Driverless vehicles

A new engine for economic transformation?
Driverless vehicles – a new engine for the economy

The autonomous vehicle – no longer a distant vision of the future, but a real prospect for our roads and an opportunity for fresh economic growth.

The UK Government outlined in the Queen’s Speech for 2016 that Britain seeks to lead the world in autonomous vehicle testing. The initial plan to introduce driverless testing to UK roads in 2017, with a view to paving the way towards nationwide introduction as soon as 2020, is already happening, with limited tests in Greenwich and Milton Keynes having already taken place.

The focus on ‘driverless’ cars is on what they lack – a driver. Often this misses what they enable – Barclays wanted to look into how the era of driver-free transport could transform the world around us, from increased productivity to supply-chain efficiencies, transforming communities and improvements to personal mobility.

What we found is an exciting new future where cars could be bought based on how well they integrate with your work emails rather than how well they drive; where trucks are able to run in land-trains meaning significant logistical cost-savings and where suburban roads are freed from their perpetual car park status into green shared spaces for pedestrians and vehicles.

The sharing economy is likely to position car rental firms in a prominent position to benefit, with inner-city car share services like Zipcar and DriveNow particularly well-placed to be among the biggest beneficiaries. When a car can drive itself to where you are, the need to own your own car could be rapidly diminished, with the number of multi-car families to decrease significantly – we estimate that car ownership will decline from 1.2 cars per household in England today to 0.7 cars per household once autonomous vehicles are the established norm.

While estimates suggest that in the era of driverless cars vehicle ownership could decline, those vehicles that are on the road are likely to run a significantly higher mileage than they do today. This is because they’re likely to spend more time travelling between pick-ups with no one on board at all. This means that the demand for new vehicles to replace these is likely to remain much closer to today than one might at first imagine.

94% of accidents are caused by human error, meaning autonomous vehicles are likely to reduce the number of deaths and injuries in road accidents significantly. This in turn could bring motor insurance policies down dramatically, but there remain fundamental questions over where liability may sit; in the short-term the insurance industry recommend that we will still need policies to cover us for both autonomous and ‘traditional’ vehicles, but that legislation changes to allow insurers to recover costs from manufacturers in the event of the vehicle being at fault would be required.

We hope that this report will help you start to consider some of the possibilities and opportunities for your business as driverless cars become a reality.

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The history of the driverless car

There’s a story about the development of the motor car in the late part of the nineteenth century where many referred to them as ‘horseless carriages’. The concept of the motor car itself was so new they had to describe it in terms they did understand; driverless cars are much the same. We can’t imagine a car without a driver, so we focus on that thing it is lacking.

Despite a number of high-profile trials of the vehicles – none have ever truly been driverless at all yet, for the simple fact that a driver has been required to remain present and ready to take over the controls. Trials of autonomous taxis in Pittsburgh and Singapore have both included a driver sat in retrofitted vehicles poised to take over the controls should they be required.

In the UK, the GATEway Project has been working on an £8 million trial of autonomous vehicles – much more akin in their design to trams and buses than cars – in truth these vehicles appear much more like modern giant toasters cruising around the streets than they do cars, and reminded us somewhat of the ill-fated Sinclair C5 of the 1980s than a slick vision of the future.

<table>
<thead>
<tr>
<th>Location</th>
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<tr>
<td>California, TX</td>
<td>Google’s tests are perhaps the best known, and the most robust with over 1.5 million miles driven since 2009. This has been a combination of retrofitted Lexus and Toyota vehicles, and Google’s own prototype.</td>
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<tr>
<td>Milton Keynes</td>
<td>Autonomous vehicles equipped with technology produced by Oxford University’s Robotics Institute are trialled in pedestrianised areas of the town centre.</td>
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<td>Pittsburgh</td>
<td>Uber trial their first ‘self-driving’ cars, with Ford Fusions retrofitted with Uber technology picking up passengers in the Steel City.</td>
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<td>Singapore</td>
<td>Self-driving taxi trial by nuTonomy, a US-based start-up founded by two MIT researchers. Small electric cars manufactured by Renault and Mitsubishi were fitted with software and sensors developed by the firm, and passengers treated to free rides.</td>
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<tr>
<td>London</td>
<td>GATEway project runs limited trials of autonomous vehicles, driving 100km around the Greenwich peninsula.</td>
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 Trials of driverless cars around the world
Motor manufacturers have not been slow to wake up to the possibilities of autonomous vehicles, keen not to make the same mistakes as the music and film industries who were somewhat caught napping in their speed of adaptation to new digital technologies.

