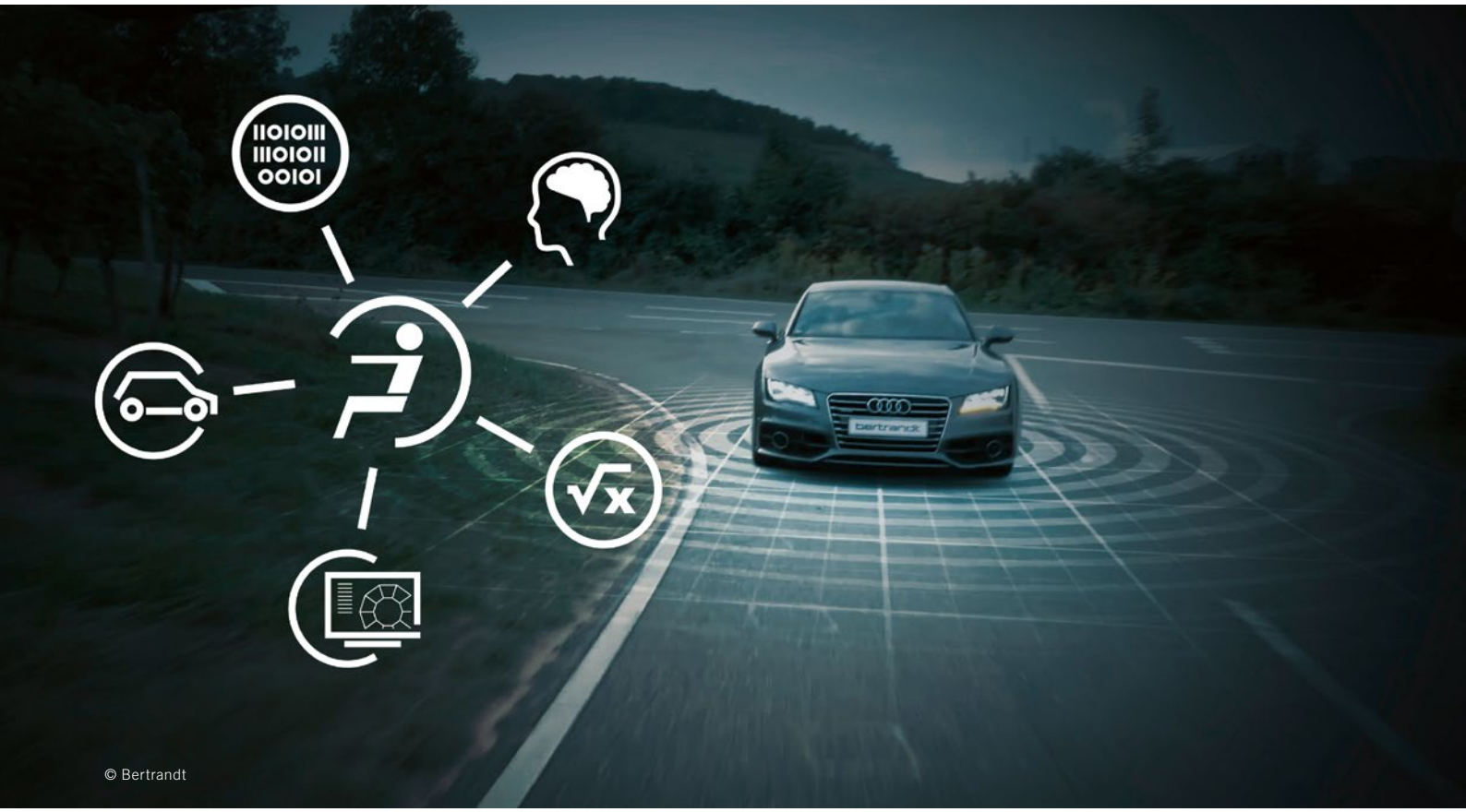

AUTHORS

Dipl.-Ing. Ulrich Haböck is Team Leader and Project Manager for Driver Assistance Systems at Bertrandt in Regensburg (Germany).

Dipl.-Ing. Jochen Schwenninger is Function Developer for Driver Assistance Systems at Bertrandt in Regensburg (Germany).

Dipl.-Ing. Andreas Redepenning is Lead Engineer and Project Leader for Driver Assistance Systems at Bertrandt in Regensburg (Germany).

Claudia Buchner, B. Sc. Psychology was responsible for all the psychological aspects of the project and currently studies Psychology at the University of Ulm (Germany).

