safe APP started a document that focusses on the adaption of the ESoP to application programs. It references the generic principles and the application design principles of the ESoP as far as they are relevant for application development. The paper also will deal with standards that work as an interface between different applications and applications and service provider.

OICA White Paper

End of 2013 OICA (Organisation Internationale des Constructeurs d'Automobiles) started a white paper with the title "Recommended OICA Worldwide Distraction Guideline Policy Position". The basic statements of this paper are:

- Vehicle manufacturers have long recognized the importance of supporting the driver's ability to maintain proper awareness of the driving situation.
- OICA members have worked to develop and adhere to regionally appropriate distraction guidelines for integrated systems.
- Since the introduction of these guidelines no significant increase of accidents caused by distraction from integtrated devices has been observed.
- The overly restrictive NHTSA guidelines for integrated vehicle systems are expected to push drivers toward the use of nomadic devices and thus reduce driving safety.
- OICA recommends not to develop additional guidelines, but that countries wishing to adopt distraction guidelines should follow one of the existing guidelines, namely, Japanese (JAMA)/ United States (Alliance)/European (ESoP) guidelines, in order to avoid unnecessary divergence among individual countries. The ESoP is a cultural independent approach.
- OICA supports efforts to develop and implement standards for automatic pairing of portable devices to vehicle integrated systems. This makes the use of in car input devices and displays possible and also allows to disable certain functions while driving.

NOMADIC DEVICES

Nomadic devices are personal electronic devices that can be brought into the car and have defined functionality including a user interface to control those functions. This definition includes smartphones, personal navigation devices (PND) or MP3 player. As pointed out in the introduction smart phones are the biggest concern because they are often used while driving in spite of the inappropriate user interface. Therefore this chapter focuses on smartphones. One possible way to reduce the distraction potential of smartphones is to connect them to the car: This has two advantages:

- The smartphone can use the large display and the automotive controls
- Certain functions can be disabled while driving

There are several realization of this concept by different organizations and companies.

OEM Integration

Nearly every car manufacturer has its own solution for integrating apps into the car e.g. Audi connect, BMW connected drive, Ford sync, Mercedes drive style, Volkswagen car net, Volvo Sensus Connected Touch. Besides the mirror technology (running the app on the smart phone while using input and output devices of the car) also other approaches are used. Some alternatives are: the car has its own communication device and does not need a phone. The software then can run on the head unit a server. In other cases the touchscreen of the smartphone is used and the HMI is adopted in a way that it fulfills the relevant guidelines even with a smaller display. From the view of an app developer this is a highly fragmented market place so most applications are developed by the car manufacturers themselves.

Apple CarPlay

Apple has defined a connection between the iPhone and the head unit of the cars with the brand name CarPlay. It uses different types of input devices like touchscreens, buttons or rotary knobs. A voice control (Siri) is implemented and can be activated by a button on the steering wheel. Of course all these features only work if the car makes these controls available to the iPhone. The applications within CarPlay are optimized for automotive use to reduce driver distraction.

Android Auto

Google has developed a similar interface for the connection of android phones to the car. They worked together with car manufacturers but also established their own HMI labs. Their guidelines regarding driver distraction followed the same general principles like ESoP, AAM and NHTSA guideline. Their interface to the app developer is template based. That means that templates are defined (e.g. selection from a list) that the app developer has to use. These templates can be tested regarding certain properties that have an influence on driver workload, especially font size and contrast. Together with rules about menue depth and list length the main factors regarding driver distraction are under control.

MirrorLink

The Car Connectivity Consortium (CCC) is a cross-industry collaboration to develop MirrorLink, an OS agnostic solution for smartphone and in-vehicle connectivity. The organization's more than 100 members represent more than 80 percent of the world's auto market, more than 70 percent of the global smartphone market and quite a number of aftermarket consumer electronics vendors.
The philosophy of MirrorLink was just to apply the existing guidelines (ESoP, JAMA and AAM) in the respective regions. But nevertheless it was necessary to compile new documents for the app developer for some reasons: The existing guidelines are written for experts of automotive HMI. For app developer with less experience of this topic some additional explanations are necessary. On the other hand the guidelines contain some parts (e.g. position of a display) that are important for automotive ergonomics but irrelevant for an app developer.
In addition to the guidelines CCC establishes two certification processes that cover both technical issues and driver distraction compliance. This means to authorize test labs and to select Subject Matter Experts. It is a challenging task to establish this process with many different stakeholders.

