

DRIVERLESS VEHICLES

Innovation to revolutionise the way we transport modern societies July 2017



INTRODUCTION

The motor car was invented more than 100 years ago and has remained one of the defining inventions ever since. From the first Model T Ford rolled off the production line in 1908, the car has revolutionised the lives of billions of people by providing a convenient and affordable way to get from 'A' to 'B'.

Globally, there are now over 1.2 billion road vehicles in use¹. In the UK alone there are over 37 million registered vehicles on the roads² with a new car sold every 12 seconds³. What is remarkable about the car is not how widespread car ownership has become in the past 100 years, but how the basic technological concept has changed so little since 1908. The concept of a car remains essentially a metal chassis with a wheel in each corner, powered by carbon fuels, with a driver controlling the vehicle via a steering wheel.

With the growth of the digital economy, all this is about to change.

THE BIRTH OF CONNECTED AND DRIVERLESS VEHICLES

The 'Internet of Things' or 'IoT' is one of the key innovations shaping developments in vehicle technology, opening up the potential for a new generation of connected and autonomous vehicles. The IoT involves computing devices in everyday objects such as televisions, gaming consoles, laptop computers and mobile phones – as well as the homes we live in and the vehicles we drive – becoming "connected' to each other via the internet. The universe of connected items is potentially almost endless and it has been estimated that there will be over 30 billion connected objects on the IoT by 2020⁴.

This has major ramifications for transportation systems in assisting with the integration of vehicle communications, control and information processing. The effect will be not just on the vehicle but also the driver and the wider transport infrastructure relating to all modes of transportation – road traffic, aviation, rail and shipping. This opens a totally new way of transporting goods and people by enabling both intra and inter-vehicle communications, smart traffic control, smart parking, electronic toll collection systems, improved logistic and fleet management, vehicle control and safety and road assistance. It is the invention of the connected vehicle – capable of talking to other vehicles and assessing the surrounding road environment – which has created the prospect of a new generation of fully autonomous or driverless vehicles.

With the move towards connected and autonomous vehicles, every aspect of transportation is set to undergo potentially fundamental and rapid changes. These changes are not limited to the underlying vehicle technology and road infrastructure but they will also impact on driver behaviour with new patterns of vehicle ownership and usage. We will also require a new way of apportioning liability with new insurance products which address product liability issues, as well as dealing with new and emerging risks such as cyber security and data protection.

CONSUMER RESEARCH – METHODOLOGY

This report explores how such innovations are viewed from the perspective of motorists and other road users. We explore the extent to which the UK public feels comfortable with the notion of driverless vehicles and how that level of comfort shifts depending on the context. With the UK government aiming to place the UK at the forefront in developing driverless vehicles, we explore what factors are likely to shape whether the UK can successfully build a public consensus in favour of adopting such technology and what obstacles may need to be addressed.

To help us assess the state of public opinion, we conducted an online survey based on a sample of 1,000 UK adults. The survey was designed and commissioned by Cicero Research between 18 and 20 April 2017 based on a nationally representative sample of people aged 18 and over living in the UK.

Within this total sample size, 87% of respondents currently hold a UK driving licence and 80% are licenced to drive a car. However, not all of those who hold a licence currently own or drive their own vehicle. Sixtyseven percent do, which equates to over 30 million adults in the UK.

The respondents also included several important social groups who fall outside of the existing motoring population, but who might be able to change their behaviours with the advent of driverless technology. For example, 7% of the sample were currently unable to drive owing to their poor state of health or disability. The social impact on this group could be potentially transformative.

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¹ The International Organisation of Motor Vehicle Manufacturers (OICA) 'vehicles in use' data for 2014. Taken from the OICA website as of April 2017.

- ² Ibid
- ³ Society of Motor Manufacturers and Traders (SMMT)
- ⁴ Institute of Electrical and Electronics Engineers (IEEE), 18 August 2016

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The consumer research findings show that Britons remain to be convinced of the benefits of driverless vehicles. Overall, the UK public does not currently have a consensus view in favour of driverless vehicles. Only a minority – 44% of UK adults – favoured the use of driverless cars on the UK roads. A major public debate focussing on the benefits of the technology could see this picture shift quickly.

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EXECUTIVE SUMMARY

PUBLIC CONCERN IS GREATER WHEN CONSIDERING DRIVERLESS COMMERCIAL VEHICLES

People are uncomfortable with the thought of sharing the roads with driverless commercial vehicles.

- Only one-in-five people are comfortable with the idea of driverless heavy goods vehicles being allowed on our roads.
- Meanwhile, 40% said they would be less inclined to get on board a driverless bus. 37% would be less inclined to use a driverless taxi.
- Even where automation is already widely used, such as trains, the public feels uneasy.
 34% would be less inclined to take a driverless train.
- Those who drive commercial vehicles are among the least supportive (no doubt automation is perceived as a threat to their livelihood). Just 40% of those who drive as part of their day job support driverless vehicles.

SUPPORT FOR AUTOMATION HAS ITS LIMITS

The notion that the driver should be able to take over control of the vehicle is central to the public's concept of what kind of technology they would want to see developed.

- Over two-fifths support the notion that vehicles could in future be allowed to drive on the UK's roads without a human taking control at the steering wheel.
- However, just 4% support moving towards so-called 'Level 5' technology in which the car is always in control with no human override.
- Therefore, some kind of 'handover' function would be a necessary feature in order to maximise public support. This feature needs to be properly explained to help overcome concerns about potential driver confusion.

IMPROVING THE DRIVER EXPERIENCE

Driverless cars seem like an affront to those who enjoy motoring: 40% thought it would make driving less fun. But there are many potential benefits for drivers.

- 65% said driverless cars would result in 'efficiency' benefits, such as knowing which routes are less congested and being able to take the quickest routes.
- 65% thought connected vehicles would be less likely to get lost.
- 61% recognised that this would free up time to do other things.
- 64% liked the car's ability to collect its owner on demand.

SAFER ROADS AND LOWER INSURANCE PREMIUMS

The prospect of fewer road traffic accidents is very real, but there is still a widespread view that humans exercise better judgement than computers.

