



© Valeo

Cockpit Concept for Conditional Automated Driving

In the course of the increasing automation of the automobile, one question is receiving more and more attention: which non-driving-related activities drivers might choose to engage in while their vehicles drive themselves. Valeo is working on what an appropriate Human Machine Interface (HMI) should look like.

END-USERS' NEEDS AND EXPECTATIONS

For the development of a new HMI concept for conditional automated driving (SAE Level 3) [1], Valeo focused on end-users' needs and expectations. At this level of automation especially, interactions and communication between the driver and vehicle are extremely important. Drivers are able to hand the driving task over to the car and so address themselves to other activities, but they must

also be able to resume driving as quickly as possible at all times.

In an international study conducted in 2012 in the US, China, Germany and France on the subject of Intuitive Driving Valeo elicited participants' expectations of an automated vehicle. The participants firmly endorsed automation for traffic jams [2]. In the light of this, and given increasing possibilities for delegating control to the vehicle in other circumstances, new expectations concerning communication and entertainment

AUTHORS



Dipl.-Ing. Patrice Reilhac, M. Sc.
is Innovation & Collaborative Research Director for the Comfort & Driving Assistance Business Group at Valeo in Bietigheim-Bissingen (Germany).



Dipl.-Ing. Julien Moizard
is Innovation Manager for the Comfort & Driving Assistance Business Group at Valeo in Bobigny (France).



Dipl.-Ing. (FH) Frank Kaiser
is Innovation Manager for the Top Column Modules Product Line at Valeo in Bietigheim-Bissingen (Germany).



Dipl.-Betw. (FH) Katharina Hottelart, MBA
is Product Marketing Analyst for the Comfort & Driving Assistance Business Group at Valeo in Bietigheim-Bissingen (Germany).

are emerging. At the time of that study already, participants put Smartphone use at the top of their wish-list for activities they could perform during automated driving, especially for emailing and messaging. Most of the respondents confessed that they already used their Smartphones when they drove, even without automated driving.

For the respondents the ideal place to read messages would be directly in front of them, in line with the road, on a head-up display for instance. But the

information the driver needs during automated driving is not limited to communication or entertainment: displays and indicators are needed to build trust in the system. Valeo found this out in more than 60 in-depth interviews conducted in Germany, China and France in 2014. The driver wants a system of transparency of information about what the car is detecting, what it is going to do next and why. Predictive information is very important for trust building. People are not readily willing to hand responsibility for their safety over to a machine. To build trust the car needs a carefully thought-out HMI concept which can reassure the driver and permit them to concentrate on other tasks.

Many of the participants did however presume that they might need less information after an initial adaptation phase. As positive experiences boost trust, the need for information is progressively reduced. But it can at least be said in general that drivers never want to be out of the driving loop. They always need to keep an eye on all information relevant to driving, like speed, GPS, traffic information, etc.

In addition to these opinions and attitudes, Valeo also gathered data on the driver's physical abilities and limitations which could play an important role for automated vehicles. Driving tests focused on topics like situational awareness and motion sickness in order to evaluate the effects of different HMI concepts. Since the tests focused on the relation to perception and well-being, the test subject was sitting as a passenger in a normal car driven by another driver.

Especially in automation Level 3 the presence of situational awareness plays an important role. Test drives simulating automated driving mode with 30 participants showed that situational awareness could be increased by 30 % during an automation phase by a higher positioning of the display on which the driver was reading an article. This adjustment enhanced the driver's perception of the environment by keeping his gaze closer to the road. Simultaneously, it has been found that the risk of motion sickness decreased by 50 %.

After a thorough analysis of the various data in the study, two particular challenges emerged:

ENHANCE SAFETY

In all markets Valeo found very safety-conscious end-users. Safety in the context of intuitive human machine interface means, firstly, that it is clear and easy to use and that the right information will be provided at the right time. This enables a request for take over from automated to manual driving to be executed in a correct and timely manner.

Secondly, the HMI must be used to promote trust and at the same time comfort or well-being in an automated car. The feeling of being out of control is both uncomfortable and not reassuring because it implies a lack of safety.

