Department for Transport

The Pathway to Driverless Cars: A detailed review of regulations for automated vehicle technologies

February 2015

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Foreword

Driverless vehicle technology has the potential to be a real game changer on the UK's roads, altering the face of motoring in the most fundamental of ways and delivering major benefits for road safety, social inclusion, emissions and congestion.

The UK is already a world leading centre for vehicle research and technology. We have some of the best innovators, engineers, facilities and opportunities for automotive investment in the world.

This review concludes that our legal and regulatory framework is not a barrier to the testing of automated vehicles on public roads. This creates a tremendous opportunity for the whole country to share in shaping the future of these exciting developments and the Government, working with the devolved administrations, wants to play its part in making that happen. I believe we have one of the most welcoming regulatory environments for development of this technology anywhere in the world.

This document lays out the Government's plans to facilitate the testing and production of vehicles in which the driver can choose to use their travel time in ways that have never previously been possible. When you consider that the average driver spends the equivalent of six working weeks driving a year, this represents a real opportunity. In addition, automated vehicles that never get tired or distracted could hold the key to substantially improving road safety.

We are setting out the best possible framework to support the testing of automated vehicles, to encourage the largest global businesses to come to the UK to develop and test their technologies.

I would like to thank those individuals and organisations that contributed so positively to the development of this review. Their knowledge and experience has brought huge benefit and will help to take the technology from the test track to the urban laboratory. Supported by the right investment we can create the right industrial and regulatory conditions in the UK for building the automotive technologies of the future.

Claire Perry, MP
Parliamentary Under Secretary
Department for Transport

Executive summary

Background

Driverless cars and other automated vehicles offer major potential benefits and could profoundly change our lives for the better.

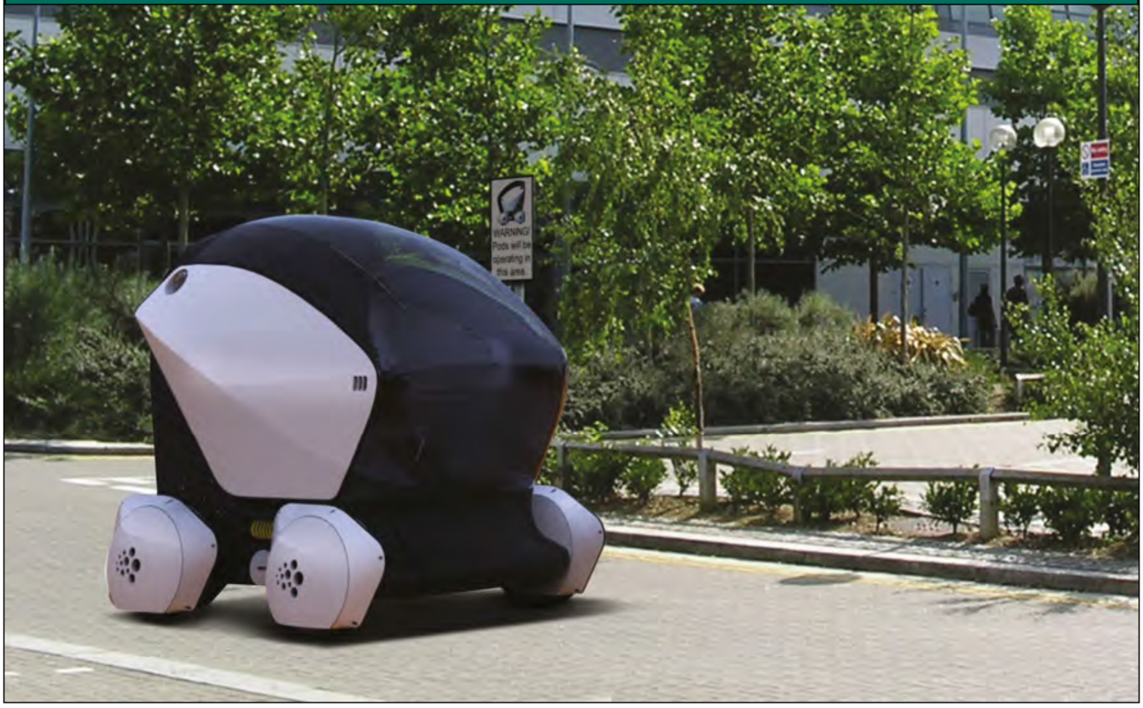
1. They will make driving easier, allow people to be more productive and offer greater mobility to a wider range of people than ever before. They will also help improve road safety, reduce emissions, and ease congestion. As a result they could provide significant economic, environmental and social benefits, including improving social inclusion. This review marks the UK Government's initial stage in analysing, understanding and developing a strategy to ensure we capture these potential benefits while maintaining our excellent road safety record.

2. The simultaneous development of a combination of technologies has brought about this opportunity. For example, some current production vehicles now feature adaptive cruise control and lane keeping technologies which allow the automated control of acceleration, braking and steering for periods of time on motorways, major A-roads and in congested traffic. Advanced emergency braking systems automatically apply the brakes to help drivers avoid a collision. Self-parking systems allow a vehicle to parallel or reverse park completely hands free. Developments in vehicle automation technology in the short and medium term will move us closer to the ultimate scenario of a vehicle which is completely "driverless".

3. The next step is the introduction of vehicles in which the driver can choose whether they want to drive or not. If they select an autonomous mode, they can allow the vehicle to take care of driving while they make use of the journey time in other ways.

4. While the term "driverless" is often used to describe these technologies, the reality is that entirely removing the need for a driver (and therefore automating steering and other controls) is a longer term goal for most vehicle types. Certainly for the testing phase there will always need to be a suitably qualified 'test driver' who will be supervising the vehicle and be ready and able to take over active control if necessary.

Figure 1 – An early design concept of the self-driving pods that are due to be tested in Milton Keynes in 2015



Approach

The focus of this review is to ensure the UK is at the forefront of the testing and development of the technologies that will ultimately realise the goal of driverless vehicles.

5. We have learnt from existing international experience and the views of stakeholders. This has been combined with our own internal expertise to inform the actions detailed in this report which will ensure the UK retains its significant competitive edge in this area.

6. Our review has examined the approaches being taken in North America, Europe, Japan and China. The views of stakeholders were also gathered and analysed in a 'call for evidence'. 38 responses were received from a wide range of stakeholders, including the key representative bodies for the automotive and insurance industries, the legal profession, technical institutions, and groups representing a wide range of road users, from children and disabled people to drivers, motorcyclists and cyclists.

7. Our approach also included a review of existing UK regulations and legislation to examine their compatibility with automated vehicle technologies. Three scenarios were considered: testing of automated vehicle technologies; mass production and marketing of highly automated vehicles; and the advent of fully automated vehicles in which driving controls would no longer be necessary.

Findings

Driverless vehicles can legally be tested on public roads in the UK today. The UK is uniquely positioned to become a premium global location for the development of these technologies.

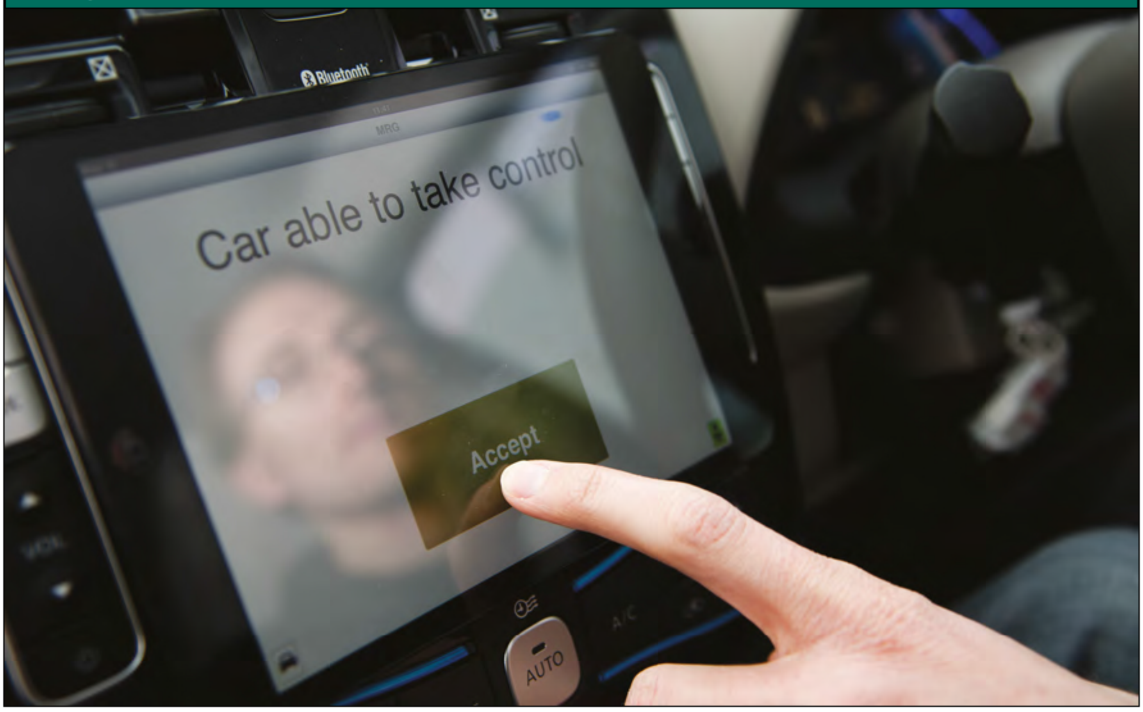
8. Our review of existing legislation found that our legal and regulatory framework is not a barrier to the testing of automated vehicles on public roads. Real-world testing of automated technologies is possible in the UK today, providing a test driver is present and takes responsibility for the safe operation of the vehicle; and that the vehicle can be used compatibly with road traffic law.

9. North America has been the first country to introduce legislation to permit testing of automated vehicles, but only four states have done this. Fifteen states have rejected bills related to automated driving and the National Highway Traffic Safety Administration (NHTSA) has issued a preliminary statement of policy which advises states against authorising members of the public to use self-driving vehicle technology at this time.

10. In Europe, only Germany and Sweden are known to have completed a review of their legislation in this area, with a further three countries currently progressing one.

11. Those wishing to conduct tests in the UK are not limited to the test track or certain geographical areas, do not need to obtain certificates or permits, and are not required to provide a surety bond (provided they have insurance arranged).

Figure 2 – The human control interface from the Oxford Mobile Robotics Group's automated Nissan Leaf vehicle



12. We believe the UK is therefore uniquely positioned to become a premium location globally for the development of these technologies.

Next steps and action plan

The Government will publish a Code of Practice in spring 2015 for those wishing to test driverless vehicles on UK roads.

13. The primary action from this review is for the Government, working with the devolved administrations, to publish a Code of Practice, to promote safety and set clear guidance to be followed in responsible testing. The Code of Practice will be developed in collaboration with key stakeholders before being published in spring 2015.

14. A Code of Practice will be quicker to establish, more flexible and less onerous for those wishing to engage in testing than the regulatory approach being followed in other countries, notably in the US. This will help to maintain the UK's position at the forefront of developments in this important technology, while maintaining safety.