- Over half of all respondents (51%) believe driverless cars would result in fewer road accidents.
- 63% believe they would reduce the number of road rage incidents.
- 63% expect there to be a drop in motor insurance premiums.
- Concerns for road safety are an important factor among those who do not support driverless vehicles. Six-in-ten are concerned about the dangers posed by driverless vehicles to other road users, such as pedestrians.
- 61% of those who oppose the technology prefer to place their trust in human judgement, even though driver error is currently a major cause of road traffic accidents in the UK.

66 12% of current motorists say they would be less inclined to own their own car. This could mean four million motorists trading their car in. **9**

SOCIAL BENEFITS

Never having to worry about falling asleep at the wheel or being able to drink alcohol and still 'drive' are obvious benefits. But the real social transformation lies in extending social inclusion and independence to Britain's elderly, disabled and rural communities.

- 73% of people thought driverless cars would enable elderly or disabled people to maintain their independence.
- 84% of those who are currently unable to drive due to disability support the introduction of driverless cars. Potentially one million people living with disabilities would become more likely to own their own car.
- The benefits extended to helping make rural communities less reliant on infrequent public transport services. 45% thought driverless vehicles would offer a significant benefit in this respect.

LONG-TERM CHANGES IN MOTORING BEHAVIOURS

It is not just the technology which is set to change. The way Britons own and insure their cars is set to transform dramatically.

- 12% of current motorists say they would be less inclined to own their own car. This could mean four million motorists trading their car in.
- 17% said they would be more inclined to lease their car and replace it regularly to keep up with technology. This could mean five million extra leased vehicles on the UK's roads.
- Currently, almost all motorists rely on fully comprehensive annual renewal insurance policies. However, 17% said they would be less inclined to take out an annual insurance policy, reflecting changing behaviour patterns.

PART 1 BROAD CONTEXT

BROAD CONTEXT: DEVELOPING A NEW FRAMEWORK FOR A DRIVERLESS WORLD

One of the first challenges in adopting fully autonomous vehicles on the UK's roads, centres on creating an appropriate legal framework which addresses the shifting responsibilities from driver to motor manufacturers. A large body of law is already in place including Road Traffic Acts in UK legislation, Motor Insurance Directives in the EU and the United Nation's Conventions on Road Traffic.

Table 1 – Legal framework

UK motor vehicle law: Legal obligations of drivers

Governing law/ standard	Provision/objectives	Scope
Road Traffic Act 1988 (RTA 1988)	Covers use of all vehicles on roads	 Principal road safety provisions (including compliance with The Highway Code) Construction and use of vehicles and equipment Licensing requirements Driving instruction Third-party liabilities: third-party insurance legal minimum
The Highway Code	Prepared by the Department of Transport and Driver & Vehicle Standards Agency to promote road safety	 Information on road signs, road markings, vehicle markings and road safety Vehicle maintenance and security Licence requirements Legal requirements that may be used in court under the RTA 1988 to establish liability
Public Passenger Vehicles Act 1981 (PPVA 1981)	Covers public service vehicles	Fitness of public service vehiclesOperators' licencesRegulation of conduct
Highways Act 1980 (HA 1980)	Covers management and operation of road network in England and Wales	 Creation, maintenance and improvement of highways Enforcement of liabilities Lawful and unlawful interference with highways

Governing law/ standard	Provision/objectives	Scope
Drivers and Vehicle Licensing Agency (DVLA)	Executive agency sponsored by Department for Transport	Enforces driver requirements including: • Vehicle registration • Vehicle tax • Getting an MOT test
The European Communities (Rights against Insurers) Regulations 2002	Confers on residents of EU Members States a right to issue proceedings against the insurer of the person responsible for an accident in the UK	Applies to any claimant who is resident of an EU Member State or of the European Free Trade Association States (Iceland, Norway, Switzerland and Liechtenstein)
Motor Insurance Directive 2009 (MID 2009)	Covers insurance against civil liability in respect of use of motor vehicles and enforcement of obligations to insure against such liability	All motor vehicles in the EU must be covered by compulsory third party insurance to drive in other EU countries
"eCall" Regulation (EU) 2015/17	Requires all new cars be equipped with eCall technology from April 2018	In the event of a serious accident, eCall automatically dials 112 – Europe's single emergency number
Green Card System	An international certificate of insurance to facilitate movement of vehicles across international borders and to protect victims of accidents involving foreign registered vehicles	 Responsibility rests with Motor Insurance Bureau Provides visiting motorists the minimum compulsory insurance cover required by the law of the country visited Comprises 47 countries including the EU, EEA, Switzerland, Russia and the Middle East
Geneva Convention on Road Traffic 1949	Promotes development and safety of international road traffic. Signed and ratified by the UK	 Rules of the road / signs and signals Provisions applicable to motor vehicles and trailers Drivers of motor vehicles in international traffic Definitions of motor vehicle (and cycle) Technical conditions concerning the equipment of motor vehicles
Vienna Convention on Road Traffic 1968	Designed to increase road safety through standard traffic rules among contracting parties. Signed but not ratified by the UK	 Cross-border vehicles Technical requirements for legal road use Minimum mechanical and safety equipment requirements Contracting parties

The first Road Traffic Act was introduced in the UK in 1930 which created much of the legal framework motorists would recognise today. Notably, this legislation addressed the issue of road safety and the need to create a more robust liability framework for regulating the use of road vehicles. This lead to the introduction of the Highway Code, the introduction of driving offences such as dangerous, reckless and careless driving, as well as the introduction of compulsory third-party insurance which transferred onto the insurer the duty to defend, indemnify and settle claims relating to their policyholders.

International conventions on transit transport have also influenced the domestic picture – aiming to facilitate international transport while providing for high levels of safety, security and environmental protection in transport. The process of legal reform has continued to evolve with each generation of new vehicle technology. The advent of driverless technology brings with it a set of new challenges, requiring a fresh examination of the legal framework, not just in terms of UK legislation but also in terms of European and global standards. If the cars of the future can communicate with each other, and drive themselves, then they will need to speak in a common language with standardised protocols for determining how vehicles respond not just to each other, but also to other road users. This requires enhanced cooperation between a range of parties.