MORE VALUE FOR THE END-USER

An automated vehicle will only represent real added value for end-users when they can make good use of the time freed up during automation. Therefore a HMI concept is needed, that supports non-driving related tasks in a safe and comfortable way. This is another factor which will facilitate the acceptance of automation.

In automated mode any negative feelings experienced whilst performing non-driving activities will erase any added value. So for example since reading is one of the preferred activities, motion sickness is an important issue to deal with.

THE SOLUTION APPROACH VALEO MOBIUS

Valeo Mobius, **FIGURE 1**, is a response to these challenges [3]. The cockpit concept is composed of a 12.3 inch instrument cluster placed above the steering wheel as close as possible to the direct line of sight, enabling peripheral perception of traffic and frequent switching of glances between road and display. In automated mode the driver is able to connect mobile devices like a Smartphone or tablet via wired connection (e.g. HDMI) or even wireless. The complete content of the smart device will be mirrored in the instrument cluster display and can be controlled from the steering wheel. What the user usually sees directly on the phone is now in front of him, even if the smart device is located somewhere else in the car. This control is executed via a



FIGURE 1 Key products of the Valeo Mobius concept and QR code leading to the movie (© Valeo)

wireless connection as well, in this case it is Bluetooth Smart and two innovative touch screen based steering wheel switches, **FIGURE 2**, one on each side of the steering wheel, which replace conventional steering wheel switches.

The core component of this input device is its integrated touch screen. It enables a complete, open, configurable HMI providing a high degree of contextualisation. For example function could be dependent on the driver or on the situation. Furthermore, software updates and upgrades of the user experience can be carried out easily. The switch offers

several input possibilities like simple pressing, touching, gestures and so on.

In order to avoid the activation of safety critical features, like for example the activation of the automated driving mode, dedicated safety measures can be taken, e.g. a long press on the switch surface which then activates a micro switch.

The full content of a mobile device will be displayed in the digital instrument cluster in order to allow peripheral perception of traffic and simple and quick glance switching between road and display without eye accommodation. Even if the driver is actively distracted by a

non-driving related task it allows him to quickly resume the driving task since their hands are already on the wheel and their eyes facing the road. This setup therefore combines a modern and intuitive user experience with a high depth of application and a low level of distraction.

In addition the driver can always keep an eye on the most relevant driving-related information, even in automated mode. A dedicated space on the instrument cluster provides the driver with real time information on the speed, surroundings, GPS information and so on. By pursuing the objective of keeping the driver in the driving loop and building trust into the system, situational awareness is increased and motion sickness reduced.

Valeo Mobius does not only innovate in the manner of control. It also contains a driver monitoring system which is crucial to the critical transition from automated back to manual driving. A camera monitors the driver to make sure they are looking at the road and dedicated sensors in the steering wheel detect if their hands are on the wheel. The driver will not be able to resume control until both eyes are on the road and hands on the wheel.

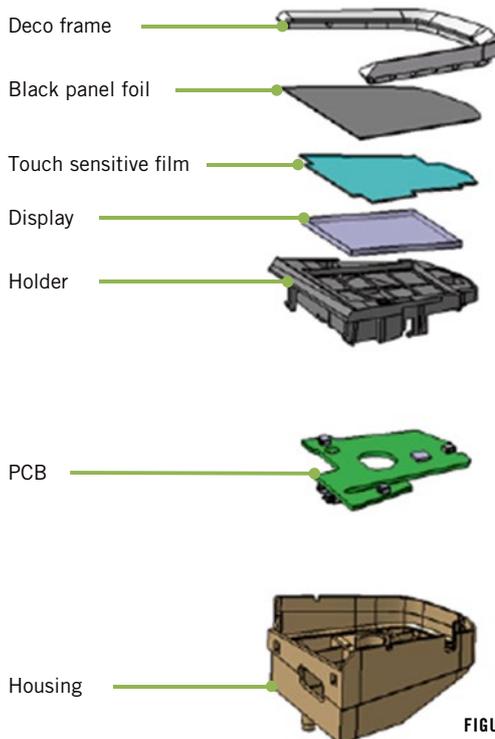


FIGURE 2 Exploded view of the display based steering wheel switch (© Valeo)

