# Please switch to autopilot!

**by Johannes Winterhagen, VDI Nachrichten, 16 November 2012**
**Dusseldorf**

Futurama: It's not just at Google but also in the German automobile industry there is an intensive effort under way to introduce autonomous driving. The way forward is plastered with technical and legal hurdles. But in traffic jams on day soon, a driver will be able to activate the autopilot.

Historians of technical history will one day fight about when the automobile truly lived up to its name. A self-driving car is a thing of the present, if what is meant by that is that one doesn't have to get out and push it. But the way to a fully automatic automobile, that is one that drives itself, is being taken by the automobile industry in only tentative steps.

The beginning of this effort was made by the European Union in the 1980s with the "Prometheus" research project. In 1995 a scientist drove a robot car developed in this project from Munich to Odense (Denmark) and back. But about every nine kilometers it was necessary for the otherwise idle driver to make an adjustment. Other results of the project were more practically relevant: the fundamentals for the distance-holding cruise control were developed, and these were implemented is series cars before the turn of the century.

A dozen other assistant systems were developed that populate nowadays the options list of premium vehicles. Each brought new sensors on board, for example the lane-holding system, whose functioning requires a video camera. Also actuators that "by wire" accelerate, brake, or steer are now available, having been developed for series cars.

So today's automobile sees all and can do all alone. So what obstacle still remains to autonomous driving? "The intelligence of a driver doesn't just depend on the sharpness of his senses, but also from his/her ability to grasp a situation and also to be able to think ahead," explains Rolf Isermann, controls engineer at the Technical University of Darmstadt. "Computers can do that too, but within certain limits."

Engineers and scientists around the world are working on the capability to interpret correctly massive amounts of data from the fusion of different sensors. Gradually they push back the narrow boundaries that were set by the traffic laws and a UN convention stemming from 1968. Inside these legal limits are partially automatic systems, according to most experts, which require the constant surveillance of a driver.

Thus the auto supplier Continental has proposed many times a traffic-jam assistant system, which at low speeds takes over starting and stopping as well as the steering. This system will be ready for introduction in series vehicles in three years.

The driver can completely relax in about 2020, when the first highly automated systems for autobahn driving come onto the market. Then the driver will be needed only in an emergency situation, that is up to a certain speed—maybe 130 km/h (80 mph). Otherwise the driver will be free to attend to other things. Already test vehicles with special permission are being tested on public streets.

Researchers from BMW ran a prototype on the A9 (autobahn) from Munich to Ingolstadt in 2011. This car behaved itself as if it had a very cooperative driver. For example it switched lanes from the right to the middle lane when another vehicle was merging at an on-ramp. For the centimeter-precise positioning, an onboard computer integrated multiple data sources: lane and ground marks, which the camera recognized, positioning data from the satellite navigation system, and finally odometer data, derived from the vehicle's movement.

And even though databases and control strategies are already quite advanced, there are still plenty of technical challenges. One of the biggest is the reliable safeguarding of such a system. A highly automated auto, according to Michael Heimrath of BMW, must travel 100 million kilometers to test the constellation of all possible scenarios. Open also is the question, with highly automated system, how does one monitor the availability of the driver, should he/she be needed to intervene and take control of the steering wheel. "If the driver falls asleep," explains Heimrath, "we must bring the car to a stop on the side of the road."

An idea such as this was investigated by Audi in cooperation with the University of the Armed Forces in Munich on a closed-off test area. While driving, test subjects had to solve set problems with their iPads and at the same time use a joystick to maintain a graphic column in a heads-up display at a certain level.

If the column fell below a certain height, the autopilot would shut off. The column was set to sink at varying rates, so the driver could not anticipate when it would fall below the minimum level. This system was accepted by the majority of drivers, but with a large standard deviation, so there was a large variety of opinions about it.

The last step, fully automated driving, won't happen before 2025. The driver climbs in his/her car, says aloud where he/she would like to go, and is then chauffeured there, not just on autobahns but also through the complex traffic web of the inner city. The most important requirement for such a system: it must recognize immediately under all circumstances the weaker participants in traffic movement—for instance, pedestrians.

A competition organized by the U.S. military, the DARPA Urban Challenge, showed in 2007 that the necessary technology existed. The competition, in which the German teams dropped out, took place in a prop-city on a retired Air Force base.

