# Autonomous Driving

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The original cars were completely human controlled, but each generation of cars introduces new features that shift the responsibility of driving from the human to the car. From cruise control and ABS to cars that are able to drive themselves on the highway without any human intervention, the role of humans as controllers of cars has been and will continue diminishing. This paper will look at the current state and future of technology related to autonomous cars in both production and research environments, and the impact of the technology on the world.

There are two different groups of at least partially autonomous cars: those that are in production and regularly driven on open roads, and those that exist as research projects. In production cars there have been a continuous supply of innovations, usually designed to improve the safety of drivers, such as traction control and electronic stability control systems. These are not noticed by the driver until the car detects something wrong, at which point it adjusts the power and applies brakes as needed to each wheel to prevent the driver from losing control. More recent advances include adaptive cruise control, which uses radar to detect slower traffic and and adjusts the vehicle's speed to prevent collision, relieving a driver in busy highway traffic of adjusting their speed.

Although not yet an actual part of the driving of production cars, the last few years have shown a large increase in GPS navigation devices. Even without controlling the actions of the car, they have shown society how computers can help with transportation by virtually eliminating the need to plan a drive in advance. This is an important step for fully autonomous cars, as route planning and navigation is by no means trivial, and it helps build consumer confidence in the reliability of computers.

Advances on the research front of autonomous cars is even more impressive. Over a decade ago OSU's Center for Intelligent Transportation Research built a car that was able to navigate highways

with mixed manual and autonomous cars, adjusting speed as needed, steering to keep the current lane, and adjusting lanes as needed to pass other cars. More recently the Urban Challenge sponsored by DARPA demonstrated fully autonomous cars driving through simulated city conditions. Over the next decade or two it can be expect that these features will slowly be integrated into production vehicles.

The impact on society of fully autonomous transportation would be extreme. Looking first at the benefits to society there are numerous advantages, the first and foremost being safety. With almost all car accidents caused by driver error, the usage of autonomous cars could save almost 40,000 American lives a year, besides saving many billion dollars every year. Worldwide over one million deaths and about 40 million injuries could be prevented each year. Safety improvements of that scale can be considered justification alone for the development autonomous cars.

More related to what people would directly notice from fully autonomous transportation would be the convenience. Driving would no longer be a task, but simply a time to relax, work, or have fun. In effect, every family would have a personal chauffeur, preforming whatever driving tasks need to be done. Parents would no longer have to drive to pick up their kids from school, the car could simply go for them; Parking would be irrelevant, as the car could drop off and pick up passengers exactly where they want to go. A single car could handle an entire family, getting the children to school, the parents to work, and everyone home in the evening without wasting any family member's time.

A last benefit of fully autonomous driving would be beneficial side effects to the environment. Autonomous cars would be able to optimize their driving so as to avoid wasting gas doing things that humans are prone to do, such as accelerating unnecessarily. Such optimizations could save a large amount of whatever resources are being used to power cars at that time. Cars would also be able to cluster very close together, reducing a large amount of wind resistance and saving further resources, and making trips faster. Finally with proper systems a car could avoid traffic problems, and thus avoid idling needlessly.

However, the deployment of fully autonomous vehicles would not be without cost to society. In

terms of money alone, a large amount would have to be spent on developing the technology, but that would be mostly covered by first adopters of partially autonomous cars. More important however would be the impact on employment, as fully autonomous vehicles would take over virtually every job related to driving today would be replaced by computers. Truck and taxi drivers would be out of work, and if the number of accidents reduced as much as expected, many body shops would also be out of business. Although this would create hard feelings among some, history has shown that the economy would adjust and open new opportunities.

There are a number of social issues that stand in the way of autonomous cars becoming standard. The first step is getting drivers to accept that a car can drive itself. Even some new partial autonomous features such as adaptive cruise control can be hard for drivers to accept. Trusting that a car will apply brakes as needed to prevent an accident is not something that comes naturally to an established driver. Convincing society to trust a car navigating rush hour traffic will take many years at best, but with the slow roll out of features like adaptive cruise control and automated parking, it should be much easier for people to accept autonomous cars.

There is also the aspect of convincing people, most importantly law makers, to allow autonomous cars on the road. People who don't trust computers will believe that autonomous cars will only cause more accidents, and attempt to keep them off the roads. Also, there are many issues regarding who is responsible for car accidents that are caused when a car is driving itself, especially in the case of a fully autonomous vehicle without any human controls. Upon resolving these issues it should not be difficult to get government permission to use autonomous cars, but getting there will take a lot of work.

Although the average safety of driving would be increased by autonomous cars, there would still be cases of failure that people would use to argue against the acceptance of such vehicles. A prime example is that of when a GPS navigation system sent a British ambulance on a two hour trip to the hospital while carrying a girl who had just been hit by a car. The trip should have only taken 15

minutes, but because of a fault in the algorithm they were sent in the wrong direction. Many people would argue that if something so simple could go wrong, how could a car be trusted to navigate roads? It is important to see however that computer failures would be statistically less likely by a few orders of magnitude than human driver error.

Finally, one of the most important social consequences would be the decline of the American driving sub-culture. Driving is a hobby and a sport to many Americans, and there many visions of a future world where manual drivers could not be incorporate alongside the road with autonomous cars. Optimized driving and inter-car communication would make traffic more complex then a driver could handle, and even with all the benefits of autonomous cars, there are many people who simply would not want to give up driving.

Research such as the Urban Challenge has shown that fully autonomous cars are completely possible, and we can see that there are great benefits to be reaped, but many issues to overcome on the path to fully autonomous vehicles. Simply getting society to accept self-driving cars will be tough, but with the small steps being made now people are becoming accustomed to their cars driving some for them. Getting political acceptance and recovering from the unemployment that will result will be difficult, but by no means impossible. Although the decline of the American driving sub-culture will be disappointing to some, the gains in convenience, safety, and environmental benefits will inevitably lead to fully autonomous cars.

**References:**

http://www.ece.osu.edu/citr/Demo97/osu-av.html
http://abcnews.go.com/Technology/Techreview/story?id=3820602&page=1
http://www.gpsdaily.com/reports/Sat_Nav_Directs_British_Ambulance_Off_Course.html
http://www.onlinelawyersource.com/personal_injury/car/statistics.html
http://www.sightline.org/daily_score/archive/2006/06/29/crash-counter