15. Failure to follow guidance in a Code of Practice would be a clear indicator of negligence. A Code of Practice that reflects good and responsible practice with regard to the safety of other road users would carry considerable weight on any issue of liability. By involving industry stakeholders in developing the code we expect them to act in accordance with it. Those involved in the three trials jointly funded by Government will be required to comply with the Code.

16. The Code of Practice will be subject to periodic review to ensure that it keeps pace with best practice and takes into account experience from testing.

The Government, working with the devolved administrations, will review and amend domestic regulations by summer 2017 to accommodate driverless vehicle technology.

17. Looking ahead to the everyday use of vehicles designed to allow the driver to disengage from the task of driving, it is clear that the legal and regulatory framework needs to be reviewed and amended in a number of areas:

- **Clarification of liabilities** – There needs to be greater certainty around criminal and civil liability in the event of an automated vehicle being in a collision. Under the current legal framework these issues would be dealt with on a case by case basis by the Courts. We will aim to provide additional clarity and certainty in legislation, to provide a sound basis upon which to allocate criminal and civil liability.

- **Amending regulations on vehicle use** – Existing regulations governing how vehicles are used and maintained will need to be revised to allow the use of automation technology without a test driver and to ensure that the technology is maintained correctly. This may involve changes, for example, to the MOT test to check roadworthiness. It may also be appropriate to revise *The Highway Code* to include a section on automated vehicle technologies.
- **Promoting safety** – Safety is of paramount importance. The Government will consider whether a higher standard of "driving" should be demanded of vehicles operating in an automated mode than would be expected of a conventional driver. Government will also consider how the existing regulatory framework may be developed to ensure automated vehicle technologies are protected from possible cyber threats.

18. We expect that this review will stimulate a range of further independent testing of automation on UK roads. We will also be taking the opportunity to learn from real-world experience on these issues from the joint government and industry-funded trials taking place in four UK cities, which were announced in the Autumn Statement 2014.

The Government will liaise at an international level with an aim to amend international regulations by the end of 2018.

19. There will also need to be changes made to the European standards (known as type approval) with which mass production vehicles are required to comply prior to sale, as well as to ISO standards such as that on symbols and driver warnings. Developing these standards is likely to take several years.

20. It therefore makes sense to encourage testing on a national level to gain first-hand experience of these technologies, which can inform our negotiations on international standards.

21. The Government will continue its existing engagement with our international partners in the area of vehicle standards with a particular focus on ensuring that the necessary amendments can be put in place before vehicle manufacturers are ready to bring these technologies to market.

Summary

22. In summary the UK is uniquely positioned to help develop automated vehicle technologies and bring these to market:

- The Government is developing a light touch/non-regulatory approach to the testing and development of these technologies – as set out in this review.
- The Government can facilitate long distance and large area public road testing now – our Code of Practice approach can be applied across the UK, unlike many other countries which offer only selected roads or small, restricted geographical areas.
- The UK has some of the most challenging and diverse traffic, road and weather conditions in Europe and London is Europe's only 'Megacity'. This makes the UK the ideal centre for testing and developing these technologies.

In this review the Government has set out clear next steps showing how we will continue to ensure the regulatory and legislative framework is there to support the further development and mass production of automated vehicle technologies.

PART 1: Setting the scene

Contents

1. Introduction

1.1 The advent of driverless and automated vehicle technologies offers enormous opportunities. It will make driving easier, improve road safety, reduce emissions, and ease congestion. It will also enable drivers to choose to do other things than driving during the journey. Ultimately access to fully automated vehicles will also improve mobility for those unable or unwilling to take the wheel, enhancing their quality of life. As a result driverless vehicles could provide significant economic, environmental and social benefits.

Creating more free time

1.2 The average driver in England spends 235 hours driving every year. That is the equivalent of six working weeks. Despite the increasing sophistication of modern vehicles, and greater application of driver assistance technologies, the driver must still concentrate on driving 100% of the time. Highly and fully automated vehicles will change this. For the first time since the invention of motor vehicles, the 'driver' will be able to choose whether they want to be in control, or to hand the task of driving over to the vehicle itself. This represents a major opportunity – allowing drivers to safely use the journey time however they wish, from reading a book, to surfing the web, watching a film or just chatting face to face with other passengers.

The average driver in England can save up to **6 working weeks** a year driving time

Improving safety

1.3

Human error is a factor in over 90% of collisions. Failing to look properly, misjudging other road users' movements, being distracted, careless or in too much of a hurry are the most common causes of collisions on our roads. Automated vehicles will not make these mistakes. They use a range of sensors which will constantly monitor their surroundings. We have come to rely on many technologies that assist the driver of a vehicle, for example Anti-lock Braking Systems (ABS), cruise control or parking sensors. As these technologies evolve, they are reaching the point where a vehicle is capable of operating for periods of time with reduced, or in some instances without, driver input. Evidence from automated technologies available today already demonstrates significant safety benefits.[1] For example automatic emergency braking, lane departure warning and electronic stability control have all been assessed to have improved safety based on existing evidence.

1.4 The insurance industry recognises the potential benefits of increased use of automated vehicle technologies. They are already working to encourage the fitment of automatic emergency braking systems to all new vehicles, and a reduction in insurance claims could lead to lower premiums.

1.5 Highly and fully automated vehicles are a natural progression from today's automated safety technologies. They will be required to obey all road traffic laws and *The Highway Code* and are expected to substantially reduce collisions, deaths and injuries.

Reducing emissions and easing congestion

1.6 By communicating with their environment and other vehicles, automated and driverless vehicles offer the promise of better use of road space, reducing congestion and providing more consistent journey times, through the use of "connected vehicle" technologies. "Connected vehicles" would communicate with each other and their surroundings to identify the optimum route, helping to spread demand for scarce road space. Vehicles could also communicate with roadside infrastructure such as traffic lights and use this information to minimise fuel consumption and emissions.

1 AAA Foundation, "Evaluating Technologies Relevant to the Enhancement of Driver Safety", 2014

Increasing access to vehicles for everyone

1.7 Most people take driving for granted and could not imagine life without their car. However there are still many people who do not have a driving licence, or access to a vehicle. Disabled people may be unable to drive. Elderly people may be judged unfit to drive. Others may simply not want to drive or be concerned about their ability to do so.

1.8 When automated vehicle technologies develop to the extent that vehicles which can undertake door to door journeys without the need of a driver at all, they could improve mobility for all these people, enhancing their quality of life.

Government policy on automated vehicles

1.9 The Government recognises the significant benefits that driverless and automated vehicles will bring. As a result it is working to support their development and introduction.

1.10 As part of the 2013 National Infrastructure Plan, the Government pledged a review of the legislative and regulatory framework to enable the trialling of driverless cars on UK roads. These plans were also announced in the 2013 Autumn Statement.

Background to the driverless cars competition in the UK

On 30 July 2014, the Government launched a "driverless cars" competition inviting UK cities to join together with businesses and research organisations to host vehicle trials locally.

The results were announced in December 2014 with Greenwich, Milton Keynes, Coventry and Bristol being selected, and £19 million being provided by the Government to allow testing of automated vehicle technology.

This review provides the legal clarity to support the trialling of automated vehicles on UK roads.

1.11 Automated technology represents a significant area of interest and investment in the global automotive industry. Manufacturers recognise the potential benefits the technology offers, and are carrying out extensive testing on private test tracks. The next step is to carry out carefully controlled testing on public roads.

1.12 This document reviews the legislation and regulations to ensure that there is a clear and appropriate regime to enable highly and fully automated vehicles to be tested on UK roads.

1.13 In our review, most of the legislative provision relevant to testing is reserved and applies throughout the UK, and where not reserved the provisions in different parts of the UK are closely aligned if not necessarily identical. Substantial parts of Road Traffic law also give effect to European law obligations which apply throughout the EU.

1.14 The Government will work with the devolved administrations to revise and amend legislation to support the introduction of automated vehicle technologies. Where legislative change is proposed for the future it is necessary to recognise that this may mean changes in different parts of the UK.

Figure 1.1 – Mercedes concept vehicle demonstrates how passengers could face each other while the vehicle is in an automated mode

2. Definitions

Introduction

2.1 It is important to be clear about terminology as the phrase "driverless car" can be interpreted in different ways. Truly driverless, or "fully autonomous", vehicles would mean that a driver does not need to be present. However most commentators do not expect vehicles capable of fully autonomous operation on public roads in all circumstances to become available until at least the 2020s.

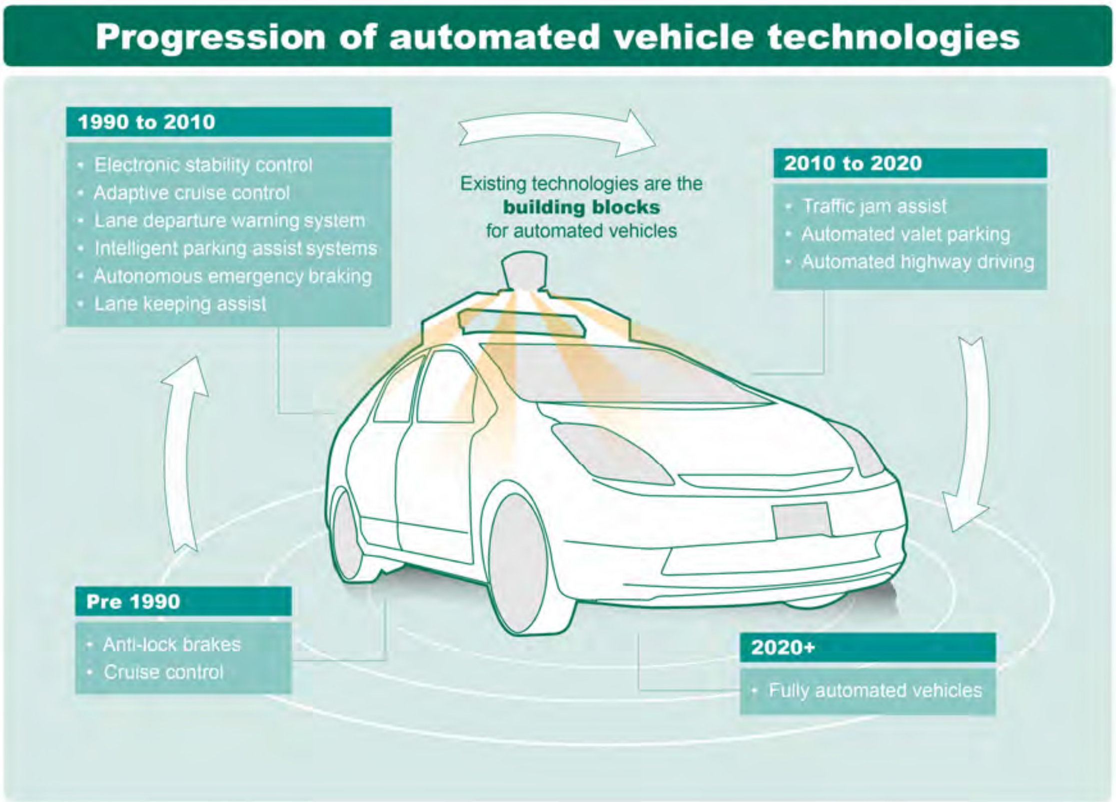
2.2 Before the technology reaches this stage, vehicles will become available which can undertake increasingly large proportions of journeys autonomously while still requiring that a driver takes manual control some of the time.