END-USER STUDIES WITH VALEO MOBIUS

The early involvement of the customer in the innovation process and evaluation is important to Valeo. Thus, Valeo Mobius was and is constantly tested and further developed by doing end-user studies. In early 2015 Valeo launched the first tests with a prototype to evaluate usability and acceptance. The study included small focus group interviews, moderated usability testing and in situ inter-

Distraction	SAE Level 2 Baseline	SAE Level 3 using Valeo Mobius	SAE Level 3 using Smartphone
Manual	–	–	✓
Visual	–	o	✓
Cognitive	–	✓	✓
Head position			
Hand position			

– Not distracted o Partly distracted ✓ Distracted

FIGURE 3 How the three test conditions differ in the level of distraction from driving task (© Valeo)

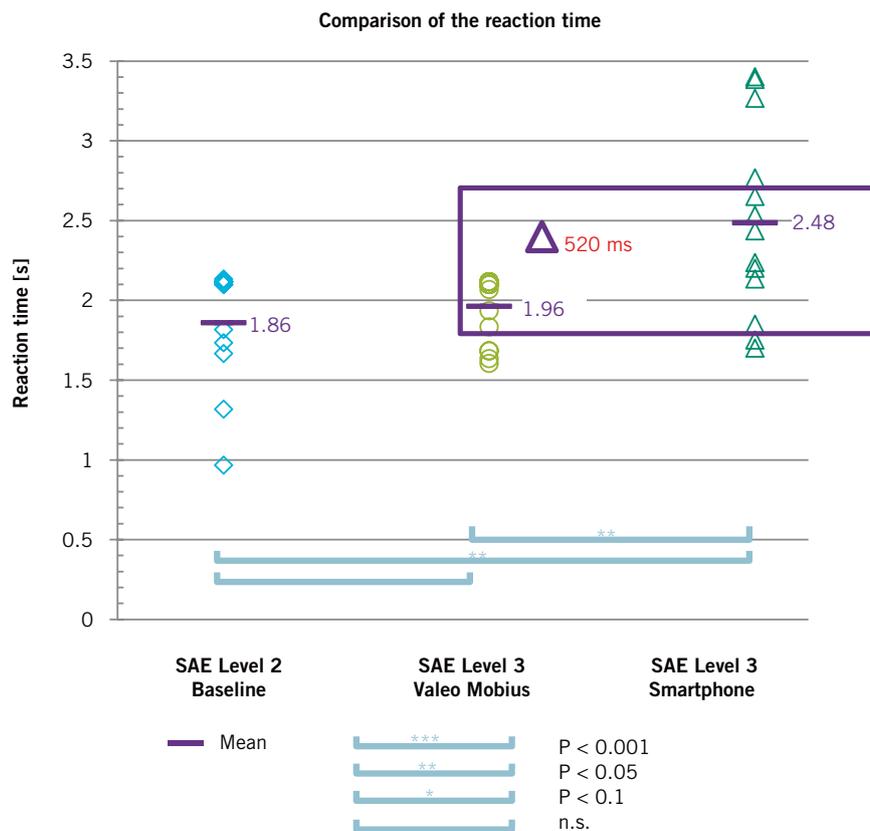


FIGURE 4 Reaction times braking after surprise take over request (© Valeo)

views where subjects were interviewed during testing.

End-users perceived the overall concept as very appealing and attractive. The control through the touch screen steering wheel switches was rated intuitive

and innovative. The connection and control of the full mobile device content during automated driving was a real highlight. During the simulated transition phases drivers felt well guided and supported by the system. Of great impor-

tance was the combination of audible and visual warning and information elements. Many also perceived additional information or instructions delivered by voice as very positive.

