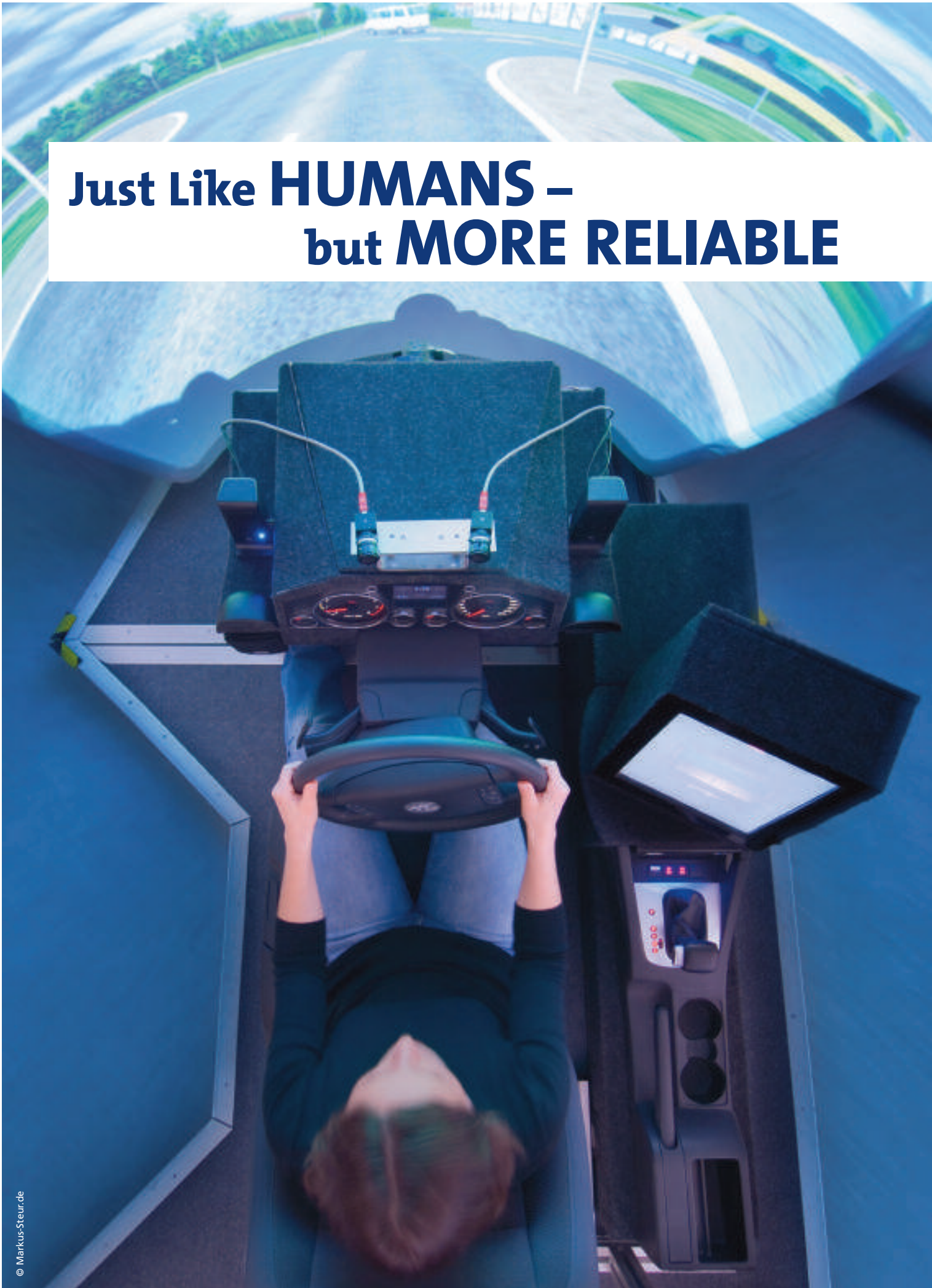


Just Like **HUMANS** –
but **MORE RELIABLE**



Technology to Assist Drivers – Safe, Reliable, Ergonomic

By Jürgen Rataj

If you want to drive a car today, you will be confronted with an array of demands and influences. The driver has to navigate, maneuver and stabilize the vehicle as well as master the modern operating elements of his vehicle. Assistance systems provide support and can help to make transport safer, more efficient and environmentally friendlier. They prevent accidents by informing or warning the driver or even intervening. Assistance systems can also reduce traffic jams by optimizing driving behaviour and coordinating the different road users. This also has a significant effect on conserving resources and reducing pollution. The DLR Institute of Transportation Systems in Brunswick researches and develops technical systems for driver assistance.

Driver assistance technology has high demands to satisfy: the system must always provide correct information and actions. The driver must be able to trust his assistance system at all times. And last of all, the driver assistance system must be ergonomically designed so that people can operate and understand the technology. Only in this way can assistance and automation become a trusted companion for mobile people.

Technical driver assistance systems essentially fulfill four tasks: They acquire information, interpret it, ascertain the appropriate form of assistance for the driver and communicate this in a comprehensible manner. In order to really support the driver with his tasks – navigating, maneuvering and stabilizing – assistance systems require information about the driver, the vehicle, the surrounding traffic and the available transport infrastructure. Sensors, communication, posi-

tioning, database and information processing technologies are necessary for this. Depending on the assistance function, movements in the driver's line of sight or his blinking frequency can be detected. Information about the behaviour and condition of the vehicle for stabilization (ESP – electronic stability program) is gained with the aid of vehicle sensors, for example on the wheels. To assist maneuvering, the surrounding traffic and transport infrastructure is assessed (e.g., with cameras, radar or infrared sensors).