Stakeholder	Implications
Motor manufacturers	Manufacturers will need to work together to ensure that every make and model utilises interoperable technology in which each vehicle can communicate with each other and anticipate how other vehicles and other road users behave in each circumstance. This will require coordination of activities across the supply chain including IT suppliers, who may also be retrofitting technology onto existing vehicles, and data storage companies, who will be hosting vast amounts of additional data.
Motor insurers	Motor manufacturers and motor insurers will need to cooperate to address implications for changes in liability with the development of new product liability and professional indemnity insurance to address the increasingly significant role of computer programmers in keeping our roads safe.
Governmental	The framework for facilitating international road traffic will require updating both at the European level as well as the United Nations Convention on Road Traffic. Governments will need to create internationally consistent ground rules in which the technology can be safely developed.





THE VEHICLE TRANSPORT AND AVIATION BILL

In an important milestone in this journey, the UK government introduced the Vehicle Transport and Aviation Bill in 2017 to address some of the new challenges posed by autonomous vehicles. Part 1 of the Bill highlighted the issues around the liability framework emerging from a road environment in which cars, rather than humans, would become more responsible for ensuring road safety. The Bill fell short of a complete overhaul of the liability framework – for example, it did not include product liability issues with the government arguing that the legislation should not seek to pre-empt the development of the technology – but it did deal with a variety of other issues including:

- Liabilities facing insurers in the event of accidents caused by automated vehicles.
- Contributory negligence.
- Accidents resulting from unauthorised alterations or failure to update software.
- The right of insurers to claim against a person responsible for an accident.

The legislative programme as outlined in the Queen's Speech on 21 June 2017 includes the Automated and Electric Vehicles Bill. While the detail of the Bill is awaited, the purpose – as before – is to address the changing motor liability framework. The Bill "will extend compulsory motor vehicle insurance to cover the use of automated vehicles, to ensure that compensation claims continue to be paid quickly, fairly, and easily, in line with longstanding insurance practice".

THE UN CONVENTION ON ROAD TRAFFIC

Beyond UK legislation, there is a wider global context. The UN Convention on Road Traffic, concluded in Geneva in 1949, created uniform rules to improve road safety in international road traffic. However, when viewed from the perspective of autonomous vehicle technology – which was not anticipated in 1949 (nor in 1968 when the Convention was updated) – there are issues surrounding the definition of basic legal terms and the limited degree of global participation.

Definition	Computers are already capable of achieving the requirements on driver behaviour set out in the articles of the Geneva Convention, however, there is a more fundamental issue. Article 8.1 stipulates that every vehicle shall have a driver. Article 8.5 goes on to require that "drivers shall at all times be able to control their vehicles". However, the agreement does not define the term 'driver'. The definition of 'driver' was clearly intended to refer to human control in the context of technology available in 1948. But in an era of driverless cars, who or what is the driver?
Participation	A further issue with global standards is highlighted by the subsequent Convention of Road Traffic (commonly known as the Vienna Convention) which was concluded in 1968. With only 36 signatories to the agreement, many of the world's major markets have not signed up – this includes the US, Canada, India, China and Australia. The UK has signed the Convention but has not ratified it; yet abides by its principles. A much more comprehensive global approach will be required to encourage cross- border cooperation in the area of driverless vehicles.
Driverless vehicles	The Vienna Convention has been updated to accommodate automated vehicle technologies. As of 23 March 2016, technologies transferring driving tasks to the vehicle will be explicitly allowed in traffic, provided that these technologies conform with the United Nations vehicle regulations or can be overridden or switched off by the driver.



PART 2 MEASURING PUBLIC SUPPORT FOR AUTONOMOUS VEHICLES

PUBLIC SUPPORT FOR THE USE OF DRIVERLESS VEHICLES

The UK government has set a clear goal to position the UK as a global leader in the development and adoption of driverless vehicle technology. In its Autumn Statement in 2016, the government announced a funding package worth £391 million to support, among other innovations, the development of connected and autonomous vehicles. The funds will be used for several pilot projects which aim to develop the technology further. But before any government can consider the widespread adoption of driverless vehicles on the UK's roads, consideration will need to be given to the views of the general public, the extent to which they support the new technology, and the subsequent requirement to build a broad consensus in favour of change.

As we have seen with previous technological innovations, such as genetically modified foods (so-called GM foods) the failure to first explain the benefits of such technology and secure public support, can have a profound impact on the long-term adoption of new technology. The public debate around GM foods was dictated by often unfounded concerns about "Frankenstein foods" with the public perception that GM food posed a threat not only to public health but also to the environment. The debate around driverless cars should aim from the outset to be based on a rational understanding of both the costs and benefits.

Overall, the UK public does not currently have a consensus in favour of change.

London is the only UK region where a majority support the use of driverless vehicles. However, there are marked variations in support among different groups. Men, those living in built up urban areas, and – perhaps most notably – those who are currently prevented from driving on grounds of ill health or disability, are among the groups most likely to support driverless cars. The views of people living with disabilities are explored in detail later in Part 3 of this report.

Chart 1 – Only a minority of people support the use of driverless vehicles on the UK's roads

44% of UK adults favour the use of driverless cars on UK roads

49% of men are supportive, falling to 39 percent among women

84% of those unable to drive due to disability are supportive





Groups of motorists who use their cars more are also more receptive to using driverless car technology.

With commercial fleet operators potentially on the fast track to adopting driverless vehicles, it is notable that support falls among commercial drivers – those people who drive a vehicle as part of their working day – from an overall national average of 44% to 40% – reflecting a potential concern that their jobs could be put at risk in an age of driverless vehicles.

PLANES, TRAINS OR AUTOMOBILES: WHICH TYPES OF VEHICLES WOULD BE MOST APPROPRIATE FOR THE DEVELOPMENT OF DRIVERLESS TECHNOLOGY?

Moving beyond the broad concept, the context in which the technology is being applied makes a difference to whether people feel comfortable or uncomfortable about driverless vehicles. When it comes to different modes of road transport, the public are more likely to feel comfortable in using driverless vehicles in the context of their own car rather than the various forms of mass public transport.

Half (51%) feel very or somewhat uncomfortable about using driverless technology on railways.