The automation race

We have already seen a whole host of advanced driver assistance systems (ADAS) make their way into vehicles on the road’s today. Technology already commonly found on the UK’s roads includes:

- **Handsfree parallel parking**
  Sensors will analyse parking spaces and automatically steer your vehicle into place. The driver continues to control the brakes and accelerator.

- **Lane control**
  Technology that can detect when you are drifting out of your lane and gently corrects your position on the road.

- **Adaptive cruise control**
  Automatically braking and accelerating in order to maintain a safe distance to the traffic ahead while in cruise control.

- **Assisted braking**
  Using front-mounted radar, vehicles can detect when there is a hazard ahead on the road and apply the brakes to help prevent an accident.
The car in front has a powerful electronic brain

Mobileye, who produce the technology behind ADAS for manufacturers including Honda, GM and Ford have now partnered with BMW and Intel to bring driverless cars to full production by 2021. While BMW cars already use Mobileye’s software and sensors to enable features like assisted braking, the two have partnered with Intel because, according to Intel CEO, Brian Krzanich: “Highly autonomous cars and everything they connect to will require powerful and reliable electronic brains to make them smart enough to navigate traffic and avoid accidents.”

The technology within the cars for parts suppliers is likely to continue to become more expensive, which could limit the impact of an overall reduction in part volume.

Parts suppliers will need to be aware that if driverless cars mean less cars sold, then they will have to be agile in looking at their product portfolios, dropping products that have reached the end of their cycle faster and adapting them to seek out new areas of growth. The technology within the cars for parts suppliers is likely to continue to become more expensive, which could limit the impact of an overall reduction in part volume.

The motor manufacturers will be hoping to show to consumers that their own technology or partnerships with technology brands are the preferred model – such as Uber equipping Volvo and Ford vehicles with sensors. Google has already revealed their first custom-made vehicle, and it’s an open secret in Silicon Valley that Apple are working on their own vehicle(s), with some sources reporting that the famously secretive tech giant has recruited “over a thousand” engineers to the project.\(^2\)

An example of the fierce competition in this space among motor manufacturers is that of Mercedes Benz’ former R&D CEO for North America, Johann Jungwirth, who in 2014 was poached by Apple to work with their Special Projects Group before Volkswagen swooped in and he was appointed as the head of the newly formed Digitalization Strategy Department.\(^3\)

\(^2\) http://www.bbc.co.uk/news/technology-35280633
Demand for vehicles holds up

In the US, Barclays estimates the number of cars per household will fall from 2.1 currently to 1.2. In England, there are 1.2 cars per household today so using the same methodology of our US colleagues, we estimate this will fall to 0.7 in the future when autonomous vehicles are the established norm. This is due to the fact that the vast majority of trips undertaken by a household that have two or more vehicles do not overlap, and so one vehicle would be able to serve such families.

But car manufacturers need not look at these figures and despair completely, because although car ownership is likely to reduce, the amount of miles each vehicle will cover is likely to almost double. If one imagines a single autonomous vehicle owned by a family: unlike today, it would travel unaccompanied between family members for part of its time. Researchers at the University of Michigan’s Transportation Research Institute (UMTRI) estimate that the average vehicle’s annual mileage will increase by 75% from 11,661 to 20,406 miles.

This means that the demand for new vehicles to replace these is actually likely to remain much closer to today than one might at first imagine.

Also among unknowns are the amount of people who will continue to own additional vehicles purely for the pleasure of driving. Certainly among a large proportion of people across the world, the experience of driving is unlikely to be something given up lightly. There will also remain the status of owning the latest vehicle, and this is something that the marketing teams at the established – and new-to-market – manufacturers will continue to stoke, particularly targeting those early adopters who are enamoured with having the latest technology.

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4 ‘Disrupted Mobility’, Barclays Investment Bank Research, 2015

0.7 Cars
Predicted per household

Mileage will increase by
75%
from...

11,661 to...

20,406 miles
Supply chain efficiency

Beyond vehicle manufacturers, there are huge potential cost-savings across the industry more broadly, particularly in the costs of logistics trickling down through the supply chain.

At the very least, platooning is one area that is very keenly being looked at as a way of making significant cost savings on fuel. Cycling or motorsport fans will be familiar with the concept under the more common names of chain-ganging or drafting. Truck platooning allows a line of lorries to travel much closer together than would normally be safe to do so with the following lorries passing control of steering, braking and accelerating to the lead vehicle. Using wireless technology, the following lorries can brake almost instantaneously with the lead lorry, meaning that they can significantly reduce drag and in turn save energy.

