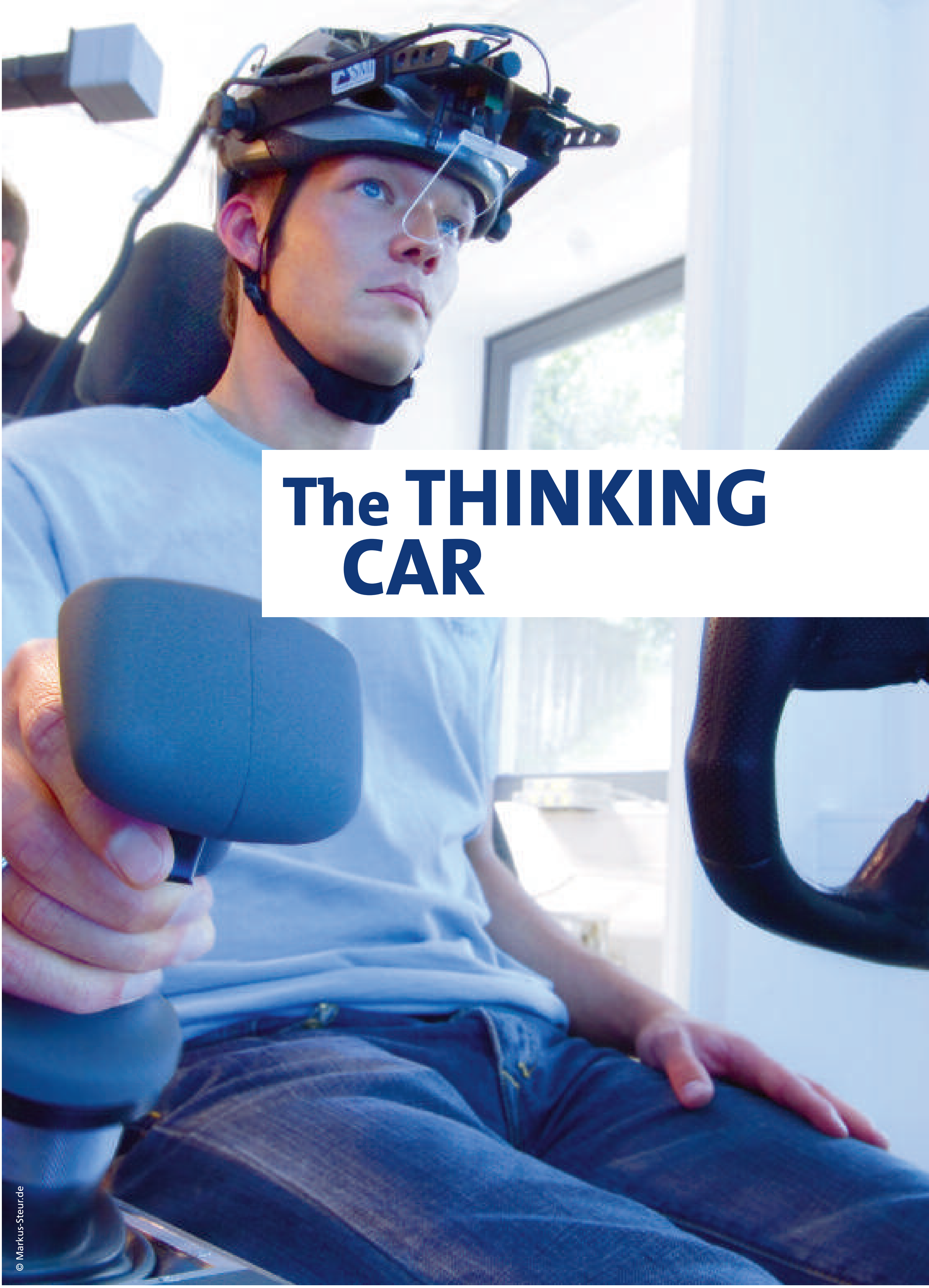
The THINKING CAR



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Assistance System Developers Have Set their Sights on Drivers

By Prof. Dr. Mark Vollrath

“... a massive pile-up occurred on the A2 late Sunday evening ... According to information from the police dealing with the incident, the accident was caused by the driver of a car who did not see an approaching vehicle when pulling out into the outside lane, causing the approaching car to brake. Twelve cars behind collided with each other due to high speeds and the lack of a safe distance between the vehicles.”