Table 2 – Support is greater among those with higher mileage

Supportive groups	Mileage
Men	Drive nearly 3,000 miles more than women annually
Young people	Drive over 3,000 miles more than those over the age of 55
Londoners	Drive on average more than 2,500 miles in excess of those in Northern Ireland – the least supportive region

Table 3 – Driverless road vehicles

PRIVATE



27%

would feel very or somewhat comfortable in allowing people to possess their own driverless car.

PUBLIC/COMMERCIAL



Public comfort falls to 18% when people were asked to consider whether the technology should be allowed on buses. 40% said that they would be less inclined to use a bus company which used driverless vehicles.



20%

would feel very or somewhat comfortable with the use of this technology to allow commercial road vehicles such as Heavy Goods Vehicles (HGVs) to operate in platoons where chains of lorries are controlled by the lead vehicle.



of the public would feel very or somewhat comfortable with the idea of using driverless cars for taxi services.

Table 4 – Public views on other forms of transport

AVIATION



People feel much less comfortable with the notion of pilotless or 'drone' technology. This technology is advancing rapidly with the announcement of planned 'sky taxi' services using driverless drones in Dubai as early as this year⁵. However, the level of public discomfort remains high when considering any pilotless craft intended for civilian passengers. 56% of the British public would feel 'very uncomfortable' in allowing civil aviation to make use of pilotless aircraft. This falls to just 33% who would feel likewise if delivery companies could make use of drones to make their deliveries.

RAIL

Surprisingly, half (51%) feel very or somewhat uncomfortable about using driverless technology on railways, even though numerous light rail systems have been making use of driverless vehicles for decades. For example, the Victoria Line on London's Underground has been using Automatic Train Operation or ATO systems since it opened in 1967. London's Docklands Light Railway (DLR) has been using a Grade of Automation Level 3 (in which the trains run automatically but with a staff member located on the train) since it first opened in 1987. However, 34% said that they would be less inclined to use a train if it did not have a driver.

⁵Wall Street Journal website, 15 February 2017

Chart 3 – Most people feel uncomfortable with driverless vehicles – more so with planes and ships

If driverless vehicles were to be introduced more broadly, how comfortable would you feel if each of the following were allowed? Please rank your responses on a scale of 1-5 where 5 equals 'very comfortable' and 1 equals 'not comfortable at all'.



Allowing delivery companies (e.g. Amazon) to use drones to deliver parcels to your front door

Allowing you to possess your own driverless car

Allowing train companies (e.g. Virgin or First Trains) to operate driverless trains

> Allowing taxi companies (e.g. Uber) to operate driverless taxis

Allowing vehicles (HGVs) to travel in platoons where the lead vehicle is able to control the following vehicles using driverless technology Allowing bus companies (e.g. National Express or

Stagecoach) to operate driverless buses

Allowing shipping or ferry companies to operate boats without a captain

Allowing airlines (e.g. British Airways or Easyjet) to operate pilotless aircraft

Is there a technological threshold beyond which the public's appetite for further automation becomes exhausted? Or is it the case that the public remains open minded about the benefits of such technology even in a world where fully autonomous vehicles become part of the road environment?

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PART 3 DEFINING AUTONOMOUS VEHICLES What is an appropriate level of automation?

Before we explore the issue in further detail it is important to first understand what we mean by autonomous vehicles. The terms "driverless" and "autonomous" are often used interchangeably. However, not all levels of autonomy, involve the driver giving up full control of the vehicle. For example, low levels of autonomy such as cruise control or assisted parking, will still involve the driver being in control of the vehicle. A classification system was developed by the Society of Automotive Engineers (also known as SAE International) based on six levels of automation ranging from none to fully automated systems. The SAE classifications are reproduced below.

LEVEL	CHARACTERISTICS
0	Automated system issues warnings but has no vehicle control.
1	Driver and automated system shares control over the vehicle. Examples would include Adaptive Cruise Control (ACC) – where the driver controls steering and the automated system controls speed – and Parking Assistance – where steering is automated while speed is manual.
2	The automated system takes full control of the vehicle (accelerating, braking, and steering). The driver must monitor the driving and be prepared to immediately intervene at any time if the automated system fails to respond properly.
3	The vehicle will handle situations that call for an immediate response, like emergency braking. The driver must still be prepared to intervene within some limited time, specified by the manufacturer, when called upon by the vehicle to do so.
4	No driver attention is ever required for safety. Self-driving is supported only in limited areas (geofenced) under special circumstances, like traffic jams. Outside of these areas or circumstances, the vehicle must be able to safely abort the trip, i.e. park the car, if the driver does not retake control.
5	No human intervention is required.

Table 5 – Classification of autonomous vehicle technology

66 The protocols required for ensuring safe handover between vehicle on-board computers and the driver remain a key area in the development of future technologies.

As more of the vehicle's controls are handed from the driver to the on-board computer, this has implications for the driver-vehicle relationship. Where we use the term "driverless" vehicle in this report, we are referring narrowly to those more advanced stages of autonomy at Levels 3 and beyond (this degree of autonomy has yet to be introduced on the UK's roads).

It is important to understand the varying levels of public support for each stage of automation. Is there a technological threshold beyond which the public's appetite for further automation becomes exhausted or is it the case that the public remains open minded about the benefits of such technology even in a world where fully autonomous vehicles become part of the road environment?

There is very little support among the public for the concept of fully automated vehicles where the car is always in control. Within the 44% of people who supported further automation, just 4% would support moving towards Level 5 technology in which the car is always in control.

The rest are split evenly between those who think that the driver should be able to take back control with the car driving itself only in lowrisk conditions like being on a motorway or in less challenging driving conditions, and those that think that the car should be able to drive itself in all conditions, but with the driver being able to take back control whenever they want.. This means that to maximise public support, any technological solution must provide a mixed approach in which the car can either be controlled by the driver or the on-board computer depending on the driving conditions.

Interestingly, among those who do not support further advances in driverless technology, one-third thought that we have already gone far enough with today's level of technology (for example, utilising assisted parking or cruise control) and 11% thought that we had already gone too far.