On public streets only a handful of academic institutions, like the Technical University of Braunschweig, are testing cars—and a company that doesn't come at all from the automobile industry: Google. Their prototypes have driven some 500,000 km, reported Chris Urmson at a VDI conference. Urmson is responsible for the development of autonomous driving at the Internet giant.

To recognize the environment in which the car finds itself, Google depends on a 360° laser scanner mounted in the roof of the car, which recognizes 1.5 million pixels per second. "Not really a series-ready sensor," admits Urmson. But Google regards automated driving as primarily a data-processing problem—and that suggests a solution.

The German automobile industry is working feverishly at present on series-appropriate sensors that can recognize pedestrians. The first goal is to engage an automatic emergency brake, if a pedestrian unexpectedly enters the street.

Manufacturers and component developers pursue in this regard differing strategies. Mercedes has developed a stereo camera, whose pictures are evaluated with the data reduction process "semi-global matching". An emergency braking procedure can be initiated within 150 milliseconds. Audi is developing on the other hand a photon mix detector that can evaluate a reflected laser signal by its time of reflection (distance) and by its spatial resolution. Both of these technologies are expected to be part of a new pedestrian protection system to be introduced in series autos in 2013.

The fully automated car of the future parks and also drives out of a parking space—the driver is not even in the car. This is known as "driver out of place" by the lawyers. This is not allowed by current laws, for besides the German traffic provisions there are the German traffic laws. And Paragraph 18 states clearly: In case of doubt in an accident, the guilt belongs to the driver.

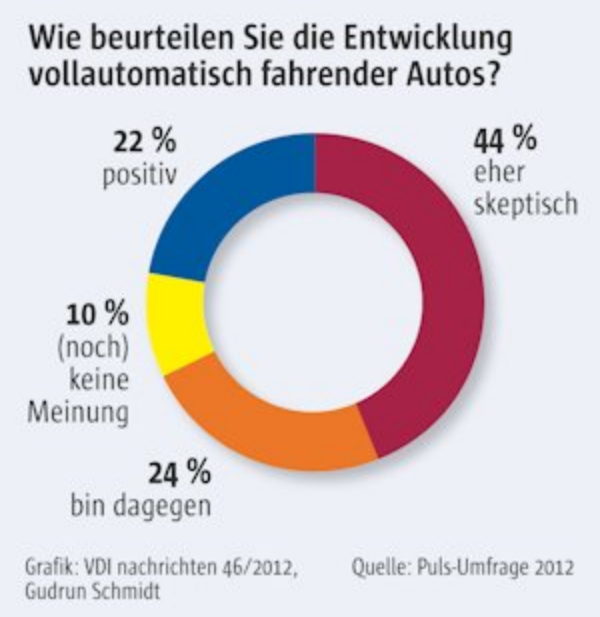
This passage would not be applicable—to the horror of the automobile makers, who in no way want to take on the blame for traffic accidents. Herein lies the biggest obstacle on the way to a fully automated vehicle: The concern that a technology, that in the big picture should make driving safer, will be

thwarted. That automation increases safety on the streets has been shown by the introduction of an automatic emergency braking system on the Volvo XC60. According to a study by the British research institute Thatcham, this model auto has been involved in 27% fewer damage claims since the introduction of this driver assistance system.

Key technologies for autonomous driving: Recognition of the lay of the land:

- For autonomous autos to drive safely through the streets, today's radar and lidar sensors are not exact enough.
- Google uses for its outfitted Toyota Prius test fleet a 360° laser sensor on the roof.
- Bosch and Continental are working currently on the basis of compact stereo video cameras—at first for the use of emergency braking systems in city traffic.
- The German Center for Aeronautics and Aerospace (the German NASA) is shortly coming out with "Romo", its first prototype, which offers an environment sensing capability built on eight stereo cameras.
- To be able to react quickly in an emergency, new picture-recognition systems like "semi-global matching" are being applied. They make it possible to evaluate 10,000 pixels in 40 milliseconds.
- Alternatively laser sensors are being further developed, such as photon mix detection—for example by Audi.

**Most drivers are skeptical**




**How do you rate the development of fully automatic autos? 22% positive, 44% rather skeptically, 24% against, 10% no opinion**

- According to a poll conducted in October 2012 by the market researcher Puls only a fifth of all drivers positive about autonomous cars, two-thirds are skeptical or even against these vehicles.

- The most cited reason for the doubt was "too dangerous" (18%) or "no more driving fun" (8%).