Volvo believe that the technology will also reduce congestion on motorways, because the working effect that can occur in traffic would be reduced as the vehicles ahead are moving at a consistent relative speed.

The fuel efficiency savings could be as much as ten per cent when three trucks are platooning, according to Mercedes-Benz; not much in isolation but when multiplied across a continent like Europe, the CO2 reductions as well as the cost-savings could really mount up.

The Chancellor announced in his March 2016 Budget that the government would clear the way for trials of truck platooning on UK roads, as part of a package of measures to help "establish the UK as a global centre of excellence in connected and autonomous vehicles."

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The competitive advantage for rental firms

One of the key questions in an autonomous future is the question of who will own and maintain the fleets of vehicles. If car ownership among households declines, rental firms are well-placed to take advantage of the burgeoning short-term hire market. Indeed the Avis Budget Group acquired Zipcar – who have cars parked on city streets available for a tap-and-go hire via a smartphone app – in 2013 for $500m.

For those less familiar with Zipcar’s service – they are only based in London, Glasgow, Bristol, Oxford, Cambridge, Edinburgh and Maidstone in the UK – their model is about providing a simpler rental service. Their vehicles are parked on streets right across the cities they operate in, as opposed to in centrally operated garages as a traditional rental car business. And unlike traditional rental cars, fuel is included (up to a limit). The simple idea is that the car is near you when you want it, for a reasonable price, and therefore is a viable alternative to car ownership in larger cities where vehicle ownership is less necessary than in rural areas.

Rental firms have the fleets and the maintenance resources in place to potentially be the big winners of the driverless car era. They also have a regular turnover in vehicles, so will be able to introduce the technology to drivers before they’ve had the opportunity to consider purchasing their own. Given that these fleet managers have such close relationships with the vehicle manufacturers already, the noises coming out of these businesses will be the key ones we need to listen to in the coming years.
Insurance Industry

Questions over who would be liable in the event of an accident of an autonomous vehicle make for an interesting line of thinking. The model of a driver taking out an insurance policy for their personal vehicle – and the claims model of apportioning blame to one or more drivers at fault is something that could be completely upturned in the era of autonomous vehicles.

The insurance industry need to be ready for the potential impact this could have on their business, and ready to adapt to the model with technology. Led by the Association of British Insurers (ABI), 13 insurance companies including Aviva and the Direct Line Group formed the Automated Driving Insurer Group to feed into ABI policy and Government consultations on the emerging legislative and technological picture.

Insurers are actively looking to support progress and innovation

The group have said that insurers are not standing in the way of driverless cars becoming a reality but are “actively looking to support progress and innovation.” It’s vital that insurers aren’t left behind by consumer demand, so recognising the potential improvements to safety that could be brought by taking humans out of the driver’s seat is in itself a crucial step.

The questions that insurers and policy-makers will have to answer include:

Who is liable after an accident – manufacturer, programmer, driver, maintenance companies or a combination of these?

With roads carrying a mix of autonomous, semi-autonomous and traditional driver-controlled vehicles, how do policies adapt to the potential for any and all of these to have a collision?

What changes to existing road traffic laws might be required?

The developments we’ve seen towards increasingly autonomous vehicles are already reaping rewards – with autonomous emergency braking reducing collisions and injuries and helping to bring down insurance premiums. Truly driverless cars have the potential to dramatically reduce deaths and injuries on the roads and could revolutionise what we think of as public transport. The role of motor insurance in such a future will be very different to what it is today, but insurance will be part of the picture.9

James Dalton
Director of General Insurance Policy at the ABI

InsurTech

In early consultations with Government, the Automated Driving Insurer Group have suggested that the preferred model retains the driver being required to purchase a single motor insurance policy, but that this would cover them for both manual and automated driving. In accidents where the vehicle technology was found to be at fault, rather than the driver, insurers would seek to recover costs from the manufacturer. The group feel that a new legal framework for this right to recovery would be required.\footnote{https://www.abi.org.uk/News/News-releases/2016/09/Autonomous-vehicles-response}

With the model being so new, many of the so-called InsurTech companies – emerging businesses specialising in disrupting the insurance industry with technology – might be well-placed to take advantage of the new vehicles. Businesses like Cuvva – who provide short-term insurance policies for an hour or two rather than a fixed annual period – would plug very well into the sharing economy that would be more likely in the driverless era. We expect established insurers will need to follow the example set by Cuvva in the years ahead, irrespective of the advent of autonomous vehicles.