To detect the same information, dependent on the maneuver different sensors are required. The distance to a car in front is measured by radar or lidar on highways and with an ultrasonic system for parking. To assist with navigation, the position of the vehicle is determined using satellite positioning and matched with a digital road map

The sensor information that is gathered in the car is also important for other drivers in the vicinity. Beyond purely visual means, i.e., via turn signals and brake lights, information can also be directly exchanged between vehicles (Car2Car) and between vehicles and the transport infrastructure (Car2Infrastructure).

The information basis for driver assistance is thereby extended to include data outside of the range of the vehicle's own sensors. The vehicle in front can, for example, pass on a measured slip on the front wheel as information and provide a warning against slippery roads.

From the infrastructure system, a vehicle can receive information about current speed limits and use this to directly set the ACC system (Adaptive Cruise Control). In order to fully exploit the potential of this technology field, infrastructure operators, auto-

otive manufacturers, suppliers and research institutions such as the DLR are working together in the globally organized Car2Car Communication Consortium.

A picture of the situation is created from the information that is gathered with the sensors. Future assistance systems will be able to ascertain from this what maneuvers are possible in the situation – just like a driver does from their sensory perceptions.

Future complex assistance systems furthermore require a system architecture that collects and processes the information independently from a specific hardware. In this way, the information can be used by several assistance functions that are linked together via defined vocabulary and communication channels.

One of the aims of driver assistance is to prevent errors that are made by the driver. It is therefore especially important that the assistance systems function without errors and can be operated without mistakes. Otherwise, danger can arise due to the assistance itself or through its potential failure.

Many sensors and their reliable deployment for road traffic still form the focus of research today. Among other things, DLR is currently working on improved image processing systems.

Camera images are essentially only a representation of color intensities of reality – the interpretation, which is easy for humans at a glance, must still be added. Patterns need to be recognized and classified (car, bus, cyclist, etc.) and their behaviors need to be interpreted (speed, direction, etc.).

Redundant systems ensure reliability

At the virtual institute DESCAS (short for Design of Safety Critical Automotive Systems), DLR is working together with the University of Oldenburg and the Technical University at Brunswick on a safety-focused development process. This takes into consideration what would happen if a system failed just once. What would happen, for example, if a laser failed to recognize the vehicle ahead?

Redundant elements could help here to analyze the situation, for example, to determine the position in the lane. The corresponding module can either be the driver himself or another sensor.

And what would happen if the electronics failed? Hardware errors or failures should not have a critical impact on the assistance functions. Diagnostic algorithms or redundant structures can provide a remedy. In the analytic redundancy approach, a system used in aviation, the correct behavior of the systems is simulated and compared with the measured behavior, for example. Software in contrast must not fail. However, it is possible that it contains hidden program errors that lead to problems.

Extensive component and system tests must therefore be carried out in the development process. If an assistance system does fail once, it must be possible for the driver to take over the affected function.

Once the assistance systems are working without technical glitches, it must be ensured that the driver can operate and understand the assistance systems to guarantee error-free use. This is where system ergonomics

comes in, for which intensive exchange is required between engineering science, computer science and psychology. Visual, acoustic and haptic displays and control elements are being developed that enable intuitive operation and reliable interpretation of the system's actions. If the driver understands what the function is capable of based on the information provided, the driver can also predict this function's behavior and use and monitor the function in an accordingly targeted manner to his benefit.

In order to ascertain the expectations that drivers have with regard to assistance functions, in addition to theoretical examinations, experimental investigations with test subjects were carried out in simulators. The various configurations of the human-machine interface are investigated with increasingly realistic simulations, ranging from theater simulation, in which a test subject is provided with system behavior simulations by a hidden scientist, through to tests in the driving simulator, which contains the function as well as a complete vehicle. In the test vehicle FASCar, different assistance systems can be installed and tested on real roads.

People are not just drivers – they participate in traffic in a variety of ways, but the tasks are always the same. If the road user is the driver of a vehicle, he has to carry out the tasks of navigating, maneuvering and stabilizing. Stabilizing encompasses keeping the vehicle in the lane, maneuvering means, among other things, all interactions with other road users. If the road user is only a passenger, the tasks of maneuvering and stabilizing do not apply. It is only the task of navigating that is shared by all road users.

In the test vehicle FASCar, nearly any assistance system can be installed and tested during a real journey.

Future assistance systems can assist in navigation throughout the entire trip planning and guidance process, independent of the selected means of transport. In addition to road information, the future intermodal navigation devices will thus additionally contain information about public transport, such as transfer times and locations. This increases the attractiveness of public transport and thereby reduces traffic on the roads. This improves mobility on the roads, conserves resources and allows trips to be planned more efficiently.

For the future, a ubiquitous mobile network of information, assistance and automation encompassing the different fields of application is just as conceivable as hybrid vehicle forms that act as a bridge between individual and public transport. Such new types of vehicle could, for example, automatically drive to the user and then continue their journey controlled by the user.

Author:

Jürgen Rataj is the acting Head of Department for Driver Assistance Concepts and Technology at the DLR's Institute of Transportation Systems in Brunswick.