An interdisciplinary team at Bertrandt Regensburg is working on new approaches to development in the field of human-centred engineering. The members of the team include specialists in software development, IT, mathematics and psychology, all of whom contribute knowledge from a variety of different fields. In cooperation with educational institutions such as the Regensburg University of Applied Sciences, the team is also working with social scientists. Its objective is to further analyse and develop the technological possibilities of driver assistance systems with focus on the benefits for drivers.

Human-centred Engineering
Future of the Technology Industry

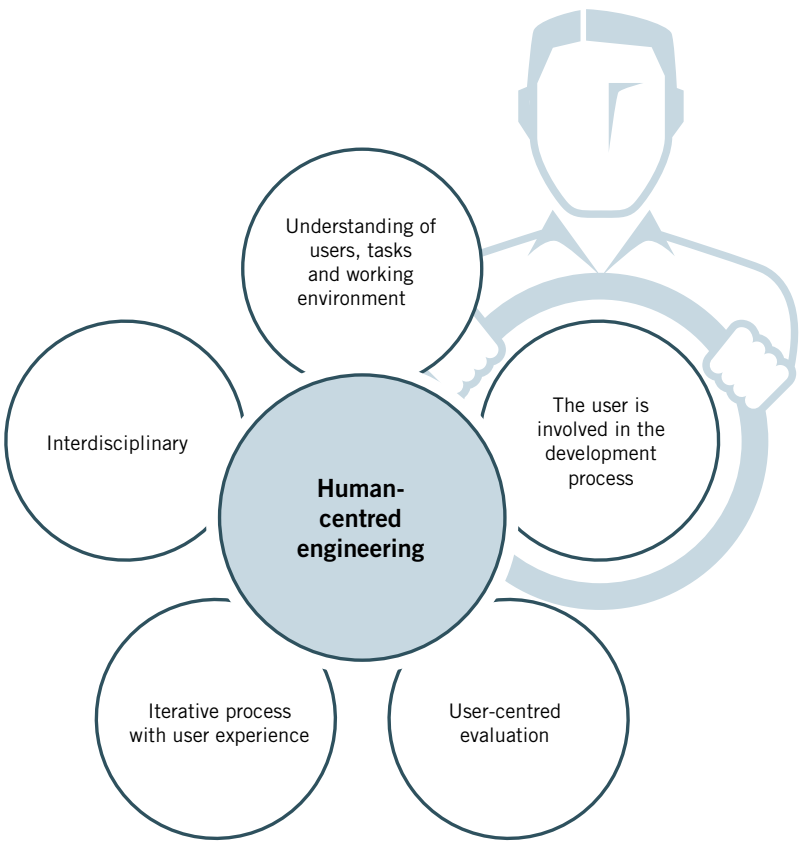

FIGURE 1 The human factor constitutes the centre of human-centred engineering to ensure that users engage with driver assistance systems in the best possible way (© Bertrandt)

INTEGRATIVE DEVELOPMENT APPROACH

Human-centred engineering (HCE) represents the future for the development of driver assistance systems, software and general technical systems relating to the Industry 4.0 megatrend. The terms "usability" and "usability experience" have been in use for some years. As early as 1993, Jakob Nielsen defined them using criteria such as "learnability" and "satisfaction" [1]. However, experience shows that the human-centred approach has not been widely used in the development of automotive systems.

The methods used until now to develop driver assistance systems were driven from an engineer's perspective and were subsequently evaluated by means of customer studies. Often this had the effect that existing systems are user-independent. This means that they are developed and configured in exactly the same way for every driver. As a result of the latest technological advances, the possibilities for developing innovative systems in the context of Industry 4.0 are almost unlimited. This has given rise to the question of how to approach new developments. One possible method is HCE, which will involve society in the process of shaping Industry 4.0, **FIGURE 1**.

The aim of introducing the human factor into the development process is to increase acceptance and create transparency. These are important considerations if we are to establish a market for modern mobility concepts in Germany. Bertrandt Regensburg has applied this method to the implementation of driver assistance systems as part of an internal project. The functionality required has already been described in an ATZ article entitled "System Adaption as key Technology towards Autonomous Driving" [2].

HCE takes an approach that goes beyond traditional technological development methods. The focus will be on exploiting the technological possibilities for the benefit of drivers, as well as taking environmental and cost factors into consideration [3]. This approach is interesting because various studies have already shown that drivers fall into a number of different groups [4]. Further studies are needed in this area in order to investigate the requirements, behaviours and necessary adaptations in more detail.