NATURALISTIC DRIVING STUDIES

During the last years there was significant progress in measurement technics. Storage media became smaller and cheaper. The same holds for cameras and sensors. Many physical data of the car are available via CAN (Car Area Network). This made a new type of experiment possible: Naturalistic Driving Studies (NDS). The basic idea is that the test persons drive a long time in their own cars which are equipped with cameras and sensors. The sensors typically include speed, acceleration yaw rate and distance to preceding cars. The cameras observe the traffic in all directions but also the face of the driver to determine glance behavior and the center stack to monitor the engagement in secondary tasks. While it has become easier to acquire all these data the processing is still a challenge especially since much of the work has to be done manually. If the objective is to analyze crash risk the statistic is still not very good since crashes and near crashes do not occur very often. So the results have to be taken with some caution. On the other hand the new method offers the opportunity to determine the relation between driver behavior including glance behavior and crash risk. All previous methods like determing driving quality or glance behavior just assumed based on the consensus of the scientific community that these are good indicators for crash risk.
Figure 1 shows the result for different secondary tasks. While previous measurements in simulators showed an Odd Ratio of around 4 for talking/listening on a phone we see here an Odd Ratio at or below 1. This means that the crash risk is lower than just driving. There are some hypothesis to explain that: 1) The influence of cognitive load on crash risk is overestimated 2) Glance behavior plays an important role and a person engaged in a phone call is less inclined to look around but always looks to the forward road. 3) The driver engages in a phone call only when the driving situation is less demanding. This means that the baseline risk is too high.

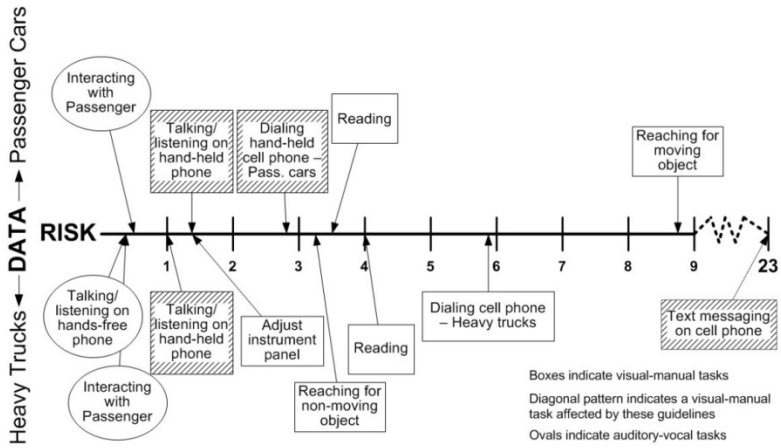

Figure 1 gives a graphical representation of some of the secondary task risk odds ratios determined by the 100-Car Naturalistic Driving Study and the Two Study FMCSA Analyses. [6]

Recently a evaluation of SHRP2 data was published [10]. This is a much bigger database than the 100 car study. It includes 3000 drivers and nearly 4000 vehicle years. Some results are shown in fig 2.

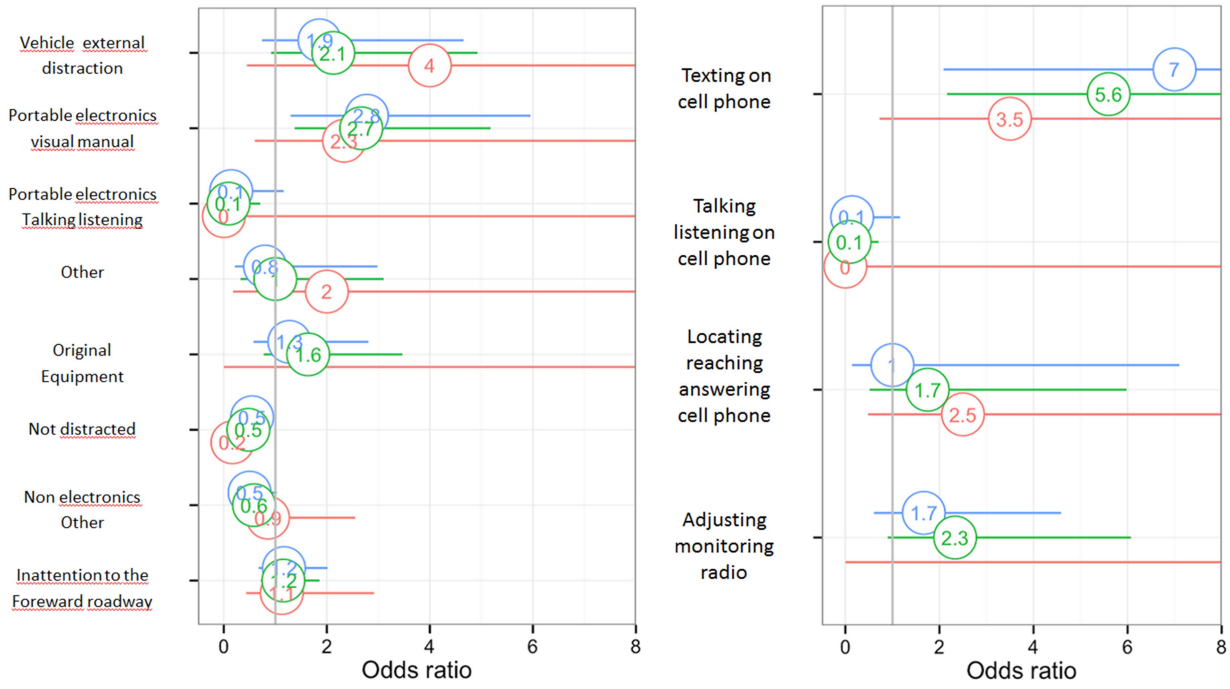

Figure 2. Odds Ratios (numbers inside circles) and confidence intervals (as horizontal lines) for classes of distracting activities in crashes (C) (red), near crashes (NC)(blue) and crashes and near crashes combined (CNC)(green). Presence of a distracting activity was coded between 5 seconds before and one second after the precipitating event.