2.3 The simultaneous development of a combination of technologies has brought about this opportunity. For example, some current production vehicles now feature adaptive cruise control and lane keeping technologies which allow the automated control of acceleration, braking and steering for periods of time on motorways, major A-roads and in congested traffic. Self-parking systems allow a vehicle to parallel or reverse park completely hands free. Developments in vehicle automation technology in the short and medium term will move us closer to the ultimate scenario of a vehicle which is completely "driverless".

Driver assistance versus higher levels of automation

2.4 The defining difference between existing "driver assistance" systems and the higher levels of automation discussed in this report is that when using any existing driver assistance systems on the market today, the driver should be "engaged" or "in the loop" at all times. This means the driver should constantly monitor road, traffic and weather conditions, remain ready to resume manual control and be responsible for the overall safe operation of the vehicle.

2.5 In the higher levels of automation discussed in this report, the systems are designed to allow the driver to completely 'disengage' from the driving task and undertake other tasks. This is sometimes known as the driver coming "out of the loop".



Levels of automation

2.6 For the purposes of this review we use the term 'automation' as a general term to describe the technologies used in driverless vehicles.

2.7 This report uses two definitions to describe different levels of automated or driverless vehicles:

- High Automation
- Full Automation

High automation

2.8 This means a vehicle in which a driver is required to be present and may need to take manual control for some parts of the journey. Under certain traffic, road or weather conditions, the vehicle's automation systems may request the driver to take control.

2.9 Early highly automated vehicles may only offer an automated mode under certain very specific driving conditions such as highway cruising or in low speed conditions. As the technology develops, the vehicle will be able to undertake driving duties autonomously for a greater and greater proportion of the time.

Full automation

2.10 This means a vehicle in which a driver is not necessary. The vehicle is designed to be capable of safely completing journeys without the need for a driver in all normally encountered traffic, road and weather conditions.[2] This can be seen as the most advanced form of such technology.

2.11 Occupants of fully automated vehicles will be able to engage in tasks other than driving for the entire journey. Fully automated vehicles may still offer a full set of controls to allow a driver to resume manual control if they so wish, but this would be entirely optional.

Relationship with definitions proposed by others

2.12 These terms are mapped to the terminology used by other organisations, as follows:

Table 2.1: Levels of Automation

DfT Level	Parliamentary office of science & technology (POST) level	SAE J3016 level	BASt level	NHTSA level
High automation	High autonomy	3 & 4	High automation and Full automation	3
Full automation	Full autonomy	5	N/A	4

Defining the driver and other vehicle occupants

2.13 A further potential source of confusion when discussing automated vehicles is the term 'driver'. Conventionally a vehicle will always have a human driver sitting in a driver's seat and controlling the movement of the vehicle through a combination of controls such as a steering wheel and pedals.

2.14 When fully automated vehicles become available for use on the public highway they may not even have a driver's seat. The "driverless shuttle" vehicles already available for sale have no manual controls or driver's seat, although they are not currently approved for use on public roads.[3]

2 In highly adverse conditions in which even an expert human driver might consider it unsafe to proceed, a fully autonomous vehicle may also determine it is not appropriate to continue.

3 "Driverless shuttle" is an emerging class of vehicles which do not have a driving seat or manual controls and typically have a maximum speed below 25 km/h

2.15 For the purposes of this review we will use the following definitions:

- **Test driver:** During testing of automated vehicle technologies, our expectation is that a suitably qualified 'test driver' will be supervising testing of the vehicle and be ready and able to take control if necessary. The test driver will be responsible for ensuring the safe operation of the vehicle at all times whether it is in 'manual' or 'automated' mode.
- **Driver:** Once highly and fully automated vehicles come to market, the term 'driver' will become less clearly defined. Highly automated vehicles will allow a person who is seated at the manual controls of the vehicle to completely disengage from the task of driving for certain periods of the journey. Nevertheless the expectation is that the person seated in this position will continue to be commonly referred to as the 'driver', even if the vehicle is in an automated mode.
- **Vehicle user:** In the case of fully automated vehicles and driverless shuttles that do not have a driver's seat, it no longer makes sense to refer to any of the vehicle occupants as a 'driver', instead they are simply vehicle users. Indeed the term vehicle user would extend to include a person who chose to use a fully automated vehicle by sending it on a journey remotely.

Figure 2.1 – Driverless Nissan Leaf developed with University of Oxford

Other common terms for automated vehicle technologies

2.16 The following terms are also commonly used in relation to automated vehicles and their technologies:

- **Anti-lock Braking Systems** (ABS): Widely available in Europe since the 1980s and all new cars in Europe have been fitted with ABS since 2007. ABS operates by releasing and re-applying the brakes multiple times per second despite the driver continuing to press the brake pedal. This prevents the wheels from locking and skidding, enabling the driver to maintain steering control.
- **Electronic Stability Control** (ESC): Applies the brakes on one wheel at a time, to permit more stable cornering.
- **Cruise control** (CC): This enables the driver to constantly maintain their chosen speed without touching the accelerator or brakes.
- **Adaptive Cruise Control** (ACC): in addition to the abilities of normal CC, uses sensors to detect other moving vehicles in the same lane as the subject vehicle. It will then automatically decrease its speed to maintain a constant headway to the vehicle in front. If that vehicle ceases to be in the way, for example if the driver chooses to change lane to overtake it, the vehicle will automatically accelerate back up to the chosen speed.
- **Advanced Emergency Braking System** (AEBS): Applies the brakes without driver intervention if an obstacle is detected.
- **Lane Departure Warning System** (LDWS): Warns the driver to prevent involuntary lane changes on highways when the vehicle move out of its lane.
- **Lane Keeping Assistance** (LKA): Enables vehicles to steer themselves in order to stay in lane on motorways.
- **Intelligent Parking Assist System** (IPAS): Enables vehicles to steer themselves at low speeds and/or during parking manoeuvres.
- **Advanced Driver Assist Systems** (ADAS): Technologies designed to ease the driving task but where the driver should be "engaged" or "in the loop" at all times. This means the driver should constantly monitor road, traffic and weather conditions, remain ready to resume manual control and be responsible for the overall safe operation of the vehicle at all times.
- **Autonomous vehicle:** autonomous means capable of acting independently – by definition this implies that an autonomous vehicle is capable of operating without the driver needing to be "in the loop" for at least some of the time. A fully autonomous vehicle has no need for a driver.

- **Cyber car:** means a vehicle controlled by computer. Cyber cars are typically road vehicles with fully automated driving capabilities. A project named 'CyberCars' was funded by the European Commission in 2001-2004.
- **Self-driving vehicle:** this term is self-explanatory in that by definition it means the vehicle is capable of driving itself at least some of the time. However it can be used in reference to a range of levels of autonomy.
- **Driverless shuttle or pod:** this term refers to an emerging class of vehicles which do not have a driving seat or manual controls and typically have a maximum speed below 25 km/h. Several manufacturers have started to produce such vehicles although they are not yet approved for use on public roads in the UK.

Figure 2.2 – Concept image of the driverless shuttle to be used in the GATEway project at the Greenwich Peninsula

3. International situation

Introduction

3.1 The increased interest in automated vehicle technologies has led some countries around the world to review their regulatory requirements and a few have already taken steps to amend their legislative framework accordingly.

3.2 Europe has recognised the importance of ensuring the regulatory environment is suitable to allow the development of driverless cars and automated vehicle technologies. Automated and autonomous transport technologies are recognised as enablers to meeting Europe's target of a 60% reduction in transport CO_2 emissions and "vision zero" – where nobody is killed in road collisions – by 2050.[4]

3.3 This chapter of the review summarises the situation, at the time of writing, in countries where it is known that testing of automated vehicles has progressed. More detailed information can be found in Annex A: International situation.

Vienna Convention

3.4 Many countries are signatories to the Vienna Convention on Road Traffic. This requires that 'every moving vehicle or combination of vehicles shall have a driver' and that 'every driver shall at all times, be able to control his vehicle'. Some have taken this to be a barrier to the introduction of automated vehicles. The Convention is in the process of being amended to allow a car to drive itself so long as the system can be overridden or switched off by the driver, though it has been argued a further change is needed to allow automated vehicles on the roads in many countries.

3.5 The Vienna Convention is not considered an obstacle in the UK. The UK has signed but not ratified the convention and testing is consistent with proper driver control.

European Research Projects

3.6 Europe has also initiated a number of research projects examining the potential for automated vehicles. Based on the Framework 7 programme (FP 7) these include SARTRE, HAVE-it, Citymobil, Citymobil 2, V-CHARGE and AdaptIVe. These projects have resulted in tests which have helped the

4 European Commission, Digital Agenda for Europe, Smart Mobility/Intelligent transport. (Available here: http://ec.europa.eu/digital-agenda/futurium/en/content/smart-mobility-intelligent-transport)

development of strategies, technologies and the integration of automated systems. Vehicles used in these projects include personal rapid transit systems, cars, guided buses and platoons.

3.7 Several European Member States have been taking action to address the legal and regulatory challenges posed by automated vehicles. Sweden, Finland, France and the Netherlands are known to be considering what legislative changes may be needed. Germany has already conducted an initial review of the legal situation in respect of automated vehicles.

Current individual country situations

Finland

3.8 Finland is currently preparing experimental legislation to run for five years starting in 2015, which will enable automated vehicles to drive within restricted testing areas and at certain times on public roads, once they have been issued with a permit. Between 2013 and 2015 they will assess the business potential, legislative requirements and potential profitability for the transport sector of this technology.

France

3.9 France pressed for an amendment to the Vienna Convention and published its roadmap for automated vehicles in July 2014. This included proposals such as, pilot zones for testing, changes to driver training, R&D projects running to 2018 and the development of regulatory requirements to support testing of automated vehicles and their entry to market. They are currently examining the regulatory issues which may inhibit the testing of automated vehicles. The authorisation of experimental testing on roads of partial and highly automated vehicles is targeted for the beginning of 2015.

Germany

3.10 In 2012, the Federal Highway Research Institute published a report, summarising the situation with respect to automated vehicles and current German regulations. The report concluded that existing levels of automation are compatible with German regulatory law as the driver has constant availability of control over the vehicle. Highly and fully automated vehicles do not currently comply with the German law.

3.11 In November 2013 a roundtable on automated driving was inaugurated which includes representatives from Government Ministries, research facilities, and the Automotive and Insurance Industry. This is looking at next steps in the areas of the law, drivers and cars, and research requirements. The roundtable was due to report first findings at the end of 2014.