FIGURE 2 HCE is an ideal solution for using the findings from the process of identifying driving styles to enable assistance systems for longitudinal and lateral control to be adapted intuitively and reliably (© Bertrandt)

FIGURE 3 From the first idea to human-centred engineering: Using survey, observation and analysis of measured data helped to collect important results (© Bertrandt)

THE CONCEPT

The concept specified in ISO 9241-210 forms the basis for the human-centred development process [5]. The fundamental principles of this standard include ensuring an "understanding [of] users, tasks and environments" [6]. The standard also highlights the fact that users must always be involved in the development process and that it must be followed by a "user-centred evaluation" [6]. Other important points include an interactive process that takes into consideration user experience and interdisciplinary cooperation [6]. This new concept has been put into practice in the course of an exploratory pilot study on driver assistance systems involving a team consisting of experts in the disciplines of software development, IT, mathematics, social sciences and psychology [7], **FIGURE 2**.

The study also focused on the problem that assistance systems in vehicles are often used either very little or not at all. Furthermore, the settings for the driver assistance systems in the HMI concept are not intuitive in the same way as for example smartphones. The reasons for this could lie in the complexity of the systems, the excessive number of settings and also in their lack of adaptability [3]. The inability to adapt means that key factors such as the environment as a whole – for example, the weather [8] or the lanes on the road – are not taken into consideration. This could lead to critical situations. Criteria such as control and the user's perception of safety need closer examination [3]. The issues that lie behind the low levels of acceptance in particular have not been adequately explained. The aim is to engage users in the system in the best possible way, for example by being able to predict what it will do, because the system can learn how people drive. This will help to reduce users' doubts about the functionality.

However, it must also be possible to guarantee that the driver can control and override the system, when driver assistance systems and the related innovations are in use, in accordance with the Response Code of Practice (CoP). The CoP helps to identify possible risks, analysing them and then preparing and introducing countermeasures as early in the process as the development phase.

DRIVER STUDY: DRIVER TYPES AND DIFFERENTIATED DRIVER BEHAVIOUR

The study [7] was based on the assumption that there are different types of drivers with different driving styles and behaviour in traffic. This gave rise to the question of the extent to which a system should or could automatically adapt to a driver or a driver type. The objective was to improve acceptance among users and to increase the number of drivers who use these systems, **FIGURE 3**. The cooperative study described above, involving the Institute for Social Research and Technology Assessment at the Regensburg University of Applied Sciences, was carried out for this purpose. The interdisciplinary team succeeded in confirming its assumption that drivers fall can be clustered in different groups [7].

Using quantitative and qualitative methods, the team evaluated the criteria of sportiness, safety and efficiency. This was done by a self-assessment and an external assessment by a number of independent observers. The data was collected using questionnaires, guided interviews and observation logs. One interesting factor was the interaction between the driver's self-perception and what the observers saw during the trip, because this raised further questions about the development of user-centred driver assistance systems [7], **FIGURE 4**.

In the first part of the study, which aimed to highlight the tendencies that led to different driver types, the external assessments of the three observers produced interesting results [7]. It allowed three driver types to be identified: safe and efficient drivers, balanced drivers and sporty drivers each fell into a separate group. This was the result of a cluster analysis where similar values were assigned to one group. The sporty drivers had comparatively higher mean values for the sportiness criterion than for the two other areas. The balanced drivers were characterised by relatively similar mean values in all three areas. In contrast, the safe and efficient drivers produced higher mean values for the safety and efficiency criteria [7].

In a next step the study focused on the difference between self-assessment and external assessment. Regarding self-assessment, the questionnaire and the interview provided background information about the participants' driving ability and behaviour in traffic. This was compared with the external assessment, which was based on a detailed observation log. No significant connection could be identified between the two dimensions. However, there was a tendency for the sportiness criterion to have the most similar assessments, although this was likely to be underestimated. There was a contrasting trend for the efficiency and safety criteria with the test subjects being more likely to overestimate them.

There may be a number of different reasons for the differences between the two types of assessment. These could include, for example, the different levels of detail in the survey methods and the varying definitions of the terms "road safety" and "efficiency". This latter factor could lead to different assessments of the participants and, therefore, to problems in capturing the data. No connection could be identified between the driver types and the demographic data [7].