Chart 4 – There is an even split between those wishing to go further and those who think we have already gone far enough

Cars should be able to drive themselves and there should be **ENOUGH / TOO FAR** 12 no possibility of human override. Total (44%) 21 Cars should be able to drive 11 Male (39%) themselves in all conditions -Female (49%) but humans should be able to override when they need/want. 18-24 (38%) Cars should be able to drive 25-34 (36%) themselves, but only in low-risk 19 35-44 (44%) situations 33 45-54 (46%) The current level of automation 55+(48%) is as far as we should go. The current level of automation Prevented from driving already goes too far. on health/disability Don't know. grounds (49%)

To what extent should the vehicles on Britain's roads be automated? Please tick one only.

Chart 5 – Support for autonomous vehicles stresses the need for driver input

Some driverless technologies could involve a variable degree of autonomy in which control of the vehicle could switch between the driver and the on-board computer depending on the circumstances. For example, if the weather conditions become hazardous, the on-board computer could hand over control of the vehicle to the driver. Do you support the need for motorists to be able to take control of the vehicle?

82% OF OUR ENTIRE SAMPLE SUPPORTED THE NEED FOR MOTORISTS TO BE ABLE TO TAKE CONTROL OF THE VEHICLE

With wider communications about the benefits of driverless technology it would seem possible to build public support for a move towards Level 3 or Level 4 automation.

However, when considering Level 5 technology, the idea that the driver should be able to take over the control of the vehicle seems to be quite central to the public's concept of what kind of technology they would want to see developed. The protocols required for ensuring safe handover between vehicle on-board computers and the driver remain a key area in the development of future technologies. This is an issue which is recognised by the UK public. Among those who did not support handover features, numerous concerns were cited about how the technology would work in practice. Thirty-nine percent thought that switching control between driver and computer might lead to confusion and cause more accidents on the roads. It is also recognised that the driver might not be fit to take control of the vehicle when the need arises. For example, 36% were concerned that drivers might be forced to take control when they are under the influence of alcohol. In which case, to do so might involve breaking the law if their blood alcohol levels are over the permitted limit. If blood alcohol levels are above the legal limit this could mean impaired reflexes, reaction times or concentration, which would all present a danger to road safety.

Chart 6 – Driver confusion is the biggest public concern when considering hand back features

You mentioned that you are not sure about, or do not support the use of technology which allows control of a vehicle to switch between the on-board computer and the driver. What would you say are your main concerns?



Chart 7 – Automated voice systems are the preferred warning systems

If cars were fitted with a feature which allowed the driver to take control of the vehicle in certain circumstances, which of the following early warning systems do you think motor manufacturers should use to alert drivers in advance?



'HANDOVER' PROCEDURES: EARLY WARNING SYSTEMS FOR MOTORISTS

For those levels of automation which permit the vehicle to 'hand back' control to the driver, there will need to be standard protocols governing how this hand back process operates, including warning systems alerting the driver's attention in advance.

We asked the public which kind of system they would find more useful in alerting them to the fact that the car's on-board computer was about to hand back control to the driver. Each of these systems rely on one of three different senses: touch, sight and sound.

- Systems which were based on the latter of these (sound) were the most popular overall. An automated voice signalling to the driver to take control was the single most popular option (63%) followed by a bleeping sound (55%).
- Visual warnings such as a flashing light on the dashboard were the next most popular (46%).
- Least popular were those systems which relied on touch such as a vibrating sensation in the driver's seat (30%) or a vibration in the steering wheel (27%).

'HANDOVER' CONCERNS – APPORTIONING LIABILITY

Public concerns relating to the use of handover technology extend to efforts by insurers and law enforcement agencies to ascertain liability in the case of accidents. In a chain of decision-making in which both computer and driver are potentially involved at different stages, it would not always be possible to tell who took which decisions in the critical moments in the lead up to the accident. This was a view among those who did not support Level 3 and Level 4 technology:

- 24% said that it would not be clear who was at fault – driver or car – at the critical moment that led to an accident.
- The same number of people (24%) also thought that it would be harder for insurers and the police to prove who was in control of the vehicle at the critical moment.



PART 4 THE IMPACT OF DRIVERLESS VEHICLES

UNDERSTANDING THE BENEFITS OF DRIVERLESS CARS

In the absence (to date) of a wide-ranging public debate, large parts of the British public still do not understand the full impact of autonomous vehicles. The key to addressing this issue will be answering the age-old question with any innovation: what problem is it trying to solve? It is clear from the findings in Chart 8 below that several key benefits are acknowledged by the public. These include design features which will make motoring easier, such as cars being able to park themselves (although assisted parking is already a feature on many road vehicles) and the ability for elderly and disabled people to maintain their independence.

Chart 8 – Major benefits focus on making motoring easier, with potential for improving inclusion among key social groups

Imagine a future where driverless cars are widely available and it is possible for people to get from 'A' to 'B' in their own car without having to be in control at the steering wheel. What do you think are the potential benefits of this? Please rank your responses on a scale of 1 to 3, where 1 equals no benefit at all, and 3 equals a significant benefit.

	10% 1 3	3%	29%		48%			
	13%	15%	23%		50%			
	12%	17%	26%	, D	45%			
	13%	23%		26%		389	6	
	17%	18%		27%	38%			
	17%	18%		26%	39%			
	16%	20%		27%	37%			
	18%	20%		27%	7% 35%			
	21%	21% 17%		22%		40%	6	
	15%	24%		28	%	3	33%	
	25%		20%		21%	3	4%	
	19%		30%		21%		29%	
		40%		259	%	18%	18%	
0%		20%	40%		60%	80%	þ	100%
	Don't know	1 – n	o benefit	2 – so	me benefit	3 – signifi	cant benefit	

congested route The car wouldn't get lost Car can collect you on demand People wouldn't get road rage Cost of insurance would come down Frees up time for other things There would be few road accidents People can drink alcohol and go home in their own car Would argue less with partner/ spouse about driving

The car can park itself

independence

transport

Elderly/disabled people can maintain

Rural communities less reliant on public

People can drive when tired/unwell The car would know quickest/less

GREATER INDEPENDENCE FOR PEOPLE LIVING WITH DISABILITIES

One problem where driverless cars can provide a major solution is in relation to people living with disabilities. The public acknowledge the benefits of such technology in extending the level of economic and social independence to those groups who are currently excluded from motoring on grounds of ill-health and disability.