3.12 Currently each Federal State in Germany can grant exemptions from the technical requirements of the German Road Traffic Licensing Regulations. This allows a vehicle to operate autonomously on public roads, provided there is a driver in the driver's seat who has full legal responsibly for the safe operation of the vehicle. There have been a number of vehicles tested on German roads with varying levels of automation. In January 2015, Germany's transport minister announced that the A9 autobahn between Munich and Berlin would be fitted with technology to allow driverless cars to use the road and communicate with other vehicles and the road infrastructure.

Italy

3.13 In principle, automated transport systems in Italy may be considered legal if they are certified according to a technical standard which has been developed for rail systems.

3.14 In 2010, the University of Parma launched a research and development project which saw an automated van successfully drive from Italy to China through different traffic, weather and road conditions. The van followed a lead vehicle which was also automated but required some input from a human driver.

3.15 Other research projects included the testing of both automated cars and buses. One of these projects, PROUD, was carried out in a mix or rural, freeway and urban traffic. It required a police escort at all times and a passenger ready to use the brake pedal in an emergency.

Netherlands

3.16 In June 2014 the Dutch Government announced its intention to allow large-scale testing of self-driving vehicles on Dutch roads, but acknowledged that to permit this, existing legislation needed to be amended.

3.17 In January 2015 a proposal to extend exemption rules to allow 'large-scale' testing of self-driving cars and trucks was approved. A spokesperson stated that testing would start in summer 2015 once parliament approved the necessary legislative changes.

3.18 They also plan to initiate amendments to international regulations and have launched a study into the potential issues such as liability, driving skills requirements, data traffic and the possible impact on infrastructure. The Dutch have the EU presidency in 2016 and have stated this might be an area they seek to develop.

3.19 The Dutch Government are currently backing a plan to bring automated trucks to market to deliver goods from Rotterdam to other cities in the Netherlands within 5 years. They claim benefits include reduced road space requirements, improved safety and environmental impacts.

Spain

3.20 The Spanish Road Code still contains the statement: 'Drivers should be at all times in a condition to control their vehicles', which could be problematic for autonomous vehicles. Platooning trials have also been undertaken with more planned for autumn 2016, as well as a trial testing an automated vehicle on 60 miles of highway. The Government has invested in an outdoor test track for testing the most advance technologies. Spain hosted the SARTRE FP7 project for open road platooning. FP7 projects Citymobil and Citymobil 2 hosted demonstrations of automated transport in Castellon, Leon and San Sebastian. The Spanish Government has also supported a project which saw the open road test of an automated vehicle on 60 miles of a highway, without requiring input from a driver, and have invested to build offices and an outdoor test track for testing the most advance driving technologies.

3.21 Scania is working with a Spanish test laboratory (IDIADA) to test their entire platooning system on Spanish roads in autumn 2016.

Sweden

3.22 Testing of highly automated vehicles on public roads has already commenced in and around Gothenburg as part of the Volvo 'Drive Me' project. These vehicles are currently being tested by engineers but it is expected 100 highly automated cars will be available for use by the public in 2017.

Figure 3.1 – Volvo's 'Drive Me' automated vehicle testing in Gothenburg

3.23 Initial findings from the Swedish Transport Agency in May 2014 state that current vehicle legislation, driver's licence rules and liability rules may need amending to permit the testing of vehicles using systems, which might be considered beyond those offering only driver assistance.

3.24 There would be a need to amend existing vehicle regulations and roadworthiness testing to cover the hardware and software used for automated vehicles. Driving licenses could be introduced for those with impairments to license use of fully automated vehicles only. The study highlighted required improvement to Sweden's registry of all national and local traffic regulations.

3.25 The "world's first full size safety test track for driverless vehicles" opened near Gothenburg in August 2014.

USA

3.26 North America has been the first country to introduce legislation to permit testing of automated vehicles, but only four states have done this. California began issuing licences in autumn 2014.

3.27 State-by-state laws vary significantly and according to one source no state has fully determined how existing traffic laws should apply to automated vehicles. Fifteen states are reported to have rejected bills related to automated driving.[5]

3.28 In May 2013 NHTSA (National Highway Traffic Safety Administration) issued a 'preliminary statement of policy concerning automated vehicles'. Aimed at level 3 and 4 automation for testing purposes only it recommended that:

- License drivers to operate self-driving vehicles for testing
- Require proof of safe operation of self-driving vehicles
- Limit tests to locations suitable for self-driving vehicles
- Establish reporting requirements to monitor self-driving technology performance
- Ensure that the process for transitioning from self-driving mode to driver control is safe, simple and timely
- Require self-driving vehicles to have the capability to detect, record, and inform the driver that the automation system has malfunctioned
- Ensure that self-driving vehicle technologies do not disable any required safety features or systems
- Ensure that all information about the status of the automated control technologies is recorded in the event of a crash or loss of vehicle control

3.29 Those states permitting automated vehicle testing each have their own set of requirements which vary from one another.

3.30 Examples of requirements set out by the four states include an insurance or surety bond up to the value of $5 million and testers being required either to have a specific permit or special vehicle license plates.

5 Gabriel Weiner and Bryant Walker Smith, Automated Driving: Legislative and Regulatory Action, cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action

3.31 In January 2015 Audi conducted a 550 mile demonstration of its 'piloted-driving' from Palo Alto in California, to the Consumer Electronics Show in Las Vegas, Nevada with a journalist in the driving seat of the vehicle. To do this the journalist had to undergo driver training and Audi had to complete different application forms for each state. Audi has described the current "patchwork of rules" as an impediment to marketing their technology.[6]

Figure 3.2 – Google has built fully automated prototype vehicles with no manual controls

Japan

3.32 The first public road test of an automated vehicle on a Japanese highway was conducted in November 2013 with Prime Minister Shinzo Abe in the car. The Nissan Leaf used, was awarded a licence plate for use on the public road in September 2013.

3.33 Japan has argued that European regulations need to be updated to allow further development of automated vehicle technologies. However this review was not able to find firm information regarding Japan's own plans to review or introduce new national regulations.

3.34 Toyota has said that it is focusing its efforts on 'infrastructure-cooperative' automated driving, but has admitted to recently developing an automated vehicle that uses on-board sensors. Public road experiments are being initiated.

3.35 Nissan is aiming to be the leader in the introduction of automated features. It has stated that it will market more than one fully automated vehicle by

6 Wired.com, "I Rode 500 Miles in a Self-Driving Car and Saw the Future. It's Delightfully Dull", 7 January 2015.
(Available here: http://www.wired.com/2015/01/rode-500-miles-self-driving-car-saw-future-boring/)

2020 with lower levels of automation being released from 2016. Nissan is building a dedicated automated vehicle proving ground in Oppama, Japan.

China

3.36 Like the UK, China has not ratified the Vienna Convention.

3.37 This review was unable to find any official plans for testing automated vehicles in China. However it has been reported that Baidu, the Chinese internet search engine group started developing a 'highly automated' car in 2014. Baidu reportedly signed an agreement with BMW to research automated vehicle technology to develop a semi-autonomous vehicle within three years.

3.38 Organisations wishing to test automated vehicles in China require a Chinese number plate and Chinese driving licences for the test drivers.

Singapore

3.39 In August 2014, the Land Transport Authority (LTA) in Singapore announced it was setting up the Singapore Autonomous Vehicle Initiative (SAVI) in collaboration with the Agency for Science, Technology and Research. Singapore has also stated that public road testing will begin in January 2015.

3.40 A 200-hectare area has been selected as the first area for testing, containing light and heavy traffic test routes. Companies wishing to test must have "safety procedures including immediate manual over-ride to take full control of the vehicle at any point in time" as well as comprehensive third party insurance.

3.41 Several trials are currently underway including, a fleet of autonomous golf buggies as a car-sharing concept, as well as a driverless car. Nanyang Technological University is also testing and optimising a driverless Induct NAVYA shuttle that can seat up to 10 people. Two further trials in Singapore are also currently ongoing.

Republic of Korea

3.42 Hyundai-KIA, Renault Samsung and GM-Daewoo are all believed to be actively researching automated vehicle technologies. Hyundai-Kia Motors started a biennial competition for autonomous vehicles in Korea in 2010.

3.43 SsangYong Motor has also signed a memorandum of understanding with the Korea Automotive Technology Institute (KATECH) to develop a self-driving car, stating "the self-driving system has emerged as one of core competences for future automobile industry."

3.44 In July 2014 Hyundai released a video, demonstrating a combination of existing technologies which allowed a convoy of vehicles to circulate their test circuit with no driver present.

3.45 Research is ongoing into second generation vehicles which feature lower cost sensors and into the demonstration of the safe operation of the vehicle in a dense urban area where GPS signals may be unreliable. Research is also being conducted into Automatic Guidance Systems (AVGS).

Summary

3.46 North America has been the first country to introduce legislation to permit testing of automated vehicles, but only four states have done this. Fifteen are reported to have rejected bills related to automated driving.[7] The National Highway Traffic Safety Administration (NHTSA) has issued a preliminary statement of policy which advises states against authorising members of the public to use self-driving vehicle technology at this time.

3.47 Elsewhere in Europe and globally, legislators are considering how to accommodate the development and testing on their roads of automated technologies. Unlike the UK, many countries have found the Vienna Convention a barrier to the introduction of this technology. Although many research projects have taken place all over Europe, many locations such as Gothenburg, have restricted boundaries or roads where testing is permitted or require a permit.

3.48 Asian countries are keen for the International and European regulations to be updated to allow further development of automated vehicle technologies. Testing of automated vehicles on the road has been possible, with some countries restricting testing areas and having special requirements for license plates and driving licences.

The UK is a premium location to develop automated vehicles

We believe the UK is uniquely positioned to become a premium location globally for the development of these technologies. Those wishing to conduct tests are not limited to the test track or certain geographical areas, and do not need to obtain certificates or permits. Provided they have insurance arranged, they are not required to provide a surety bond.

7 Gabriel Weiner and Bryant Walker Smith, Automated Driving: Legislative and Regulatory Action, cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action

PART 2: The review

Contents

4. Driver testing and licensing

Introduction

4.1 This chapter considers whether the existing driver testing and licensing requirements could represent a barrier to the testing and longer term use of automated vehicles on GB roads.

Current Situation

4.2 Anybody who drives a motor vehicle on a road must hold a valid licence to drive that vehicle.[8] A licence can only be granted to persons who meet specified residence requirements and satisfy the Secretary of State that they meet one of the conditions set out in section 89 of the Road Traffic Act 1988, most commonly that they have passed a prescribed test of competence.[9] There is also a requirement for drivers to be physically fit to drive.[10] Testing for licence acquisition purposes is administered by the Driver and Vehicle Standards Agency (DVSA).

Figure 4.1 – Student taking her practical driving test

8 Road Traffic Act 1988 Part III Section 87
9 Road Traffic Act 1988 Part III Section 89
10 Road Traffic Act 1988 Part III Section 92 and Motor Vehicles (Driving Licences) Regulations 1999 Part IV

4.3 Within the EU driving licences are mutually recognised across all member states. EC Directive 2006/126, commonly known as the third driving licence directive, sets out minimum requirements for driver licencing and minimum standards for driver testing. The Motor Vehicles (Driving Licences) Regulations 1999 implements EC Directive 2006/126 and makes provisions in relation to driver licencing and testing in the UK.