We read accidents reports of this kind all too often. Although the number of accidents is continually declining, in particular those with injury to persons, this is mainly due to technological developments that increase "passive safety", such as airbags. The protection they offer to vehicle occupants is becoming better and better. However, a greater degree of active safety, which prevents accidents in the first place, could reduce both material damage and injury. DLR scientists are looking for ways to assist drivers.

The demands that are placed on these systems are high: In certain situations, they need to be more intelligent and reliable than people. To achieve this, the technological system of the car needs to be completely re-designed. However, the first step is to analyze what errors are made by drivers and how they can safely deal with the respective situation.

In over 90 percent of accidents, it is the driver who contributes at least in part towards the cause. But what exactly are the causes of accidents? An analysis of around 5,000 accident reports filed by the Brunswick police has revealed two main causes to DLR scientists: Drivers "overlook" important information, which means that they are unable to react in the correct way. There are many reasons for this. Drivers are often not concentrating, distracted, tired or overtaxed. The second cause is wrong decisions. Drivers consciously take risky actions but decide to accept these risks, often overestimating their own abilities. A typical example is rear end collisions in icy and slippery conditions caused by driving too fast. Driver assistance systems can prevent such mistakes. With radar technology, for example, obstacles can be identified and then be avoided. It is more difficult to calculate a speed that is suitable for the respective situation.

Information about weather conditions, road conditions, speed restrictions and the course and layout of the road must be combined with information from sensors (e.g., grip of the tires to the road), with highly accurate position information and constantly updated databases containing route information (e.g., traffic jams, detours).

It is even more difficult when it comes to intersections: The situation must be correctly analyzed, all relevant road users need to be identified and their behavior correctly interpreted. With better sensor technology, new data fusion possibilities and increasingly intelligent vehicle systems, these problems will be solved in the next few years. With its experience in aerospace, DLR provides important stimulus for these developments.

But how can drivers be induced to adopting the correct behavior? The apparently simplest solution would be the automatic corrective intervention of the assistance system: The driver cannot exceed the permitted maximum speed; the car brakes at

The driver-focused approach to developing driver assistance systems allows room for new forms of interaction. Here, a test subject is driving with a sidestick in the SMP-Lab.

The Test Person is Virtual.

OFFIS and DLR are Jointly Developing Driver Models.

Von Andreas Lüdtke

IMOST is a project that integrates the "human factor" into the development process of electronic control devices to prevent risks caused by misunderstandings or incorrect operation. The abbreviation stands for Integrated Modeling for Safe Transportation. In the project, which is funded by the Federal State of Lower Saxony, DLR is cooperating, among others, with the associate institute OFFIS.

In the IMOST project, the model-based approach, which is already being used today for the development of driver assistance systems, is being extended to include cognitive models regarding the behavior of the driver. This involves more than just incorporating human behavior. All components ? driver assistance system, vehicle, environment and humans ? are integrated into a common semantic model. This allows assistance systems to be fully tested in the virtual world in order to predict the impact on safety – entirely without the involvement of real test drivers.

An interdisciplinary working approach is followed within the project. The University of Oldenburg, DLR and OFFIS have consolidated their expertise. DLR's empirical approach, which includes the investigation of driver behavior in test vehicles and simulators, provides important information for the runtime capable driver models which OFFIS develops.

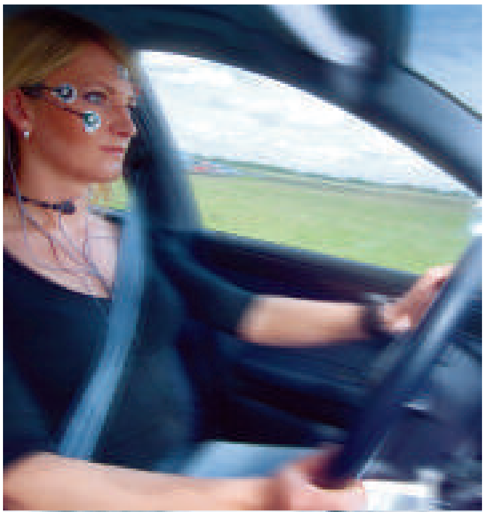
With its Safety Critical Systems (OFFIS SC) area, OFFIS concentrates on the development process of electronic components for safety-critical transport systems. This includes developing methods, processes and tools for people-friendly system design. At the center of it all are virtual test operators in the form of cognitive models which imitate key aspects of human behavior as "cognitive crash test dummies" and enable error predictions in realistic application scenarios. Fields of applications for this are pilot assistance systems and driver assistance systems.

