Automotive HMI – Current Status and future Challenges.

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BMW Group
Automotive HMI – Status & future Challenges.

Overview.

I. Situation Analysis

II. Challenges

III. Approach

IV. Conclusions
I. Situation Analysis – Automotive HMI.

History.

⇒ steadily increasing number of displays and controls led to the introduction of the first bordcomputer in 1994 with built-in navigation.
I. Situation Analysis – Automotive HMI. Concepts today.

**Classic Concept:** 1 Unit comprising Display and Controls

![Mercedes-Benz](image1) ![Porsche](image2)

**Japanese Concept:** Touchscreen

![Lexus GS 300](image3) ![Cadillac STS](image4) ![VW Tiguan](image5)

**iDrive Concept:** Control(s) separated from Display

![BMW 5-series](image6) ![AUDI A6](image7) ![MB S-Class](image8) ![Honda Acura RL](image9)
Even by today far more mobile navigation systems than fixed installed systems are used while driving.
I. Situation Analysis - Market

Functionality becomes more and more independent of system type

By 2012, telematics UPDATE expects 90 Mio. GPS-phones to be shipped to Europe alone.

HMI significantly differs according to system type – but the driver´s capabilities are always the same
I. Situation Analysis – HMI-Guidelines

HMI-Guidelines evolving from each other

Europe

1999
- European Statement of Principles on HMI
  25.01.2000

2000
- ESoP Expansion
  July 2001

2001
- ACEA self-commitment on ESoP - 2001

2002
- EC Member States’ reports on ESoP

2003
- eSafety WG on HMI

2004
- Final Report on HMI
  by eSafety WG on HMI

2005
- Revised ESoP
  22.12.2006

2006

U.S.A.

2000
- Draft Guideline v 1.0
  12/2000

2001
- EC Member States’ reports on ESoP

2002
- Draft Guideline v 2.0
  Commitment by AAM
  22.04.2002

2003
- AAM-Guideline v 2.1
  Commitment by AAM
  19.11.2003

Japan

1999
- JAMA Guideline on visual display devices

2000
- JAMA Guideline on visual display devices

2001
- Revised ESoP
  22.12.2006

2002
- AAM-Guideline v 3.0
  for In-vehicle Display Systems – 18.8.2004

2003
- AAM-Guideline v 3.0

2004
- AAM-Guideline v 3.0

2005
- AAM-Guideline v 3.0

2006
- JAMA Guideline v 3.0

I. Situation Analysis – HMI-Guidelines

HMI-Guidelines evolving from each other
I. Situation Analysis – HMI-Guidelines

3D-HMI-Matrix, applied by eSafety-WG HMI

For each box:
- Situation Analysis
- Responsibility
- Solutions
Existing ESoP covers all system types, but ...

- is not applied by all stakeholders.
- does not fully cover all issues related with Nomadic Devices.
- needs to be supported by a communication/implementation strategy
I. Situation Analysis – HMI-Guidelines

eSafety Goals on HMI

1. System design according to ESoP

2. System use to enhance Safety
I. Situation Analysis – HMI-Guidelines

ESoP Application by OEMs

functions, Use-cases, requirements

HMI - Design

Installation  Information Presentation  Interaction  System Behaviour

Usability
Effectiveness
Acceptance
Controllability

HMI - Evaluation

HMI-Concept
I. Situation Analysis – HMI Guidelines

iDrive Concept reflects the ESoP

- Installation
  - Highly mounted display
  - Easy to reach control, no need to glance at

- Information Presentation
  - ISO-Character sizes
  - Display minimizing glare and reflections

- Interaction, Logics
  - Driver-paced interaction
  - Driver can interrupt interaction at any time

- System-behaviour
  - TV, Video are switched off automatically
  - No uncontrollable sounds

Driving Functions

Comfort Functions

Displays

Controls
In 54% of all 200,000 six-second baseline epochs drivers were engaged in tasks other than driving, in 73% drivers did not solely concentrate on driving. 

⇒ People make use of the steadily increasing amount of time they spend in their vehicles.

2. “Reaching for a moving object” had the highest impact on the likelihood of crash or near crash followed by “external distraction”, “reading”, “applying makeup”, and “dialing a hand-held device”. 

⇒ Driver distraction must be regarded, therefore, as a societal problem. 

⇒ Driver pragmatically chooses any possible way to fulfill his demand.
I. Situation Analysis – Driver Behaviour.

Integrating functionality means to offer a more suitable way of interaction.

Driver’s way of integrating functionality is pragmatic but often safety critical:
- Fixation to windscreen restricts forward field of view
- Holster may cause injuries
- Regulations on forward field of view, EMC and passive safety usually not fullfilled

⇒ Offering integrated functionality does not mean to offer more functionality, but to offer a more appropriate solution
⇒ Most drivers only use a small fraction of their systems functionality, which largely differs interindividually.
II. Challenge 1.
How to ensure that all system types are designed according to the ESoP?

