Cars that can drive themselves

A The idea of the self-driving car dates back to before the Second World War. Visitors to General Motors' 'Futurama' at the 1939 World Fair in New York were shown a vision of the future in 1960, in which radio-controlled automobiles would zip along perfectly safe highways. In the 1950s, General Motors and the Radio Corporation of America began experimenting with such a system, digging radio-transmitting cables into roads at a cost of around $100,000 per mile.

B The system worked. In 1958, a Chevrolet impala made it round a special course 'without the driver's hands on the steering wheel' but it joined the list of other expensive automated dreams. The first real breakthroughs for self-driving cars took place in the late 1980s, in the £800m Eureka Promethesus Project, led by Ernst Dickmanns of the Bundeswehr University Munich, a pioneer of computer vision. Using just four black and white cameras, Dickmanns's cars managed two road trips of more than 1,000 kilometres through Europe in 1994 and 1995, driving without human intervention 95% of the time. Automated cars have made huge leaps and bounds in recent years. Starting in 2004, Darpa, the high-tech research wing of the US military, ran a series of competitions for driverless vehicles. The winning team was hired by Google, and for years the technology company ran a fleet of automated cars around the highways of California. So far the cars have clocked up 200,000 miles and have been involved in one minor human-caused accident. Google is not on its own. Other car manufacturers also have some kind of automated car in the works, with research and testing also going on in the UK and Germany.

C Most driverless cars share the same 'Velodyne' laser system on their roofs. 64 spinning lasers provide a constant, 3D view of the environment 40 metres around the car, while radars on the bumpers and a rear-view camera also feed in information. The data is sorted by algorithms that distinguish between cars, pedestrians, plastic bags and cats, and tell the car what to do. Automated cars are programmed to be model drivers: they stop when pedestrians step onto the road; they give way when they should; they stay out of other cars' blindspots and nudge forward when other cars should be letting them through.

D Across the world, 1.2 million people are killed or injured on the roads each year with human error to blame 90% of the time. 'It's amazing to me that we let humans drive cars,' says Eric Schmidt, the executive director of Google. Paul Newman, a robotics engineer at Oxford University, says it is only a matter of time before we hand over the wheel. 'It's crazy to imagine that in ten to twenty years we'll still have to sit behind a wheel, concentrating hard, not falling asleep and not running over people', he says. Computer-controlled cars offer the benefits of safety, fuel efficiency and speed. Roads full of automated cars, all communicating with one another, will see vehicles going bumper-to-bumper at 70mph, eliminating traffic jams.

E In spite of the encouraging pace of development, however, enormous hurdles still remain, notably how to engineer human common sense. 'Imagine a situation where a box falls onto the road in front of you,' says John Leonard, a mechanical engineering professor at the Massachusetts Institute of Technology. 'The system needs to make a split-second decision to either go straight through it or to swerve left or right – which might have worse consequences than just going forward'. Other challenges include recognising the weaknesses of automated cars: how do their sensors respond to glare, poor weather, or damage?

F However, no matter how good, their guidance systems are, self-driven cars will still have accidents. In which case, who will be responsible – the car manufacturer, the software developer or the human driver – for failing to override the computer at the critical moment? But will the cars even have people on board? One of the attractions, surely, will be in ordering them to come and pick us up: in which case will it be empty car A, or car B with driver, which is to blame for a driving mistake? In whatever form they emerge, automated cars will require the greatest overhaul of the law of the roads since the rise of the automobile in the first half of the 20th century.

G It seems unlikely, at least for the time being, that drivers will hand over their car keys. A lot of people actually like to drive and hate being passengers. More likely we will see a continuation of the gradual automation of cars that have been under way for two decades, during which automatic lane-keeping, cruise control and parking aids have been gratefully taken up. A new Volvo, for example, now maintains safe distances in heavy traffic without human intervention, and Nissan is working on software that anticipates a driver's next move, adjusting the car ahead of time. Piece by piece, radars, lasers, car to car communication, and the warning of dangers ahead will be added as well, slowly easing the wheel out of our hands.