Testing of automated vehicle technologies

4.4 In current legislation a person who holds a full category B (car) driving licence without restrictions is authorised to drive any car. Existing legislation makes no reference to highly or fully automated vehicles. From a driver licencing perspective we have not identified any legal barriers that would prevent the testing of highly automated vehicles on public roads providing the test driver holds an appropriate category of licence. We do not consider that there is a need to introduce regulatory changes in relation to driver licencing or testing to allow for the testing of highly automated vehicles on public roads.

4.5 In order to promote safety during public road testing of an automated vehicle, our expectation is that a test driver will supervise the vehicle at all times and be ready and able to take control if necessary. The test driver must hold the appropriate category of licence for the vehicle under test. This is true even if testing a vehicle's ability to operate entirely autonomously.

4.6 Test drivers supervising public road testing of these vehicles will need skills over and above those of drivers of conventional vehicles. For example it will be important to ensure they have an excellent understanding of the potential limitations of the technologies under test, and are already familiar with the characteristics of the vehicle, preferably through extensive experience of tests conducted on closed roads or test tracks.

4.7 The test driver would be expected to have had additional training to ensure they understand how the test vehicle's automated systems operate and, especially the procedures for taking direct control. It seems logical that the responsibility for ensuring test drivers have those competences should lie with the vehicle manufacturer and the testing organisation.

4.8 It may be appropriate for testing organisations to grade test drivers according to their experience and expertise. This would enable them to select the most appropriate test driver for each type of test to be undertaken. For example ensuring that only the most experienced and skilled test drivers are utilised for initial tests of a new software level.

4.9 It would be sensible for manufacturers to check that test-drivers have nothing in their driving record that would indicate that they represent a particular risk. Given the levels of concentration required it would also seem sensible to monitor the performance of test-drivers and, where relevant, to set limits on the amount of time they would be expected to maintain that level of concentration.

Production and marketing of highly automated vehicles

4.10 For a car in which the driver may opt to operate in a highly, or even fully, automated mode but which they may drive 'conventionally' at other times, the full licence requirement remains.

4.11 There is clearly a need for drivers to be fully conversant with the methods for switching a car between automated and manual modes. In the absence of regulation each manufacturer could configure their systems in a different way, and those approaches could change over time. In this situation it is difficult to see how training could be provided by anybody but the manufacturer or their agents. A measure of standardisation in this field may be desirable, in the same way that other aspects of vehicle control systems have been harmonised over the years.

4.12 The driver may need to take back control of the car in two situations:

- When the car's systems are actively telling the driver to take control.
- When the car's systems are not operating properly and there is a need to take control.

4.13 Providing the knowledge to respond to the first of these requirements, seems to fall to the manufacturer. However, the second situation raises more complex issues.

4.14 Our definition of 'highly automated' makes clear that the vehicle has been designed from the outset to allow the driver to disengage from the driving task when in an automated mode. The driver cannot be expected to be monitoring the safe operation of the vehicle. The vehicle will therefore need to have been designed to alert the driver to a self-diagnosed failure, and if the driver does not resume control, to bring the vehicle safely to a stop. This is covered more fully in Chapter 8 on vehicle standards.

4.15 The scenario in which automated vehicles are interacting with conventional cars does not, at first glance, raise any additional competence requirements for their drivers. It seems reasonable to assume that automated systems will be optimised to react appropriately to other vehicles which are under human control. If they are not so optimised, and the driver of an automated car is, in fact, required to have a higher or distinct competence in order to manage that interaction then it may be necessary to examine whether this competence should be included in future driver licence training and testing.

4.16 Whether the drivers of conventional cars need to acquire and demonstrate additional competence will, again, depend on the way in which the automated vehicles are optimised. Ideally they should behave in an entirely consistent way. In this sense it should be easier for other drivers to predict what they are likely to do. This should make their driving task simpler.

4.17 Issues which are emergent properties of the way automated systems interact will have to be addressed individually and may require research, detailed discussion, changes to legislation, and potentially changes to driver training, testing and licensing.

Production and marketing of fully automated vehicles

4.18 The Road Traffic Act 1988, section 87, provides that a person must only drive a vehicle if they have a licence authorising them to drive a vehicle of that class. In a fully automated vehicle which does not have the option for somebody to take manual control, there can be no human driver. If the fully automated vehicle retained the option of manual control only a person holding an appropriate licence would be entitled to drive it manually.

4.19 There is a strong probability that there will be those who will want to own or use fully automated vehicles precisely because they cannot or do not wish to drive conventional vehicles. For example there may be categories of disabled driver for whom a fully automated vehicle is a cheaper or more attractive option than a specially adapted vehicle. It would seem reasonable to allow ownership or use of a fully automated vehicle without the need to hold a driving licence. If the vehicle was designed to allow the driver to elect to control the vehicle manually or to take over control of the vehicle in the event of failure of the automated systems, then it would be appropriate to require that the occupant should hold a full driving licence as it may be difficult for enforcement authorities to establish whether the vehicle was being operated autonomously or manually.

4.20 **Action: Consider the existing licensing requirements for owners and users of highly and fully automated vehicles.**

Figure 4.2 – Percentage of the population without a full driving licence

5. Driver behaviour

The current situation

5.1 This chapter considers whether the current law governing driver behaviour presents any barriers to the testing and use of automated vehicles on public roads.

5.2 In civil law, road users owe a duty of care to other road users and will be liable in negligence if breach of that duty causes damage. In some other European jurisdictions an element of strict liability applies for the consequences of road collisions. In the UK the mere fact of a collision is not, of itself, a basis for imposing liability. Liability will only be justified if there is evidence of negligence. This liability is backed by the existence of compulsory third party insurance, dating back to the Road Traffic Act 1930, and it is settled law that the requirement is for all drivers to measure up to the standards of skilled, experienced, careful drivers making no errors of judgment (see Nettleship v Weston [1932] AC 562). That exercise of care includes recognising and anticipating that other road users, drivers or pedestrians, may not themselves act with reasonable care.

5.3 The nature of road traffic collisions are such that the courts have tended to regard what is reasonable as a matter of common sense with strong indications to be found in *The Highway Code* as a guide to sound driving practice and the rules of the road. In practice, the civil courts have examined and continue to examine the factual circumstances of numerous different types of collision and scenario. Case law rulings also act as a guide for insurers, litigants and their advisers as to how liability issues will be determined if heard by the court, which in turn guides the resolution of claims, the vast majority of which are settled out of court.

5.4 Road traffic law also regulates the use of vehicles and their driving through the criminal law, to ensure that vehicles are operated and driven in a sufficiently safe manner. For example, the Road Traffic Act 1988 requires that drivers must drive with due care and attention, in a competent and careful manner and with due consideration for other road users. That Act also specifies a number of other offences that involve driving behaviour that falls short of these standards such as driving dangerously, driving under the influence of alcohol or drugs, and ignoring traffic signs.

5.5 The current law is based on the assumption that when a vehicle is used on the roads there is a natural person who is the driver of that vehicle. This person has, or should have, control of direction and movement of the vehicle. There is no explicit requirement that a vehicle must have a driver because at the time the Road Traffic Act and other similar legislation was drafted it was taken for granted that a human driver would be present. Nonetheless many features of driving and vehicle use are regulated by reference to responsibilities placed on the 'driver' or on the 'user' of the vehicle.

5.6 Highly automated vehicles, as defined in Chapter 2, are designed to allow the driver to disengage from the driving task and undertake other activities if desired. For example, manufacturers may wish to market this technology on the basis that it will allow the driver to use a hand-held mobile phone, or a laptop, or even change the position of the driver's seat to face away from the road. The prospect that the traditional driver may be disengaged from the traditional concept of driving activity raises questions as to what responsibility the driver bears for the operation of the vehicle and whether regulations relating to the behaviour of the person in the driving seat will need to change in these circumstances. In this situation it does not seem reasonable to suggest that the human driver is still responsible for the manner in which the vehicle drives since they may not even be aware of the road environment or the presence of other road users.

5.7 The driver also has some other responsibilities not directly related to driving behaviour laid down in law, for example ensuring child passengers are wearing seatbelts. An important question is how this responsibility should be met in a fully automated vehicle without a human driver. An adult might ensure that children were wearing seatbelts before the vehicle set off but might not be present to ensure they continued to do so during the journey.

5.8 Our aim is to ensure that automated vehicles may only be used when it is safe to do so. One of the objectives of introducing such vehicles is the expected road safety benefits from fewer road traffic collisions. Currently, the driver of a motor vehicle is responsible for observing road traffic law, adhering to speed limits, observing traffic signs and driving in a safe and considerate manner. Where there is no longer a person in the vehicle who qualifies as a driver, our understanding and intention would be that a vehicle should not be used on a public road unless used in at least as safe and considerate a manner, and in compliance with all applicable legal requirements.

5.9 Before these vehicles are marketed to the public, it may therefore be necessary for the Government to provide some guidance as to where it believes responsibility for the safe operation of highly and fully automated vehicles rests when in autonomous mode and to legislate for these different cases.

5.10 In the future there may need to be more emphasis on ensuring an automated vehicle is safe by design, and that a person modifying a vehicle away from the safe specification or not maintaining the vehicle in accordance with set standards would be guilty of an offence. Some of this will need to be achieved by explicit requirements on vehicle construction, perhaps via the type approval system or the in-use regime. (See Chapters 8 and 9).

Testing of automated vehicle technologies

5.11 Where vehicles with a high degree of automation are tested on public roads it must be within the existing legal framework. Testing has to comply with all current legislation.

5.12 The presence of a test driver who is capable of having control over the direction and movement of the vehicle to the standard expected of a driver of a conventional vehicle, would seem advisable for the testing phase, and this should be set out explicitly by the Department. Accordingly that person would need to be able to override any automated system and take control if a position arises where the vehicle presents a danger of causing injury. Indeed, the untested nature of the vehicle would itself be reason for expecting that use of the vehicle with due care should be with a test driver present.

5.13 A test driver would be as culpable as a standard driver when the vehicle is operating manually and, being in the position to exercise or take over the exercise of active control of movement and direction of the vehicle at any moment, we believe it likely that the driver would be responsible for observing road traffic law and the liability for harm caused to third parties from the way in which the vehicle is used in autonomous mode. The test driver would therefore, for example, have the responsibility of ensuring that the vehicle drives at the appropriate speed within the speed limit, including overriding and adjusting the speed the vehicle sets if necessary.

Figure 5.1 – Test driver and passenger monitoring an Audi automated vehicle test

5.14 The test driver could therefore be prosecuted for failure to comply with current road traffic laws, for example, if the vehicle was detected exceeding the speed limit. At the same time, failure of the automated equipment might be treated in a similar way as today, with the equipment manufacturer being liable for a fault.

5.15 We believe there are no barriers in road traffic law that would stop the testing of automated vehicles on public roads, provided a test driver supervises the actions of the vehicle sufficiently to take control in time to operate the vehicle safely and to a "proper" standard. That is with at least as much control as would be expected of a driver of a standard vehicle in the same circumstances. This proposition as to the legal position of the driver when ceding control over the steering and similar features in a highly automated vehicle is untested before British courts but in a given case the court would undoubtedly determine whether liability lies in the hands of the test driver, the body carrying out the tests for whom the driver acts, or the manufacturer of the vehicle if different.