- 73% of respondents thought that enabling disabled people to maintain their independence would result in 'some' or 'significant' benefits. This view was reflected among those living with disabilities.
- Among those who are currently prevented from driving due to ill-health or disability, 84% said that they would support the use of driverless vehicles in the UK (compared to just 44% of all respondents).
- In our survey, around 7% said that they were unable to drive because of ill-health or disability. This equals around 3.5 million adults living in the UK. These people are, at present, potentially excluded from leading a fully independent lifestyle in which they are integrated into mainstream society.
- With the advent of driverless cars, as many as 28% of these people said that they would be more inclined to own or lease their own car. This represents a potential market of nearly one million additional motorists who live with a disability. Many of these new motorists will have particular needs which would require further adaptations to their vehicle.

Driverless car technology can, by its very design, reduce the need for special adaptations for disabled users, such as the need for hand controls to operate the accelerator and brake, or the need for a steering wheel knob to help the driver to turn the wheel and allow easier control of the vehicle. But not all adaptations will be addressed by autonomous vehicles which means we are likely to see an increase in demand for vehicles which require adapted mirrors, safety belts or harnesses, or rotating seats which allow people to get in and out more easily. Motor manufacturers should not therefore see the development of autonomous technology in isolation. Rather, they need to anticipate how the adoption of driverless cars will potentially impact on the physical and mental capabilities of the car's owner, and respond by designing more adaptable cars which benefit the disabled motorist.

IMPROVED FUEL AND TIME EFFICIENCIES

Efficiency is one of the main arguments in favour of the adoption of driverless technology. Fully connected and autonomous vehicles will be able to work out, before they begin each journey, what the least congested route looks like, how to locate the nearest available parking space, and the optimal speed at which to maximise their fuel efficiency. This will save the motorist from having to sit in lengthy traffic jams, saving time, fuel costs and reducing stress levels.

- 65% said that driverless cars would result in 'some' or 'significant' benefits as a result of cars knowing which routes are less congested and being able to take the quickest routes. As an extension of this theme, 65% also thought that connected vehicles would be less likely to get lost. 61% recognised that this would free up time to do other things.
- The car's ability to collect its owner on demand was seen as a benefit by 64%.
- Driverless technology could also help to take some of the stress out of driving, presumably because people felt they would be less likely to take a wrong turning or end up sitting in traffic jams. 63% thought that it would potentially help to reduce the number of road rage incidents while a further 36% thought it would result in fewer marital arguments about a spouse's driving ability.

IMPROVED ROAD SAFETY AND REDUCTIONS IN MOTOR INSURANCE PREMIUMS

Computer programmes should in theory help to eliminate human driver error which in turn will help to improve road safety and reduce the number of deaths and accidents on the roads. It sounds obvious, but computer programmes do not get tired and fall asleep at the wheel on long journeys. They could be programmed not to take unnecessary risks such as tailgating on motorways or breaking the speed limit in urban areas.

 Over half of all respondents (54%) accepted that driverless cars would result in fewer road accidents.

It follows that if the roads are safer with fewer accidents, this should result in fewer insurance claims and lower premiums. In the short-term, insurance premiums may have to rise as insurers will be pricing policies based on technology with no past claims data to help them to assess the risks. A sizeable number of those people who are against the use of driverless cars cited concerns about the increase in insurance premiums. However, as the claims data materialises over time, we should see premiums fall over the medium to long term, a view supported by a sizeable number of respondents.

- 40% believe that lower insurance premiums would form one of the 'significant' benefits of adopting driverless cars.
- A further 22% thought that there would be 'some' benefits felt in this area.

FUTURE DRIVER BEHAVIOURS: CHANGING PATTERNS OF CAR OWNERSHIP AND INSURANCE NEEDS

Of course, what benefits actually materialise will depend to some extent on any changes in behaviour among UK motorists: will UK motorists behave differently in a driverless vehicle environment? What changes can we potentially expect to witness in terms of patterns of car ownership? Will people choose to own or access vehicles and how will they insure them?

Changing patterns of car ownership:

- 16% of current motorists say that they would be less inclined to own their own car.
- With 36 million people in the UK owning their own car this could see as many as four million motorists trading their car in.
- 17% said that they would be more inclined to lease their car and replace it regularly to keep up with the new technology as it evolves. We found that it is the younger drivers (those aged under 35) who are more likely to feel this way.
- Based on the current car owning population this could mean a growth of more than five million leased vehicles on the UK's roads.

6 Among those who are currently prevented from driving due to ill-health or disability, 84% said that they would support the use of driverless vehicles in the UK (compared to just 44% of all respondents).

Changing patterns of insurance cover:

- The changes in patterns of ownership are likely to have a knock-on effect in the sorts of insurance products motorists are likely to take out. Currently, the overwhelming majority of motorists rely on fully comprehensive annual renewal insurance policies. This accounts for over 90% of UK motorists who pay an average premium of around £320 per year.
- This figure increases among those aged 18-24 years old and those living in built-up urban areas. The data also reveals that it is these groups of motorists who are the most likely to change their behaviours in terms of car ownership and car insurance in the event of driverless cars.
- Overall, 17% said that they would be less inclined to take out an annual insurance policy indicating that they would expect their needs to shift, in line with changing patterns of ownership.
- As people become less likely to own their own car, we could see more people hiring cars when they need them which would be reflected in an increase in insurance ondemand products. 13% said that they would be more likely to use a car sharing service like Zip Car.
- It is the youngest drivers who are most likely to make a change: 18% of those aged 18-24 would consider taking out insurance ondemand while 17% percent would be more likely to use car-sharing services.

66 17% said that they would be less inclined to take out an annual insurance policy. **9**

Chart 9 – Most people currently buy fully comprehensive cover, but on-demand insurance would be set to increase with driverless cars



Which of the following car insurance products do you currently own or have you used?



PART 5 POTENTIAL OBSTACLES TO ADOPTING DRIVERLESS VEHICLES

WHY DON'T PEOPLE ACCEPT DRIVERLESS TECHNOLOGY

While there are clearly many benefits to be derived from adopting a greater degree of automation in road and other forms of transport, the fact remains that at the present time, less than a majority of UK citizens support the idea. The government, working with other stakeholders, need to invest time and resources and communications are required to convince a still somewhat sceptical public.