What was striking in this study was that the majority of the study participants were not aware of the added value in safety this concept could offer. People mainly saw the added value in the use of communication and entertainment media in automated mode. Some participants questioned why they could not use profit from automated mode to take their smartphones in hand rather than operating via the Valeo Mobius controls. Only when Valeo installed the concept in a driving simulator for another study did the participants realize the potential danger of handheld usage and therefore expressed how Valeo Mobius enhanced their feelings of safety [4].

This second study was conducted in April 2015 in cooperation with the Fraunhofer Institute IAO in Stuttgart. In a driving simulator experiment with 42 test subjects two options were tested against a baseline condition, FIGURE 3. An automated driving phase was simulated in which the test subjects either looked at the street or read an article on a large smartphone or on the Valeo Mobius instrument cluster. Text scrolling was either performed via the Valeo Mobius press-touch-displays on the steering wheel or by swiping the screen of the phone. The automated drive was interrupted by an unexpected take-over request with a short time reserve. The Smartphone condition shows significantly slower reaction times compared to Mobius: 520 ms, FIGURE 4. This represents 8.4 m extra stopping distance at a speed of 60 km/h, FIGURE 5. Interestingly no significant difference between the Valeo Mobius condition and the baseline condition was identified [5].

After the simulator test drives the participants had to decide which of the two solutions they would use for reading an article during automated driving: Valeo Mobius or the smartphone. 93 % voted for the solution with Valeo Mobius. According to the test subjects the main advantage of the system is a greater feeling of safety and less stress during a sudden take-over.

This result was confirmed by additional interviews at the end of the simulator test in which the subjects were asked about the feelings they experienced during the

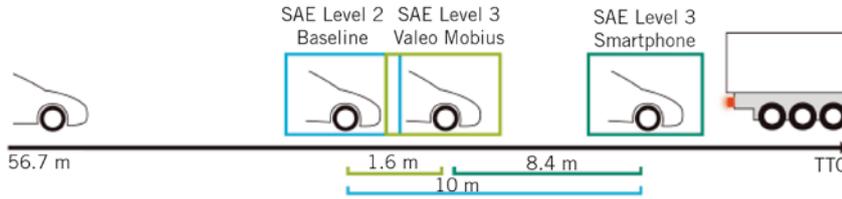


FIGURE 5 Differences in stopping distance between the conditions in the surprising take over situation (© Valeo)

surprise take-over situation. The Valeo Mobius advocates expressed how in control and unstressed they felt during the test. This feedback suggests the positive impact Valeo Mobius could have in boosting trust in automated driving.

NEXT STEPS

Valeo is currently updating the prototype in line with the needs and expectations end-users expressed. This means, for example, to work on a way to simplify text entry on the steering wheel.

The next big step in Valeo’s end-user centered approach to innovation will be the integration of the Valeo Mobius concept in an automated car. This will allow Valeo to evaluate how the concept handles real driving situations.

REFERENCES

- [1] SAE: Automated Driving. Online: http://www.sae.org/misc/pdfs/automated_driving.pdf; last access: 5 October 2015
- [2] Reilhac, P.; Millet, N.; Hottelart, K.: Thinking Intuitive Driving Automation. Tractatus Technologico-Humanicus. In: Meyer, G.; Beiker, S. (ed.): Road Vehicle Automation 2. Lecture Notes in Mobility. Springer International Publishing Switzerland, 2015
- [3] Reilhac, P.: From human factors to user experience for level 3 car automation. The 2-in-1 Mobius cockpit concept. Online: Ertrac Annual Conference, Brussels, www.ertrac.org/uploads/documents_publications/2015%20Conference%20presentations/Valeo.pdf; last access: 5 October 2015
- [4] Diederichs, F.; Bischoff, S.; Widloither, H.; Reilhac, P.; Hottelart, K.; Moizard, J.: New HMI concept for an intuitive automated driving experience and enhanced transitions. Workshop proceedings, 7th Conference on Automotive User Interfaces and Interactive Vehicular Interactions, 2015
- [5] Diederichs, F.; Bischoff, S.; Reilhac, P.: Welchen Einfluss hat das HMI auf automatisiertes Fahren? 11. Berliner Werkstatt Mensch-Maschine-Systeme, Berlin, 2015