Figure 5.2 – Test driver monitoring automated vehicle test

5.16 From a policy perspective, it is important that the automated vehicle's capacities can be fully tested, and it can drive while being monitored, while ensuring driver, passengers and other road users are safe. So it might be desirable for the driver to take their hands off the steering wheel while the vehicle is steering autonomously and while it is safe to do so.

5.17 The test driver of a highly automated vehicle will require additional skills compared to the driver of a conventional vehicle. Performing a monitoring function which requires a high degree of alertness may not involve much physical intervention but may be mentally challenging.

5.18 **Action: Make clear that the test driver (and the testing organisation for whom they are acting), will be considered responsible for the safe operation of the test vehicle whilst on public roads.**

Production and marketing of highly automated vehicles

5.19 Our definition of 'highly automated' makes clear that the vehicle has been designed from the outset to allow the driver to disengage from the driving task when in an automated mode. The driver cannot be expected to be monitoring the safe operation of the vehicle in this mode, although he or she may need to retake control given a suitable warning, if the vehicle systems indicate that this is necessary. Such a warning would need to be given in sufficient time for the driver to re-engage with the driving task, and this may need to be specified in type approval regulations. If the driver does not re-engage for whatever reason, then it will be important to ensure that the vehicle systems take the most appropriate and safe course of action.

5.20 When such vehicles are operating in an autonomous mode, they are not being driven in the currently assumed sense. Detailed consideration needs to be given to the liability and criminal penalties for collisions, particularly in respect of responsibilities currently imposed on drivers. Legislation will be required to clarify responsibility for the use of the vehicle between driver, owner and manufacturer, and appropriate penalties in case of injury or damage.

5.21 Currently, in the worst case drivers can be sent to prison where the standard of behaviour has fallen to well below that expected of a typical driver, and perhaps elements of recklessness are involved. Similar behaviour on the part of a vehicle manufacturer, in terms of reckless disregard for safety, might be theoretically possible but it is expected manufacturers will put in place procedures to guard against this.

5.22 **Action: Review the allocation of criminal and civil liability between driver and manufacturer and amend the appropriate legislation, as necessary.**

5.23 From a policy perspective it is envisaged it will be necessary to make specific provisions in law to regulate the design and use of such vehicles. There would need to be a shift towards ensuring that a vehicle is safe by design and programming, rather than regulating the driver behaviour, although all existing requirements will need to remain to cater for scenarios where the driver has taken over control. There will also be a number of areas where regulation of the behaviour of the vehicle's owner may require expansion.

5.24 While it is likely that technology will move incrementally towards vehicles with increasing capability to drive themselves, we would want to create clarity in law before these vehicles became widespread. Such regulations might include specifying requirements on vehicle (and if separate, equipment and software) manufacturers. For example, in terms of safety features of the vehicle, how much warning is given to the driver when he or she needs to take over control of the vehicle? Specific instructions or training for users on the maintenance and updating of the vehicle, equipment and software may be required. This is discussed more fully in Chapter 8 on vehicle standards.

5.25 **Action: Consider appropriate measures to ensure that automated vehicles are designed to respect road traffic law.**

5.26 A further consideration is whether Government should give guidance or regulate regarding vehicle control software and algorithms and how decisions are made in critical situations. Human drivers make split second decisions. For vehicles operating in an automated mode, the actions of the vehicle may effectively have been pre-determined by decisions made during the development of the vehicle's operating software.

5.27 **Action: Consider the need for requirements governing decisions in vehicle control software and algorithms which may have safety implications for other road users.**

5.28 Standards regarding what constitutes acceptable driver behaviour when a highly automated vehicle is operating autonomously would also need to be agreed. For example, would it be acceptable for the driver to face away from the road, move to a different part of the vehicle or even fall asleep? Some might argue that it should be acceptable for a driver of a highly automated vehicle to switch on autonomous mode and then start drinking alcohol to levels above the current legal limit if the vehicle has the capability of reaching the destination. Under the present law the latter would not be permitted, on grounds that the driver, even if not exercising control over the vehicle, is in charge of it or could be called upon to take over control.

5.29 The correct operation of the automated technology is safety critical and it should be made clear whose responsibility this is and what behaviour of the users should be acceptable prior to these vehicles going on sale.

5.30 **Action: Analyse existing regulations on vehicle use to ensure that automated vehicles are used and maintained in such a way as to preserve their compliance with road traffic law.**

5.31 Certain behaviours such as driving too close to the vehicle in front, or tailgating, currently constitute careless or dangerous driving judged by the standards of careful drivers generally. In autonomous mode, a highly automated vehicle may have a shorter 'reaction time' to apply the brakes than a human driver, particularly when in communication with other automated vehicles (known as "Platooning"), and therefore a shorter stopping distance. Automated vehicle manufacturers might therefore argue that this would allow closer following to meet the standards of careful driving. However research indicates that other drivers in conventional vehicles may adopt similarly close following distances.

5.32 Some developers of automated vehicles have also argued that the vehicles should be allowed to adopt similar driving characteristics to human drivers, including exceeding speed limits and displaying certain 'assertive' characteristics. The Department is clear that exceeding speed limits would not be acceptable. Automated vehicles will be expected to obey all current rules of the road.

5.33 Under existing legislation, the standard by which an automated vehicle's driving characteristics would be judged would be the same as for any driver – that of competent and careful human drivers generally. However vehicles operating in an autonomous mode should be able to use the various sensor and control systems to achieve a higher standard of control of the vehicle. For example sensors may react faster than the best human driver; braking could be applied to individual wheels to maximise control and use all available grip; the steering path chosen could minimise the likely risk of a collision or mitigate the effects of any impact. It may also be beneficial for vehicles operating in an autonomous mode to exhibit exemplary driving behaviours given evidence of human drivers mimicking behaviours. As a result it might be appropriate to demand a higher standard of driving from automated vehicles.

5.34 **Action: Consider whether requiring a higher standard of driving than would be expected of a conventional driver is possible for vehicles operating in an automated mode.**

Production and marketing of fully automated vehicles

5.35 When fully automated vehicles become available, similar considerations as those for highly automated vehicles would apply. Since such vehicles are capable of making journeys without any driver intervention, consideration must be given to what standard of user capability, skill or fitness may be required or not, including unaccompanied child users, disabled users, and impaired users. This will need careful consideration and a decision on such issues would need to be reached before such vehicles could be sold for use on public roads.

5.36 **Action: Review the applicability of existing restrictions on vehicle users in regard of fully automated vehicles prior to such vehicles becoming available on the market.**

6. Other road users

Introduction

6.1 It is important to consider the impact that the presence of automated vehicles will have on other road users, and how automated vehicles should react in relation to those other road users.

6.2 The other road users which must be considered are diverse, and include the drivers of other cars, pedestrians, motorcyclists and cyclists, animals being led, driven or ridden, older drivers, learners, emergency and incident support vehicles, powered vehicles used by disabled people, large vehicles, buses, coaches and trams, milk floats, amber light vehicles such as snow ploughs, recovery and traffic officer vehicles.

6.3 *The Highway Code* [11] emphasises the importance of all road users being aware of the code and states that it is essential reading for everyone. It provides guidance and rules for anyone using roads in England, Scotland and Wales. Northern Ireland has its own similar Highway Code. *The Highway Code* is generally designed to ensure different road users can jointly use the roads in a safe manner. It has a specific section on the need to take extra care around certain road users and provides advice about the risks and actions that should be taken.

6.4 An example of the type of advice can be found in rule 206 which warns road users to drive slowly when in crowded shopping streets or rule 208 which warns drivers to drive slowly when near schools. Currently drivers of vehicles fitted with driver assistance technologies and partial automation are expected to remain aware of the road environment and observe *The Highway Code*.

6.5 This review focuses primarily on the testing of highly and fully automated vehicles. When these vehicles come to market, they are expected to be sold on the basis that the driver does not have to concentrate when in automated mode. The automated operation of such vehicles will have to ensure that the car will react to other road users and the road environment as required in *The Highway Code*. For example an automated vehicle in autonomous mode will need to recognise when it is near a school and, if necessary, adjust its speed accordingly to comply with the rules of *The Highway Code*. Automated

11 Failure on the part of a person to observe a provision of *The Highway Code* does not render a person liable to criminal proceedings of any kind but any such failure may be relied upon in any criminal or civil proceedings by any party to the proceedings as tending to establish or negative any liability which is in question in those proceedings (section 38 Road Traffic Act 1988)

vehicles may need to be tested to some degree under type approval (see Chapter 8) so that the vehicles react to other road users in an appropriate manner.

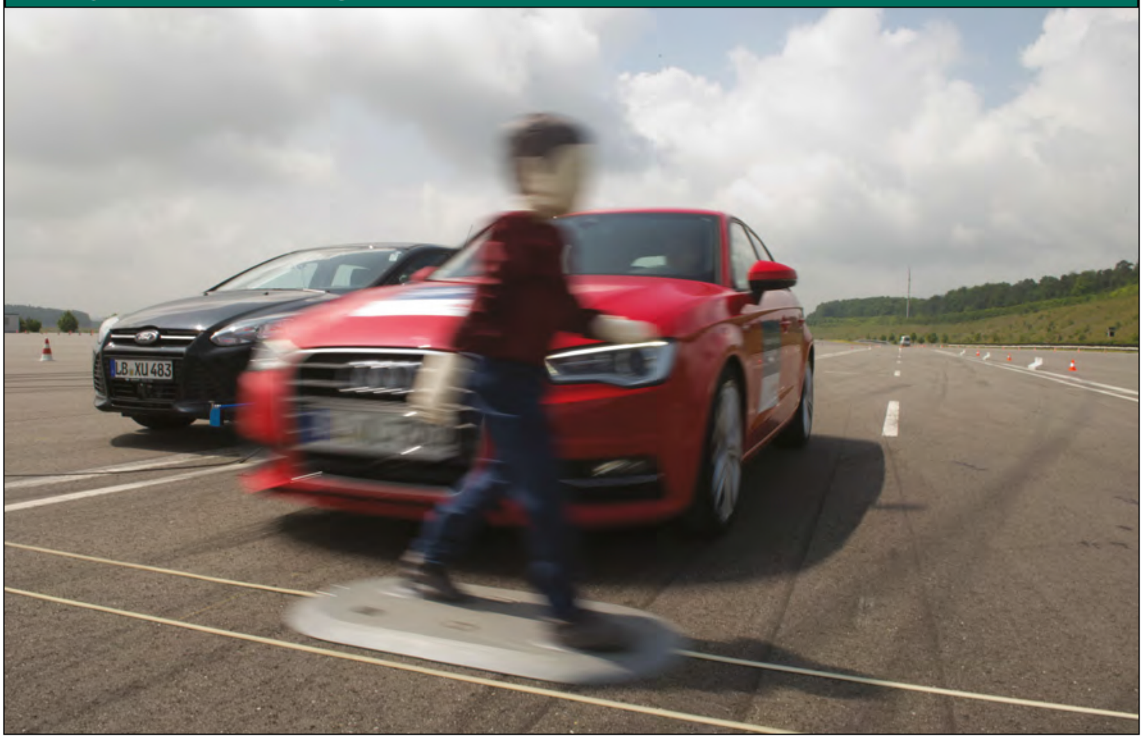
6.6 Presently, there is no guidance in *The Highway Code* about automated vehicles. However all road users need to comply with any legal requirements and drive with reasonable care and consideration for other road users (including automated vehicles) on the road.