Chart 10 – Road safety concerns top the list among those who do not support greater automation

Why do you not support the use of driverless vehicles in the UK?





CONCERNS ABOUT ROAD SAFETY – ARE THEY WELL-FOUNDED?

The reasons why people do not support the use of the technology are diverse but many focus on the fundamental issue of road safety and the lack of trust in computers to control vehicles in a safe manner.

- 61% of those who oppose the technology prefer to place their trust in human judgement.
- Over half of respondents are concerned about the risks to other road vehicles, but this concern increased to six-in-ten when it comes to the dangers posed to other road users such as pedestrians and animals.

These concerns reveal a lack of awareness about the potential impact of driverless technology in potentially improving safety on our roads.

The UK already has a good record on road safety with the number of fatalities having fallen by 46% between 2005 and 2015. The number of people who are seriously injured fell by 24% during the same period. However, this still resulted in 1,732 deaths on the roads in 2015 and nearly 29,000 people who were seriously injured⁶. There was a 2% increase in the number of road deaths in 2016⁷. Driverless cars could help to maintain this downward trend. All five of the major causes of road traffic accidents in the UK are related to errors in human judgement.

Driverless technology could help to address most of these causes by taking the decisions out of human hands. For example, on-board computers would not suffer with impaired judgement relating to fatigue and tiredness, drug or alcohol misuse. Nor would they 'lose their cool' in incidents of road rage and they would not be distracted by the radio, mobile phones or other passengers.

FOR THE LOVE OF DRIVING

Another concern, which is probably harder to address, is the impact the technology would have on breaking the psychological link between driver and car. For a large minority (40%) there is a concern that driverless cars would take the fun out of driving. These people argued that they enjoy being behind the wheel of a car and in control. They do not want to have a computer doing the driving for them. Clearly, for these people the art of driving is more important than the convenience of being able to sit back and relax while the car does all the hard work. In a potentially related point, 39% of those who oppose the technology believe that there is already too much technology on cars.

DATA PROTECTION – COMPUTER HACKING IS THE MAIN THREAT

Overall, just one-quarter (24%) of those who opposed the technology did so on grounds of data protection concerns. However, when we delved into this subject in more detail, we revealed that the concerns about data collection, storage and usage runs deeply. Obviously, computer programmes can be subjected to cyber attacks. This means that any vehicle could have its on-board systems compromised and control of the vehicle could be taken over remotely with the potential to cause accidents or deaths on the roads. Sixty one percent of respondents were extremely concerned that data breaches could result in accidents on the roads.

Hackers could also potentially breach computer programmes to steal vehicles remotely. Nearly two-thirds of respondents (64%) viewed this possibility as 'extremely' concerning.

Secondary concerns focussed on how the data would potentially be used. Many saw the potential for 'big brother' surveillance, with half (50%) being extremely concerned that the government could insist on motor manufacturers handing over the data without the driver's permission. Over a third (35%) thought that this could also result in the data being passed to the law enforcement agencies.

⁶ Department of Transport, reported road casualties in Great Britain, 2015

⁷ Department of Transport, reported road casualties in Great Britain, 2016, 2 February 2017

Contributory factors reported in accident – % of all accidents			
1	Failing to look properly – 35%		
2	Failing to judge another person's path or speed – 19%		
3	Driving in a careless or reckless manner – 16%		
3	Losing control – 15%		
5	Poor turn or manoeuvre – 14%		

Table 6 – The five major causes of UK road traffic accidents

Chart 11 – Ensuring data security is a significant challenge

Driverless cars will be capable of collecting, storing and transmitting much larger amounts of data compared to existing cars. To what extent would you be concerned about the following data issues?



66 The concerns about data collection, storage and usage runs deeply. **99**

RECOMMENDATIONS

Realising the government's pledge to make the UK a world leader in new vehicle technologies, such as driverless cars, will require a collaborative approach between government agencies, the private sector and end-users. Only by working together can barriers be removed from companies in testing and adopting the technology on the UK's roads. Below we set out some of the issues each of the stakeholders will need to consider when promoting driverless vehicles.

GOVERNMENT

- The starting point in the development of connected and autonomous vehicle technology will be to recognise the need for a clearer liability framework. The government should therefore update UK legislation by reintroducing the Vehicle Transport and Aviation Bill, which begins to address the issue of insuring driverless cars involved in road traffic accidents.
- The UK government needs to continue to work in collaboration with the EU and the UN to develop common standards where possible to ensure that new technologies are developed consistently between different motor manufacturers and between different jurisdictions.
- In parallel with any legal changes, the government must undertake a wide-ranging public awareness campaign around the perceived benefits of the new technology. The public often fail to appreciate the potential for improved road safety and a reduction in the number of accidents and road deaths. Building greater awareness and public support will be essential in ensuring that the technology is quickly adopted.



- The UK also needs to strongly consider the need for a broader and more inclusive process of public consultation around what type of technology is required to ensure that the voice of the end-users is heard when developing a new legal framework.
- The government could also take more of a leadership role in helping to facilitate greater collaboration between stakeholders, by building greater communications between motor manufacturers, technology firms, motor insurers and end-user groups to help define what consumer needs look like and how best to address those needs through a set of common standards around driver behaviour and vehicle communications.
- A longer-term objective will be to work with all stakeholders in the development of new road infrastructure including new road layout, changes to junctions and slip roads, new road signage and any amendments to the Highway Code, all of which will be required to support the roll out of driverless vehicles. This also needs to be reflected in updated theory tests for all new drivers sitting their driving test.

MOTOR MANUFACTURER

All manufacturers need to:

- Work collaboratively to develop common standards governing driver and vehicle behaviour and vehicle communications. The potential danger of a fragmented approach between manufacturers operating in different jurisdictions needs to be avoided at all costs.
- Consult widely with motorists around the implications arising from Level 3 and Level 4 automated vehicles and the consequences for any move towards fully automated vehicles (Level 5). This needs to reflect that public support for Level 5 automation is currently very low.