Heavy-Duty, On- and Off-Highway Engines

Sustainable concepts put to the test

10th International MTZ Conference

24 and 25 November 2015

Speyer | Germany

NEW DIESEL, GAS AND DUAL-FUEL ENGINES

Working Process and Design Concepts

COMPLETE SYSTEM OPTIMIZATION

Engine and Component Design

EMISSION REDUCTION

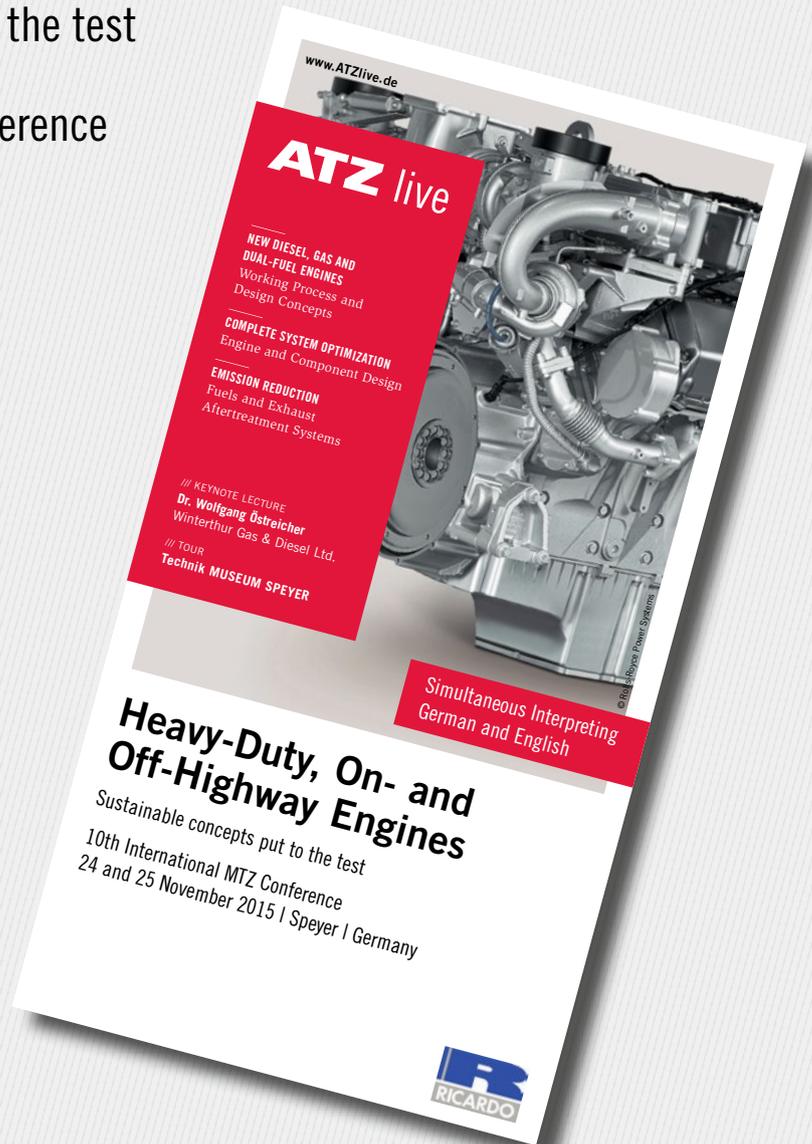
Fuels and Exhaust Aftertreatment Systems

/// KEYNOTE LECTURE

Dr. Wolfgang Östreicher
Winterthur Gas & Diesel Ltd.

/// TOUR

Technik MUSEUM SPEYER



/// KINDLY SUPPORTED BY



ATZ live
Abraham-Lincoln-Straße 46
65189 Wiesbaden | Germany

Phone +49 611 7878-131
Fax +49 611 7878-452
ATZlive@springer.com

PROGRAM AND REGISTRATION
www.ATZlive.com