- All system types need to be designed to the same standards – the driver`s capabilities are always the same.
- System Installation should comply with regulations on driver`s field of vision, passive safety and EMC ⇒ Certificate
- Without certificate, using the system while driving is not allowed.

<table>
<thead>
<tr>
<th>HMI – ASPECT</th>
<th>Problems (examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Behavior</td>
<td>• TV, Videos, Games accessible while driving.</td>
</tr>
<tr>
<td>Interaction</td>
<td>• Interaction not driver-paced, i.e. system state changes after timeout.</td>
</tr>
<tr>
<td></td>
<td>• Interaction not sufficiently interruptible, e.g. character input with pen.</td>
</tr>
<tr>
<td>Information</td>
<td>• Very small font size, not in accordance with ISO15008</td>
</tr>
<tr>
<td>Presentation</td>
<td>• Display with low contrast, glossy display causing glare &amp; reflection.</td>
</tr>
<tr>
<td>System Installation</td>
<td>• Fixation to windscreen obstructs forward field of view.</td>
</tr>
<tr>
<td></td>
<td>• In case of crash, injuries by „flying“ device and sharp edges.</td>
</tr>
</tbody>
</table>

Nomadic Device, e.g. PDA
II. Challenge 2
How to promote competent driving while offering information, communication and entertainment functionality.

1. 100-car-study shows, that drivers do not resign from information, communication, entertainment.
   ⇒ Provide functionality in the most appropriate way while driving. ESoP helps to design a good HMI.

2. Similar Information is provided by different systems in varying quality, e.g. traffic information by AM/FM, satellite radio, internet, I2C ...
   ⇒ Provide validated, up-to-date, exact and reliable information instead of leaving this task with the driver.

3. Most accidents involve driver mistakes on the manoeuvring level, e.g. wrong estimation of following distance, relative speed, curve radius etc.
   ⇒ Strengthen anticipation of route and traffic situation, thus enabling the driver to distribute his attention adequately.
III. Approach

Classification of tasks and functionality

**Secondary Task**

- **Entertainment**
  - Music, video
- **Communication**
  - Private, business, traffic
- **Information**
  - News, Traffic, Travel

**Information- & Communication Systems (IVIS)**

- **Life**
  - AM/FM, Satellite Radio, DAB …
  - **Replay**
    - CD, MP3, DVD
- **Telephone**
  - Messaging, e-mail
- **Services**
  - z.B. auf Basis von Radio, Internet, C2C, C2I

**Driving Task**

- **Navigating**
  - Choice of route
- **Manoeuvering**
  - Choice of course and speed
- **Stabilizing**
  - Operating steering wheel and pedals

**Assistance System**

- **Navigation System**
- **Advanced Driver Assistance System**
  - e.g. ACC, Lane Keeping Assistance
- **Chassis Control Systems**
  - e.g. ABS, DSC/ESC

**Senses**

1. **Feel**
   - Acceleration sensors
   - Equilibrium organ
2. **See**
   - Radar, Lidar, Camera….
   - hear & speak
3. **Communicate**
   - GPS, C2X, DSRC….
III. Approach: competent interaction means to decide timely and correctly.

⇒ Driver Assistance Functionality in order to increase Anticipation capabilities
III. Approach
deciding timely and correctly requires anticipation of workload.

- Initiating secondary task operation also requires the driver to anticipate its associated demand and matching it with the demand expected from the driving task.
- Information Management can ease Workload Management by driver.
III. Approach.

Workload imposed by secondary task must be compatible to that of the driving task.

Secondary Task

- dial handheld phone
- drink coffee
- increase temperature (HVAC)

Driving Task

- 3-lane straight, < 60 km/h, no traffic
- 2-lane curved, 100 km/h, moderate traffic
- Winding mountain road, high accelerations, moderate traffic
IV. Conclusions

Automotive HMI: Current status and future challenges

- Major achievements ten last years
  - ESoP 1999 = HMI design guideline formulated by scientists and industry. ESoP 2006 supported by AIDE is almost ready to use.
  - ESoP is applied by OEMs and has easily noticeable effect on system design.
  - Market driven Introduction of Driver Assistance Systems has significantly improved traffic safety.

- Major problems, now and in coming ten years
  - ESoP is not applied by large parts of the industry.
  - Number of systems used while driving, but not designed for this use-case has rapidly increase and will continue to increase - 100 Mio by 2011.
  - Navigation functionality on mobile phones will further compromise traffic safety.
IV. Conclusions

Automotive HMI: Current status and future challenges

- **Most promising solutions**
  - ESoP needs to be applied to all system types, leading to secure installation, good information presentation, driver paced interaction and lock-out of TV, DVD, Gaming & free Internet while driving.
  - System design which respects the driver as ultimate workload manager and assists him in anticipating the future workload imposed by the driving task, but also by secondary tasks.

- **Research needs**
  - Analysis of workload managing strategies by the driver.
  - Analysis and Validation of HMI-design parameters improving workload management by the driver.
  - Analysis of driver behaviour when interacting with whole continuum of systems formulating minimum requirements for integration (installation … system behaviour)