OFFIS was founded in 1991 as the "Oldenburg Research and Development Institute of Computer Science Tools and Systems" by the Federal State of Lower Saxony, the University of Oldenburg and professors of the Department of Computer Science. As an associated institute of the university, OFFIS researches new forms of computer-aided information processing in hardware and software systems and implements the results in application-oriented developments.

the intersection to ensure that the right of way is given. This example indicates just how problematic this type of assistance would be. The manufacturer would have to be able to guarantee that these interventions are one hundred percent safe. Otherwise, the driver would be unnerved if the car did not react the way he wants it to. Another problem would be the danger of becoming too used to the system, which would result in a lack of drivers' own action in the event of a system failure. This type of intervention system is therefore only to be considered for extreme situations.

Information systems, which, for example, display the current speed limit, are different. Here, the driver has control and the responsibility. But what is the benefit of such systems? It is a well-known fact that in the case of ice and snow the speed of the car has to be adjusted to the weather; additional information is of little help here. If a driver is already overtaxed at an intersection, he will oversee additional information about other road users just as much as the problem with the other road user.

Consequently, the support that is provided by information is only helpful in preventing accidents in certain cases. A balance between these two approaches is warnings. The driver's attention is specifically drawn to the dangerous aspects of the situation and it is made clear to him how he needs to react. For example, a warning about a cyclist is triggered at an intersection with an alarm signal from the right-hand speaker and a light signal in the right-hand exterior mirror as soon as the driver begins to turn right. It is important that



Picture above and center: On the road in the ViewCar – the measuring vehicle is used to analyze driving behavior. Different sensors monitor the driver, the vehicle and the surrounding area.
Picture below: The dynamic driving simulator provides a realistic driving feel. This allows unusual or dangerous situations to be investigated with or without driver assistance.

Pictures: Markus-Steur.de

a warning is only given when the situation really is dangerous and the driver has failed to react as required. Otherwise, the risk arises that the driver may become used to the warnings and would then start to ignore them.

A multitude of possibilities exists for assisting drivers. But when do drivers need which particular form of support? How do you provide the driver with the right degree of assistance? – In order to tackle these questions, DLR is inviting different types of drivers to drive the measuring vehicle ViewCar in different traffic situations. The driver behavior (how does the driver react?), the visual behavior (what information does the driver take in?), the strain on the driver (how high is the strain?), the behavior of the vehicle and events in the vicinity are measured.

From this, it can be derived in which situations the psychological strain increases particularly for certain drivers. If the driver is overtaxed, this can result in mistakes. Important information will be overlooked or the awareness of risk declines. Using the ViewCar, the scientists observe driving in day-to-day situations which could become critical due to their complexity (intersections, highway onramps ...). For investigating more unusual or dangerous situations, DLR uses various driving simulators.

In the virtual environment, an accident has no consequences for the test driver. Under controlled conditions, it can thus be identified why errors are made and how drivers react to them. In the next step, driver assistance systems can be developed and tested for their ability to prevent accidents. These systems can eventually be tested in reality in the test vehicle FASCar, which DLR has been operating since 2006. The FASCar is able to drive certain routes automatically. However, automatic driving is not the aim but rather a prerequisite for an adequate degree of driver assistance.

With driver assistance, the scenario described at the start of this article could have turned out as follows: During the journey, radar and infrared sensors recognize vehicles in the neighboring lanes. By means of a driver model, the probability of a lane change is constantly calculated.

If the driver initiates a lane change and another vehicle is located in the dangerous area of the next lane, a warning will be issued and steering wheel resistance will be activated. The driver does not change lanes and the dangerous chain reaction is prevented.

Author:
Prof. Dr. Mark Vollrath followed a job offer at the Technical University at Brunswick to the newly established Chair of Engineering Psychology in October 2007. Prior to this, he managed the Department of "Human Factors" at the DLR Institute of Transportation Systems in Brunswick.