6.7 It is important to consider how other road users might react to the presence of automated vehicles on the road. This is considered in the following sections.

Inappropriate behaviour by other road users

6.8 Drivers of other vehicles may be tempted to test the capabilities or responses of automated vehicles knowing that they will likely be programmed to operate defensively. For example, they may pull out in front of an automated vehicle or cut in front of it too close after overtaking. Pedestrians might be tempted to cross just in front of a vehicle knowing that the sensor systems would activate the brakes. Identifying automated vehicles which are undergoing public road tests, for example by means of a roof sign or special number plate, might be counter-productive as those road users who might be tempted to engage in inappropriate behaviour, would know which vehicles were automated.

Figure 6.1 – Testing of automated braking system on private test track with child pedestrian dummy



6.9 There is an argument for other road users being warned in advance of such testing and provided with information and reassurance about how the testing will affect them. In fact, it should not affect them in any way, as the vehicle should behave in the same manner as one driven by a safe and competent driver. For the validity of the tests, it will be important that other road users do not behave any differently from normal.

Signalling

6.10 It is necessary to consider how automated vehicles will react to different signals, including flashing headlamps or hand signals from other drivers – which might not be in line with *The Highway Code*. Rule 110 of the code provides that headlamp flashing should only be used to warn of a vehicles presence but many drivers use it to signal "after you" or even to warn of a police speed enforcement camera. The "after you" headlight flashing scenario might lead to a situation where the automated vehicle is waiting patiently for another driver who has flashed their headlamps indicating that they wish the automated vehicle to proceed.

6.11 Automated vehicles would also need to recognise the presence and signals of other road users such as horse riders. Riders may signal to a driver approaching from behind whether it is safe to pass or whether they should wait. An automated vehicle will need to respond appropriately in this situation.

6.12 Eye contact with other road users can be an important component of road user interaction. An automated vehicle will need to be designed in a way that minimises any problems that the lack of eye contact produces.

6.13 Situations where the police signal for vehicles to stop, or where an ambulance is proceeding to an emergency with blue lights flashing and siren sounding, would also need to be taken into account in the design of such vehicles.

Figure 6.2 – The Mercedes F015 demonstrating its laser projected zebra crossing to help communicate with pedestrians that it is safe to cross

Testing automated vehicle technologies

6.14 During the testing phase there are not expected to be large numbers of automated vehicles on the roads. As a result it is expected that the proportion of other road users interacting with these vehicles will be small. Nevertheless it is important to ensure that the safety of the general public is maintained. Testers of automated vehicles, who are sitting in the driver's seat, would be expected to behave in a way which minimised the risk of distracting other road users. Equally other passengers in the test vehicle should avoid attracting undue attention.

6.15 Test drivers should ensure that appropriate care is taken around other road users, particularly more vulnerable ones. The vehicle's own capabilities in this regard must not be tested on public roads unless testers have a very high level of confidence that the automated systems will meet all requirements based on testing conducted on closed roads and test tracks.

6.16 We would also recommend that automated vehicles under test are not marked in a way which would enable them to be easily distinguished from other vehicles. This should minimise the risk of inappropriate behaviour or unusual reactions from other road users.

6.17 It is important that the interaction between automated vehicles and all other road users can be observed during testing and that this information can be drawn on when developing future policy.

Guidance to other road users

6.18 The introduction of automated vehicles effectively introduces a new type of road user and those responsible for testing may consider that information and guidance should be provided to other road users prior to any testing taking place, if they feel that this is necessary to ensure safety. This may depend on factors such as the views of the local highway authorities, the type of roads used for testing, and the capabilities and appearance of the vehicles in question. For example, the public may require more reassurance if the vehicle is of radical or unconventional appearance.

6.19 **Action: Recommend that those conducting testing provide information about their testing to the public, as part of their risk management process, taking into account the views of relevant stakeholders such as local highway authorities.**

Production and marketing of highly automated vehicles

6.20 The testing phase will need to establish that the questions regarding how automated vehicles successfully and safely interact with all other types of road users are addressed. Once this has been done and the technology sufficiently developed, it is expected that manufacturers will wish to market this technology to the general public.

6.21 Automated vehicle technologies are expected to provide substantial benefits for road safety, since human error is a factor in over 90% of injury collisions.[12] More vulnerable road users such as pedestrians, cyclists, disabled people and young children may potentially benefit most from this technology.

6.22 It will be important to ensure that these potential improvements in safety for other road users are realised as these vehicles are introduced to our roads. Designers and developers of the automated technology fitted to these vehicles will need to ensure they are sufficiently cautious, particularly around vulnerable road users, to ensure that their safety is maintained or improved. At the same time automated vehicles must be designed so as not to unduly impede other road users.

6.23 Highly automated vehicles must be developed in a way that they undertake necessary manoeuvres, such as overtaking a slower moving vehicle or vulnerable road user in a safe and cautious manner. The potential safety benefits of automated vehicles would be particularly valuable in such complex and challenging situations, so there should be no incentive for a user to try and take over control to make quicker progress by carrying out an unsafe manoeuvre.

12 In 2013, a factor relating to human error was reported in 94 per cent of all accidents: contributory factors under 'injudicious action', 'driver/rider error or reaction', 'impairment or distraction', 'behaviour or inexperience' and 'pedestrian only' in RAS50001 were deemed to be related to human error.

6.24 A potential advantage of automated vehicles is that they will not be intimidated or bullied into risky manoeuvres or behaviours by other road users. For example evidence suggests that many drivers feel pressured by tailgating and aggressive behaviour from other motorists if they drive at or below the posted speed limit and obey all aspects of *The Highway Code*.

6.25 If automated vehicles are designed to exhibit 'optimal' driving behaviours then this may result in other road users improving their behaviour, either consciously or sub-consciously. Such a beneficial effect would be expected to increase as numbers of automated vehicles on the road increased, with consequent safety benefits. Alternatively it is possible that if automated vehicles behave significantly differently from typical human drivers this could result in other road users failing to correctly anticipate their movements

6.26 Therefore, some aspects of the introduction of highly automated vehicles and their effect on other road users will need to be carefully monitored by the Department to ensure there are no unintended consequences. For example, when operating in an automated mode, these vehicles will enable the person sitting in the driver's seat to disengage from driving and undertake other activities such as reading a book, or using a handheld mobile phone or laptop. The impact of this on the behaviour of other road users needs careful consideration.

6.27 Vehicles operating in a highly automated mode may be able to follow other vehicles more closely than conventional drivers without compromising safety, for example when in communication with the vehicle that they are following (sometimes known as Platooning). As highlighted in Chapter 5, research indicates this can result in other drivers adopting similarly close following distances. The implications of this would need to be carefully considered and guidance for vehicle manufacturers, drivers and the police may need to be developed.

6.28 *The Highway Code* may need to be updated in due course to take into account the use of highly automated vehicles on the roads. It may be necessary to wait until experience has been gained with these vehicles and possibly research has been conducted into the interactions between such vehicles and other road users.

6.29 **Action: Determine whether a section on automated vehicles should be developed and included in *The Highway Code*, to help guide how road users should interact with these vehicles.**

Production and marketing of fully automated vehicles

6.30 Fully automated vehicles will not necessarily be fitted with any manual driving controls. Their design could be substantially different from vehicles on the road today, for example they would not necessarily have any forward visibility through a windscreen.

6.31 Fully automated vehicles may also operate without any occupants. They could also be used as transport by those unable to drive a manually controlled vehicle such as children or people who are visually impaired.

6.32 The impact of these developments on other road users will need to be carefully monitored, however it is not anticipated that this would lead to negative outcomes provided the technologies and presence of these types of vehicles on the road are adequately explained and understood by other road users.

7. Product liability

Introduction

7.1 Any business which provides products to consumers has a responsibility to ensure that those products are safe. Anyone who is injured or suffers personal loss as a result of an unsafe product may have the right to sue the company which produced and provided that product. In certain circumstances, manufacturers and suppliers of unsafe products can also find themselves criminally liable for their actions.

7.2 Vehicle manufacturers are already at risk of legal action and being held liable if it is found that a collision occurred as a result of a fault with their product. This includes collisions which result from a failure of a 'semi-autonomous' technology such as anti-lock braking or adaptive cruise control. In each case a court would need to examine the evidence regarding any failure of the vehicle and the actions of the driver, and determine the extent to which the manufacturer should be held responsible.

7.3 One crucial factor would be whether the failure occurred as a result of a design or manufacturing defect, or whether the failure could be attributed to other factors – for example, if the vehicle had not been serviced or maintained in accordance with the manufacturer's requirements. Depending on the circumstances of the case, there may be a number of legal options available to injured parties. Most notable would be the possibility of direct action against a vehicle manufacturer or importer under the Consumer Protection Act 1987 for supplying a 'defective' product, or alternatively a claim in negligence.

7.4 It is anticipated that the legal position for liability in relation to features on vehicles which incorporate higher levels of automation would not be significantly different to those for semi-autonomous elements at present. If a collision was found to be caused by a fault or failing associated with the vehicle and its technology, then the manufacturer would be at risk of being held liable. As more and more semi-autonomous features are introduced into vehicles, there is the potential for some difficult legal questions to arise in relation to how these features are designed to perform and the expectations of the general public compared to the expectations of manufacturers. Whilst the question of legal liability for defects may remain as it is currently, the question of what legally constitutes a 'defect' in a vehicle may be much more difficult to resolve.

7.5 Questions over liabilities are frequently cited as a significant barrier to the introduction of automated vehicle technologies. While the subject certainly requires careful consideration, our analysis of the existing situation indicates that liability concerns should not prevent trials of automated vehicles taking place on public roads. For the full-scale roll-out of automated vehicles, more detailed examination of the issues is recommended.

7.6 The vast majority of collisions involve human error. In 2013, a factor relating to human error was reported in 94 per cent of all recorded road injury collisions. By contrast vehicle defects were a factor in only 2%. The successful roll out of automated vehicle technology therefore has the potential to substantially reduce the numbers of collisions, deaths and injuries on UK roads.

Background

7.7 In the event of death, personal injury or damage to private property (of more than £275) resulting from a 'defective product', the Consumer Protection Act 1987 provides injured parties with a legal course of action against manufacturers (and importers) for compensation.