Investments in InsurTech companies has soared in recent years from $740m in 2014 to $2.7bn in 2015 according to CB Insights, with indications suggesting it has grown again in 2016, a trend we feel is likely to continue.

94% of accidents are caused by human error. The potential for autonomous vehicles to reduce accidents should see premiums fall dramatically, but given that insurers calculate premiums based on risk, and that this technology still represents the unknown, it is impossible to say by how much.
In the UK in 2015, the ONS estimate that almost a quarter of the UK population are over 60 years old\(^\text{11}\). In a nation with an increasingly aging population, the contribution that driverless vehicles can make to personal mobility is huge. Heavily-subsidised and infrequent rural bus services poorly meeting the needs of those members of our community who are cut off by age, disability, or the simple lack of a driving licence could be completely phased out and replaced with a fleet of autonomous vehicles.

There is a big question though over whether driverless vehicles could be relied upon to steer an emergency vehicle through traffic at speed? While a computer’s reaction time is unarguably always quicker than a human’s can be, currently the autonomous vehicles that have been tested have been programmed to follow the Highway Code to a fault. That they would be able to safely navigate red lights in the way an emergency driver can is not something that has been programmed in as yet.

Indeed, it is their obedience to the rules that have been the downfall of some autonomous vehicles, with reports suggesting early iterations were crippled at junctions with fast-moving traffic. Where a human might be able to signal to another driver to let them out of a junction, a driverless vehicle is left waiting for a safe gap that never comes.

There is also the important point of safety. The number of fatalities on UK roads has fallen every year but one between 2005 and 2015 from 3,201 to 1,775, an incredible 45% reduction. But with 94% of accidents caused by human error, the potential further reduction in that figure due to computers and sensors taking over is an enticing prospect for policymakers and manufacturers alike.

\(^{11}\) https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates
Community impact

Picture an average suburban street and what do you generally think of? Picturesque white fences, a pristine garden, azaleas neatly lining a gravel path to a front door flanked by bottles of freshly delivered milk? Possibly, but more likely than not it’s cars. Cars packed into driveways, mounted on pavements, and often if they’re not parked to one side, they’re stationery on the road due to traffic regardless. Estimates put the average car in the UK at being parked for about 96% of the time\(^\text{13}\), a figure that if you think about your own vehicle is probably not all that surprising.

Town planning for decades has been geared around creating more space for the rapid increase in vehicle ownership. In 1951, 86% of households had no access to a vehicle; 20 years later and the haves already outnumbered the have-nots, while today the picture has more or less been reversed, with car ownership being the norm in 75% of households. But while per household access to a car has stalled, population growth means that the number of vehicles on our roads continues to grow – at the start of 2004 there were 32 million vehicles registered to drive on roads in Great Britain (excluding Northern Ireland), by the start of 2016 that figure had reached nearly 37 million

And so the car has left an indelible mark on our communities, with towns and cities whose roads are as much as 12 feet narrower than when they were built with thanks to the cars lining either side of them, or front gardens long since replaced with driveways. Imagine a picture where that town plan has been re-written.

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\(^{13}\) https://shift.newco.co/the-third-transportation-revolution-27860f05fa91#.2zkgrihfc

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One or more car/van

No car/van

Source: National Travel Survey, Table NT50205\(^{13}\)
Introducing ‘Supurbia’

In an era of driverless cars, owned centrally by car sharing businesses like Zipcar and DriveNow a suburban street could be made largely free of cars.

If you were one of the thousands of people who helped to celebrate the Queen’s Diamond Jubilee on a wet British weekend in June 2012 you’ll perhaps be able to imagine this quiet life. Spaces once filled with sedentary vehicles could be reclaimed as public spaces; the pressure on our parks and countryside could be eased somewhat as we brought nature back into the hearts of our communities.

Design consultancy HTA Design have been working with the Mayor of London’s office in recent years on a project called ‘Supurbia’ looking at how technological advances and the sharing economy could transform suburbia. One element of that has been to look at what a North London road could look like if you took the parked cars away.

Using car-pool and ride-share apps that already exist, combined with cars that can drive themselves to you when booked via those apps, one could eliminate the need for car ownership at all, in theory at least. Replace the parked cars with trees, grass, paths, and a track for the driverless cars to follow, you get something like the image on the right.

