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# When Will We Have Self-Driving Cars?

## A car that drives itself nearly all the time remains far off, for technological and regulatory reasons. But automakers are making remarkable progress on some autonomous features.

By Kristin Majcher on February 18, 2015

Self-driving vehicles like the ones being tested by Google and university researchers could hit the market within the next decade. But before humans can kick back while their car drives them to work, most U.S. states have to pass laws allowing them to be tested and clarifying who would be liable if a crash occurred. From a technology standpoint, though Google's car has successfully driven thousands of miles on open streets, it still faces challenges driving in weather conditions like snow, or knowing that an object is a police officer ordering cars to stop (see "Hidden Obstacles for Google's Self-Driving Cars"). However, since Google announced its project in 2010, traditional automakers have made quick progress on features that let drivers take their hands off the wheel in certain situations. High-end cars of the next few years will be remarkably different from their counterparts of just a few years ago.

**More automation**

Super Cruise, a new feature that General Motors will debut on the 2017 Cadillac CT6, helps drivers stay in their lanes without touching the steering wheel. Tesla Motors' autopilot system uses a combination of radar, camera, and ultrasonic sensors to help the car change lanes with just the press of a button.

Mercedes-Benz's Intelligent Drive helps drivers find a parking space that will fit their vehicle. It uses radar and sensors in the car's bumper and navigates the car into the space. A version of BMW's i3 electric car, demonstrated at the Consumer Electronics Show, acts like its own valet. The vehicle can navigate itself through a parking garage with its laser scanners and arrive in front of the driver – who has summoned the vehicle with a smart watch.

**Fully automated**

Self-driving cars still need to overcome many technical challenges before becoming fully automated. Bad weather interferes with electronics systems, and the cars struggle with unpredictable situations – for example, when a previously still object suddenly moves. Even though many scenarios can be programmed into a vehicle, some may be missed. "One of the biggest issues that we have is that we're

testing a deterministic program in a very indeterministic environment," says Jeffrey Miller, an associate professor of engineering at the University of Southern California. "We have people involved, and we don't know what people are going to do."

Still, some real-world tests have been relatively successful. Google said last year that its self-driving car has logged more than 700,000 miles, with software that can detect and tell the difference between pedestrians, cyclists, and road signs. The company unveiled a new prototype car design in December.

Researchers from the University of Parma's Artificial Vision and Intelligent Systems Laboratory took four autonomous vehicles on a three-month-long, 13,000-kilometer journey from Italy to China. A 2013 article in *Intelligent Transportation Systems Magazine* describes the systems used as well as some of the challenges they faced, including overheating of the onboard vision systems, weakened GPS signal in cities, and local driving habits (like drivers blocking traffic lanes in Moscow).

University of Michigan researchers will start testing self-driving cars in July on the 32-acre "mini-city" the school built to mimic driving situations on five-lane highways and obstacles like parked cars, pedestrians, and construction. In Sweden, Volvo is testing its self-driving cars at AstaZero, a center that replicates rural roads, city streets, and multilane highways. The car manufacturer also announced last year that it would start testing 100 highly automated cars on public roads in Gothenburg. The cars can change lanes and adapt speeds to the cars around them.

Carnegie Mellon University has also taken to public roads with its customized Cadillac SRX, which uses laser scanning and radar embedded within the car. Here's a video of it driving in Pittsburgh. The university recently announced it is partnering with Uber to work on vehicle automation.

**Sensing objects**

Today's vehicles with automated features "see" in two main ways. A method called lidar, which uses laser to sense objects, gives cars a 360° view, but it is expensive. Cameras placed around the vehicle can give the car a view of its surroundings at a more affordable price. High-end vehicles use these with hardware like radar sensors, GPS receivers, and accelerometers to improve the car's cruise control or sense when the car is about to lose traction. Researchers are working to improve the computer vision software that helps the cars use this information to navigate and sense oncoming objects.

University of Oxford robotics researchers and their spinoff Oxbotica are providing the sensing system to help 40 autonomous "pods" in the U.K. program navigate, and they have also modified a Nissan Leaf to create the self-driving RobotCar. With vision technology based on cameras and laser, these cars navigate without GPS. The group uses the car's sensors to create a three-dimensional view of its surrounding environment, helping it avoid pedestrians and other objects. A recent paper from the university's Robotics Research Group, published in the *International Journal of Robotics Research,* explains a new way to track moving objects with a two-dimensional laser scanner.

Through a European Union-funded project called V-Charge, several universities are working with Volkswagen to create a system that would allow electric vehicles to automatically pick up or drop off the driver, park, and recharge. The researchers explain some of the computer algorithms they're using to do that in these recent papers.

**Why autonomy?**

Autonomous cars, in theory, should be safer than those driven by people. More than 32,700 people in the U.S. died from car crashes in 2013, and studies have shown that human error contributes to about 90 percent of accidents. Some tests have shown that self-driving cars will get into fewer crashes and even waste less gas (see "Data Shows Google's Robot Cars Are Smoother, Safer Drivers Than You or I"). In this video, Carnegie Mellon University's Raj Rajkumar explains that taking the wheel from humans could dramatically reduce injuries and fatalities on the roads. Even today's forms of automation, such as systems that use lasers, radar, or cameras to warn drivers that they're closing in on traffic and help them brake in emergencies, is helping to reduce insurance claims, says the Insurance Institute for Highway Safety.

Still, getting accidents near zero will be challenging, Rajkumar says. In a white paper, University of Michigan researchers Michael Sivak and Brandon Schoettle conclude that eliminating fatalities is not realistic. In fact, they warn that in the first years driverless cars take to the roads, traditional vehicles could be less safe because their drivers won't accomplish anything by gesturing or making eye contact with the drivers of the new vehicles. (That problem could be addressed at least in part by technologies that let cars communicate directly with each other.) Driverless cars will also lack the judgment that humans rely on to make decisions in a crash, says the University of Southern California's Miller. He is using robotic vehicles in a lab to test how cars can be programmed to make what amount to ethical decisions, like whether to hit or avoid an animal in the road. He explains some of these dilemmas and how to design software to deal with them in this video lecture.

**The Takeaway**

Cars will become progressively more automated year after year, learning to detect speed limits, stop signs, and traffic signals as they draw closer to full automation.

Do you have a big question? Send suggestions to questionoftheweek@technologyreview.com.

Credit: Photo courtesy of BMW

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