- Consider the need for additional driver awareness and training when rolling out the next generation of autonomous vehicles. All motorists purchasing an automated vehicle (Level 3 or beyond) will need to be issued with documents setting out the key features of vehicle behaviour and communications with point-of-sale training or orientation offered to motorists covering the automated vehicle safety and driver assist features.
- Communicate to customers about the importance of data protection setting out what data is likely to be collected, how it will be stored securely, and who will be able to access that information and for what purposes.
- Data management will also be a critical issue in the new driverless vehicles environment. Manufacturers will need to anticipate the rapid increase in data collection and storage and should look to create an industry-wide data bank to demonstrate what impact the technology is having. It would be beneficial to share this data with government agencies and insurers.

MOTOR INSURER

Insurers need to:

- Get fully involved in efforts to develop the new technology to help them better understand the changing profile of risk when insuring the new vehicles and the impact on premium levels and pricing models.
- Commission their own end-user research to fully understand the likely changing patterns of car ownership and its consequential impact on consumer demand for distinct types of insurance cover.

Product development teams will need to:

- Develop new types of policies which will reflect the changes in customer behaviours. This might also result in motorists buying motor insurance in different ways, for example, insurance could become more of an ancillary sale aligned with the sale of new cars. Insurers need to anticipate the changing relationship between themselves and motor manufacturers.
- Educate existing customers about the new types of technology coming onto the market and how that is likely to impact on vehicle safety and insurance premiums.

66 Only by working together can barriers be removed from companies in testing and adopting the technology on the UK's roads.



GLOSSARY

Adaptive cruise control: Also called autonomous cruise control or traffic-aware cruise control – is an optional cruise control system for road vehicles that automatically adjusts the vehicle speed to maintain a safe distance from vehicles ahead.

Assisted parking: An autonomous car-maneuvering system that moves a vehicle from a traffic lane into a parking spot to perform parallel, perpendicular or angle parking.

Automatic Train Operation or 'ATO': An operational safety enhancement device used to help automate operations of trains. Mainly, it is used on automated guideway transits and rapid transit systems which are easier to ensure safety of humans. Most systems elect to maintain a driver (train operator) to mitigate risks associated with failures or emergencies.

Autonomous vehicle: Also known as a driverless car (or auto, self-driving and robotic car) is a vehicle that is capable of sensing its environment and navigating without human input. Autonomous cars use a variety of techniques to detect their surroundings, such as radar, laser light, GPS, odometry and computer vision.

Connected vehicle: A connected vehicle is a car that is equipped with Internet access, and usually also with a wireless local area network. This allows the car to share internet access with other devices both inside as well as outside the vehicle to provide driver assistance to improve safety, vehicle and mobility management and in-vehicle entertainment. Part of the growing Internet of Things or IoT (see below).

Driverless vehicle: These included any vehicle where no human intervention is required and any vehicle where advanced stages of autonomy have been implemented. In the case of the latter, specialist driving conditions (e.g. emergency breaking, traffic jams) may result in control being handed back to the human driver.

Driverless train operation or 'DTO':

An autonomous system where starting and stopping are automated but a train attendant operates the doors and drives the train in case of emergencies.

Fully comprehensive motor insurance: The highest level of cover a person can have if they take out motor insurance in the UK. By taking out fully comprehensive cover, people are not only covered for third party claims after an incident, they are also covered for damage caused to their own vehicle.

Geofencing: The use of GPS or RFID technology to create a virtual geographic boundary, enabling software to trigger a response when a mobile device enters or leaves a particular area.

Grade of Automation or 'GoA': According to the International Association of Public Transport (UITP), there are five grades of automation of trains ranging from manual train operation where a train driver controls starting and stopping, operation of doors and handling of emergencies or sudden diversions, through to unattended train operation or 'UTO'.

'Handover': The process by which control over a given vehicle is switched between a human driver and an on-board computer.

Internet of Things or IoT: The connection of devices (other than typical fare such as computers and smartphones) to the Internet. Cars, kitchen appliances and even heart monitors can all be connected through the IoT.

Motor Insurance Directives: The body of EU law pertaining to single market (crossborder) aspects of road traffic, road safety and motor insurance ensuring that road traffic legislation within the EU supports the principles of free movement of people, goods and services.

On-demand motor insurance: Also referred to as 'pay-as-you-go' or temporary insurance policies. Rather than buying an annual policy these policies allow motorists to purchase short-term cover as and when they need it with policies providing cover from as little as one hour up to 30 days.

Classification of autonomous vehicles: An internationally agreed system that measures the level of automation installed in a vehicle (i.e. the level of control an on-board computer has over the vehicle). Ranging from none (Level O) through to fully-automated (Level 5).

Third Party, fire and theft motor insurance: The minimum level of motor insurance cover required by law in the UK. Third party policies cover the driver against costs that arise as a result of injuries or death of people, damage to other people's vehicles, damage caused to their vehicle by fire or the theft of their vehicle.

UK Road Traffic Acts: The body of traffic laws setting out the legal obligations on motorists with regards to ensuring road safety, ownership and insurance of road vehicles. This includes the creation of the Highway Code, speed limits, the requirement to register ownership of a vehicle, the introduction of statutory insurance and the penalties for committing driving offences.

Unattended train operation or 'UTO': An autonomous system where starting and stopping, operation of doors and handling of emergencies are fully automated without any on-train staff.

UN Conventions on Road Traffic: An international treaty designed to facilitate international road traffic and to increase safety by establishing standard traffic rules among the contracting parties. The first convention was agreed in Geneva in 1949 which has been accompanied with a number of additional road traffic conventions including the Vienna Convention agreed in 1968.

Vehicle Transport and Aviation Bill: A Parliamentary Bill introduced in the UK in 2017. Part 1 of the Bill makes the necessary legal reforms to the UK's liability framework to encourage the development and adoption of autonomous vehicle technology on the UK's roads.

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Disclaimer

This report does not represent the views of Kennedys Law LLP. The report is based on a survey with a sample of 1,000 UK adults commissioned by Cicero Research between 18 and 20 April 2017. The report attempts to present a balanced analysis based on the surveys conducted. Kennedys Law LLP is not aligned with any campaign group.



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