Since not all data have been included in the evaluation statistic is still poor. Note that an odds ratio is significant only when the confidence intervals are fully above or below 1 (does not cross the vertical line at 1). Nevertheless the data give some indications what results can be expected in future evaluations with better statistics and some conclusions can be drawn for future standardization work.
Not surprisingly texting on cell phone and visual manual operation of portable electronic devices show high odd ratios. But also external distraction has comparably high values. It would be an interesting topic for future research

to have a more detailed description of these information and events. Outside information is never driver paced, i.e. the driver has only a short time slot to acquire that information If there is a chance to deliver part of that information inside the car, the driver can look at it when the driving situation is less demanding.
On the other hand it can be seen that talking and listening has only a very low odd ratio, even when it is done with a handheld device. The problems arise with locating, reaching and answering a cell phone.

VOICE INTERFACES

Since a long time there are also approaches develop guidelines for speech interfaces. Some give recommendations on dialog level. SAE J2988 [8] as an example claims to be "a technology-neutral approach to voice user interface principles and guidelines applicable in an automotive environment".

But there is also the objective to measure the effective workload of speech interfaces. Additional methods to measure cognitive load are under development. An example is the Driver Response Test, which is just standardized in the ISO committee (ISO DIS 17488).

But there is a specific problem to measure the overall quality and workload of a speech interface. This is the great influence of the quality of the voice recognition. If an utterance is misrecognized by the speech engine this will irritate the user and result in additional steps in the dialog. Whatever method is used to measure driver workload the results will become worse. On the other hand recognition quality cannot be considered a constant for a specific recognition engine. Some influences are quite obvious like ambient noise or reflection in the surrounding. Some are more difficult to determine. Details of the training material are generally unknown and so is the influence of the dialect coloration of the subject group. Also speech engines may have some adaption algorithms. The influence of those should be known to the experimenter. All effects of the speech recognition should be carefully monitored. The author is not aware of measurements in the automotive field that took care of this issue.

Another observation is the fact that speech control shows a much better glance behavior than manual operation [9]. From that can be concluded that guidelines with performance parameters are not appropriate for the time being. More research both regarding Naturalistic Driving Studies and detailed analysis of speech control is needed.

CONCLUSIONS

From the developments and research of the last two years the following conclusions can be drawn:

- The existing guidelines have proved to be efficient. For the time being the need for only slight corrections has been identified.
- Further improvement can only base on additional scientific findings. The Naturalistic Driving Studies seem to be a promising approach.
- Guidelines with too much restrictions will be contraproductive. The more the functionality of a well integrated OEM device is restricted the more the driver will be inclined to use a nomadic device. Thus reducing the functionality (i.e. making guidelines more stringent) will reduce the overall safety and should be avoided.
- Speech recognition seems to reduces the crash risk significantly. More and better speech systems should be offered to the driver
- To reduce the use of handheld devices the facility co pair the HMI of these devices to the car should be offered to a greater extend

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REFERENCES

[1] Alliance of Automotive Manufacturers, "Statement of Principles, Criteria and Verification Procedures on Driver Interactions with Advanced In-Vehicle Information and Communication Systems" accessed February 9, 2012 http://www.autoalliance.org/files/DriverFocus.pdf

[2] European Commission "European Statement of Principles on the Design of Human Machine Interaction", 2006, accessed February 9, 2012. http://eur-lex.europa.eu/ Lex UriServ/ site/en/oj/ 2007/l_032/l_03220070206 en02000241.pdf

[3] Heinrich, C. "Fighting driver distraction: worldwide approaches", Proceedings of the 23rd International Technical Conference on the Enhanced Safety of Vehicles (ESV)

[4] Japanese Automotive Manufacturers Association , 2004 "JAMA Guideline" http://www.umich.edu/~driving/documents/ JAMA_guidelines_v30.pdf

[5] National Highway Traffic Safety Administration, "Driver Distraction Program", DOT HS 811 229, April 2012

[6] National Highway Traffic Safety Administration, "Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices" Docket No. NHTSA-2010-0053, Draft

[7] National Highway Traffic Safety Administration, "Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices" Docket No. NHTSA-2010-0053, Guideline

[8] SAE J2988 Society of Automotive Engineers, to be published

[9] Mehler, B, D. Kidd, B. Reimer, I. Reagan, J. Dobres and A. McCartt „Multi-Modal Assessment of On-Road Demand of Voice and Manual Phone Calling and Voice Navigation Entry across Two Embedded Vehicle Systems" Embedded Vehicle Voice Systems (2014-12-20 submission)

[10] Trent Victor, J. Bärgman, C.-N. Boda, M. Dozza J. Engström, C. Flannagan, J. D. Lee, G. Markkula. "Analysis of Naturalistic Driving Study Data: Safer Glances, Driver Inattention, and Crash Risk"