We think this vision of the future is probably a little beyond what we could expect, but it’s the sort of concept that opens your mind to the truly broad societal impacts that autonomous vehicle technology could have. It’s the modern-day equivalent of the moment you stop thinking about the horse in the horseless carriage, and start thinking about the automobile.

http://www.hta.co.uk/news/posts/supurbia-bbc-news-at-ten
The Technology View

Barclays looks at the other considerations and investment opportunities.

Buying a car is an expensive and often a subjective purchase. If you take driving out of the equation you’ll be considering more what a car enables you to do within it – the features that come with the car to provide you with enough distraction and entertainment within the vehicle when travelling. Could your Apples and Googles be really well-placed here to provide on-demand entertainment via their online services like Apple Music and Google Play?

All of a sudden the car you choose could be determined more by how suitable it is for integrating with your work emails than the handling and size of the engine.

If you take driving out of the equation you’ll be considering more what a car enables you to do within it

Where investment opportunities may lie is in the infrastructure supporting the autonomous future. Maps are already a major battleground; Uber’s apps use Google Maps at the moment but they are investing in their own mapping technology so that – in the short term – they can create maps that are more accurate in supporting their drivers, but in the long-term will be able to guide their autonomous vehicles around more precisely. Apple famously ditched Google Maps as the default on their iOS operating system over four years ago – though this was a relative PR disaster for the Cupertino firm, it positions them well to equip their rumoured project with their own first-party map information.
Adapting to the UK

Businesses around the world have been established and snapped up in the race to become the dominant player in this burgeoning industry: Uber is rumoured to have paid $650m for Otto, a driverless lorry startup15, and they also set their Advanced Technology Centre up in Pittsburgh – the same city that they apparently poached about a third of robotics firm Carnegie Mellon’s engineers, who were working on their own automated technology16. Apple have even been rumoured to be considering an offer for Formula 1 team McLaren17.

Other technology that will be needed to support the new fleets might include electric charging points. Businesses like the UK’s PodPoint, recently named among the top 100 fastest growing tech businesses in the UK18, will likely benefit from the expansion of hybrid and electric technology in driverless cars. Another area to keep an eye on is the technology that the vehicles will be using to communicate with each other to prevent accidents.

Many people doubt that driverless vehicles could adapt well to the UK’s roads. Our road network is simply older and more complex than most parts of America, which is largely dominated by a grid system. But look at these two photos. One shows Birmingham, in the West Midlands, the other Pittsburgh, Pennsylvania in the US. The latter is the city that Uber have been testing their driverless cars on in recent months, and without incident. They deliberately chose this city precisely because its roads were not all just straight.

The biggest threat to the cars lie still in human drivers

At the moment, the biggest threat to the cars lie still in human drivers. Google’s cars have been involved in around two dozen accidents. The first to result in an injury was in July 2015 and injured three Google employees, but their vehicle was stationary and had been rear-ended by a human motorist19; and in September 2016, another of their vehicles was seriously damaged when a human ran a red light and drove into the side of the Google car.

94% of accidents are caused by human error

And therein lies the rub. 94% of accidents are caused by human error, but as long as there are petrolheads – who could even become thought of as hobbyists – then the robot cars will have to share the road with the altogether less reliable human drivers. And does that mixed ecology on the roads work? Only time will tell.

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16 http://www.wsj.com/articles/is-uber-a-friend-or-foe-of-carnegie-mellon-in-robotics-1433084582
17 http://www.ft.com/cms/s/0/523422ba-7ffd-11e6-8e50-8ec15f446294.html#axzz4KuRUCQJw
18 http://www.fasttrack.co.uk/league-tables/tech-track-100/league-table/
19 https://www.theguardian.com/technology/2015/jul/17/crash-self-driving-google-car-injures-three
Key Takeaways

• Autonomous vehicles are soon to be a reality with a number of high-profile trials.

• For the automotive industry, less cars could mean parts suppliers could see a decrease in volume but with the technology likely to become more expensive – this could limit the financial impact

• There are potential cost-savings across manufacturing in the costs of logistics for example through truck platooning

• For technology, investment opportunities lie in the infrastructure for autonomous vehicles – charging points, communication between vehicles as well as the features and entertainment that will come with your car

• Insuring driverless vehicles remains an open question, who will be liable? The manufacturer, programmer, driver or the maintenance company?

• Communities and public transport could see significant change with driverless buses and ambulances and even shared ownership all transforming suburbia

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