In the next phase, the measurements recorded during the test drive (for example, the raw data from the accelerator pedal, the longitudinal and lateral acceleration and the speed) will be coordinated with the participants' behaviour in order to be able to assign specific value ranges to the three driver types. Defining the value ranges will make it possible to develop the existing algorithm used for configuring driver assistance systems.

HCE PLAYS KEY ROLE

The results provide additional information about the different behaviour of the various driver types and underline the importance of user-centred software development. The first moves have now been made, but a follow-up study with more test drivers and a much larger sample size is needed in order to produce reliable results.

The driver types will be verified using the signal sequences and this could lay the foundations for the further development of driver-adapted assistance systems. The aim of introducing these improvements is to achieve the highest possible level of acceptance and, therefore, to increase the usage of these systems. The ultimate objective is not only to improve road safety, but also to provide maximum driving comfort for drivers. Human-centred engineering is the keyword when it comes to bridging the gap between the development of driver assistance systems and the people who use them.

REFERENCES

[1] Nielsen, J.: Usability Engineering. AP Professional. Cambridge (Massachusetts), 1993

[2] Haböck, U.; Klier, J.; Schwenninger, J.; Maier, S.: System Adaptation as Key Technology towards Automated Driving. In: ATZworldwide 118 (2016), No. 4, pp. 26-30

[3] Zwerschke, S.: Untersuchung zu Bekanntheit, Akzeptanz und Kaufinteresse von Fahrerassistenzsystemen. VDI Report, No. 1960 (2006). Online: http://www.ftronik.de/files/akzeptanz__bekanntheit_fas_zwerschke_bosch.pdf, access: 27 November 2016

[4] Günnel, T.: Studie zu Fahrertypen: Bestrafer oder Philosoph? Online: http://www.automobil-industrie.vogel.de/studie-zu-fahrertypen-bestrafer-oder-philosoph-a-501778/, access: 22 August 2015

[5] DIN EN ISO 9241-210: Ergonomics of human-system interaction. Part 210: Human-centred design for interactive systems (ISO 9241-210:2010); English version ISO 9241-210:2010

[6] DIN EN ISO 9241-210, ibid, p. 9

[7] Haug, S.; Weber, K.; Wackerbarth, A.; Scorna, U.; Hoffmann, J.: Abschlussbericht Identifikation von Fahrertypen – Ein empirischer Ansatz zur Klassifikation von Fahrertypen anhand von Selbst- und Fremdwahrnehmung bei Testfahrten. Begleitstudie zur Entwicklung eines adaptiven Fahrerassistenzsystems. Unpublished report, Bertrandt Ingenieurbüro GmbH, Ostbayerische Technische Hochschule Regensburg, 2016

[8] Axa Konzern AG: Axa-Verkehrssicherheitsreport 2015. Online: https://www.axa.de/flipviewer/Presse-Verkehrsreport/Produktflyer-Verkehrssicherheitsreport/flipviewerxpress.html, access: 26 August 2016

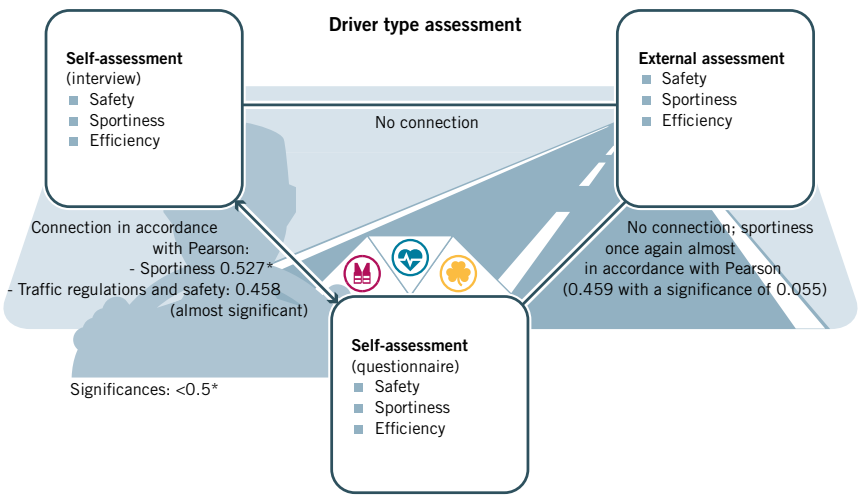

FIGURE 4 Methodical description to evaluate various driver types (© Bertrandt)