7.8 The Act removed the need for an injured party to prove a manufacturer was negligent before being able to claim damages. While a separate course of action may still exist against a manufacturer in the tort of negligence, the burden in such a case would be upon the claimant to prove fault. In the case of an action under part 1 of the Consumer Protection Act, it is not necessary to prove the manufacturer was at fault. The Act imposes a form of strict liability where a product is shown to be 'defective'. The Act defines a defective product as one where "the safety of the product is not such as persons generally are entitled to expect".[13]

7.9 The definition of a 'product' in the Consumer Protection Act is wide enough to include motor vehicles. The Act therefore imposes strict liability for injury or damage on manufacturers and importers of automated vehicles where the vehicle is found to be defective. A number of statutory defences are available for manufacturers and importers under the Act, and these are discussed below.

7.10 In considering the safety of products placed on the market, a number of responsibilities have been established for any business providing products to consumers, as follows:

- a responsibility to warn consumers about potential risks;
- a responsibility to provide information to help consumers understand the risks;
- a responsibility to monitor the safety of products; and
- a responsibility to take action if a safety problem is found.[14]

13 UK Government, Consumer Protection Act 1987. (Available here: http://www.legislation.gov.uk/ukpga/1987/43/section/3)

14 UK Government, Product liability and safety law. (Available here: https://www.gov.uk/product-liability-and-safety-law)

7.11 Vehicle manufacturers would therefore be expected to provide adequate instructions and information on the appropriate use of any automated driving features together with clear explanations of any potential risks.

7.12 It is standard practice for vehicle manufacturers to monitor the safety of their products. If a particular problem is discovered then after discussion with the DVSA (Driver and Vehicle Standards Agency), action is normally taken in the form of a 'safety recall'.

7.13 The Consumer Protection Act 1987 implemented the European Product Liability Directive 1985. Consumers therefore benefit from the same protection across the EU and all businesses operating in the EU are subject to the same rules. The UK, like all other Member States, is therefore restricted in how it can adapt and amend its domestic legislation on product liability as it cannot depart from the regime created by the harmonised EU rules. In looking at questions of interpretation of the UK's domestic rules on product liability, the courts will look to the European Directive and interpret our rules in the light of the harmonised rules.

Determining liability

7.14 The most common question raised with respect to automated vehicles is who would be held responsible in the event of a collision – the 'driver' (or operator or occupant) or the vehicle manufacturer?

7.15 In reality this question is too simplistic. In most road traffic collisions there is a range of different people or bodies which may bear or share liability:

- Vehicle drivers
- Vehicle owners
- Vehicle operators
- Vehicle manufacturers
- Vehicle suppliers/importers
- Service providers
- Data providers

7.16 Each of these parties may be found to be civilly (or in some cases criminally) liable to a greater or lesser extent depending on the exact circumstances of the situation. In the event of a collision where the parties are unable to resolve where liability lies between themselves, this process would probably take place in a court of law. All the available evidence would be examined in detail and a judge would assess whether each party is liable in law and the extent to which their fault had contributed to the loss.

7.17 Currently the vast majority of collisions are found to be due to human error, however vehicle manufacturers may also be held to be liable and subject to legal action in instances where it can be shown that they failed to fulfil their legal obligations.

Potential product liability claims

7.18 The wording of the Consumer Protection Act defines a defective product as one where the safety of the product is not such as persons generally are entitled to expect. Thus the assessment of defectiveness does not refer to either the expectations of the particular person who may have been injured or to the particular producer of the product. The claimant must show that a defect in the product caused the injury but it is not necessary to go further and show what caused the defect.

7.19 Where a court is asked to determine whether a product is 'defective' under the Act, it will look at the question of what persons are 'generally entitled to expect' by taking into account all the circumstances. In particular, section 3(2) of the Act specifically cites those circumstances as including:

- The manner in which, and the purposes for which, the product has been marketed, its get-up, the use of any mark in relation to the product and any instructions for, or warnings with respect to, doing or refraining from doing anything with or in relation to the product;
- What might reasonably be expected to be done with or in relation to the product; and
- The time when the product was supplied by its producer to another.

7.20 Section 3(2) also states a defect will not be inferred to exist in a product purely from the fact that a safer version of the product is subsequently put on the market.

Manufacturing defects

7.21 Manufacturing defects are defects which occur as a result of the manufacturing process which lead to the product departing from its intended design and not conforming to its precise intended specifications. The design of the product may be perfectly safe when correctly manufactured but a fault in the manufacturing process might lead to an unsafe product which then causes injury.

7.22 To take the example of an automated vehicle, sensors designed to scan for oncoming traffic may not detect traffic because they have been manufactured incorrectly.

7.23 A manufacturing defect could also include software related problems. Computer software is likely to form an intrinsic part of the automated features on a vehicle. The software might be designed and intended to perform in a certain way but may then produce different results for a variety of reasons.

Design defects

7.24 Design defects are defects in the original design itself. This means that the product was manufactured precisely in accordance with the design, but the design itself was flawed. A design defect may lead to a product being unsafe and then causing injury.

7.25 To take the automated vehicle example, a sensor may not be designed to withstand exposure to wet conditions despite being located in an area of the vehicle which is exposed to such conditions.

7.26 Questions surrounding design defects tie in heavily with the 'state of the art' defence discussed below. It may well be the case that a collision and injury occurred as a result of the design of a product. However, it may also be the case that at the time the product was sold, the state of scientific and technical knowledge was not such that the design defect could have been discovered. To take the automated vehicle example again, a software system on a vehicle may be 'hacked' by a third party causing the vehicle to be involved in an accident. However, the 'state of the art' defence may be relevant when considering the question of the 'defectiveness' of the vehicle or any of its components if, at the time the vehicle was sold, it would not have been possible to envisage the nature of the 'hacking'.

Failure to warn

7.27 Vehicle manufacturers have a duty to warn of hidden dangers and how to safely use a product. Established vehicle manufacturers would be expected to be familiar with the need to ensure that the vehicle owner's manual provides sufficient information and warnings to avoid failing to comply with this obligation.

7.28 Consumers may not fully appreciate the correct usage requirements of more complex new technologies such as semi- or highly automated operating modes, and may have exaggerated expectations of the capabilities of the technology. Such new technologies may therefore require more explicit and detailed warnings with a greater onus on ensuring such warnings are brought to the attention of consumers and understood.

7.29 A key area will be managing the transitions in which a driver is required to resume manual control of the vehicle. Vehicle manufacturers will need to ensure that the process is clear, easily understood and that new vehicle owners are made aware of how to safely operate the system. It is possible that purchasers of new vehicles could be given specific training on safe use of their new vehicle.

Figure 7.1 – Automated vehicle requesting the driver to retake control

7.30 Questions over product liability are further complicated when considering the ongoing maintenance requirements of complex products, such as motor vehicles. Any evidence as to the defectiveness of a vehicle or a component part are likely to be difficult to resolve if questions arise as to the condition of the vehicle generally and whether it has been maintained in accordance with the manufacturer's requirements or modified in a material way.

Potential product liability defences

7.31 In addition to the requirements which claimants must prove in order to bring a successful product liability claim (for example, the requirement to prove that the product was defective in a claim brought under part 1 of the Consumer Protection Act), there are a number of defences that a manufacturer might put forward against such claims. For a claim under the Consumer Protection Act itself, there are several express defences listed in the Act. Those which seem most relevant to vehicle and vehicle component manufacturers are:

- the defect is attributable to compliance with mandatory requirements such as domestic or European law;
- the defendant did not at any time supply the product;
- the defect did not exist in the product at the time the product went into circulation;

- in relation to component parts, the defect is essentially a defect in the vehicle and where the defect relates to the component part, it is wholly attributable to either the design of the vehicle itself or to instructions given to the component manufacturer by the vehicle manufacturer; and
- the ‘state of the art’ defence.

State of the art

7.32 Section 4(1)(e) of the Consumer Protection Act provides a statutory defence to a civil claim in relation to product liability made under Part 1 of the Act (the ‘state of the art defence’). It states that in a claim in respect of a defect in a product, it is a defence to show that:

7.33 “the state of scientific and technical knowledge at the relevant time was not such that a producer of products of the same description as the product in question might be expected to have discovered the defect if it had existed in his products while they were under his control”

7.34 The wording of the defence in section 4(1)(e) should be interpreted in light of the wording of the origin of the defence in the European Product Liability Directive. The Directive states (see Article 7(e)) that ‘the producer’ shall not be liable as a result of the Directive if he proves that:

7.35 “the state of scientific and technical knowledge at the time when he put the product into circulation was not such as to enable the existence of the defect to be discovered”

7.36 Since the technologies and understanding involved in automated vehicles may evolve and improve rapidly over time, especially during their early introduction, this defence may be particularly relevant when considering questions of manufacturer liability for potential defects in vehicle technologies.

Contributory negligence and other party’s negligence

7.37 In addition to the statutory defences mentioned above, the Act also makes it clear that contributory negligence shall be taken into account when considering an award of damages to a claimant. Contributory negligence refers to the process whereby the court apportions the responsibility for injury between the claimant and the defendant, having regard to the claimant’s own lack of care. For example, where a court finds that a manufacturer is liable for a defect in a product which caused injury, the court may also rule that the actions of the claimant were part of the cause of the injury or contributed to the severity of the injury. This is taken into account in the award of damages the claimant may receive – the greater the claimant’s contributory negligence, the more the award of damages will be reduced.

7.38 A classic example of contributory negligence is where a driver fails to wear a seat belt. It may well be the case that a vehicle collision occurred through no fault of the driver. However, if the driver was not wearing a seatbelt, the injuries suffered are likely to be far greater than if a seatbelt was being worn. As it is, in the vast majority of cases, a legal requirement to wear a seat belt, the court may well decide that the driver must accept a level of responsibility for any injuries suffered. If so, any award of damages will be reduced accordingly.

7.39 When considering liability in the context of automated vehicles, it is possible to envisage scenarios where a vehicle manufacturer might seek to argue that the claimant or some other party's actions were negligent and caused the collision. For example, where an automated feature fails on a vehicle and this leads to a collision, the manufacturer may seek to argue that the driver should have resumed control of the vehicle within a reasonable amount of time and averted the collision. This issue is closely linked to the original question over liability for 'defects'. For example, where a vehicle system warns the driver that it is about to exit autonomous mode (even if the exit itself is caused by a failure of the automated system), it might be argued that there was no 'defect' in the vehicle and it performed in accordance with the manufacturer's intentions.

7.40 As mentioned above, when a court is asked to determine whether a product is 'defective' under the Act, it will look at what persons are generally entitled to expect from the safety of a product by considering circumstances such as the marketing of the product, the product's instructions and any special warning as to risks. So these issues should not be confused with primary issues surrounding the liability of a manufacturer or importer for defects in a product.

7.41 In any case of that sort, a court would need to consider whether the driver or vehicle occupant was sufficiently aware of the potential for a collision and take into account their ability to avoid a collision. For example, the driver may have been taking advantage of the automated driving mode to undertake other tasks so may not have been aware of an impending collision, or have been unable to react in time to intervene.

7.42 This would be a potentially complex judgement which would be dependent on the exact circumstances of an individual case. It will therefore be important to have sufficient information available to determine what these circumstances were.

Misuse of a vehicle

7.43 Another issue which has the potential to engage both questions over the existence of a defect in a vehicle and the possible negligence of the driver is misuse of the vehicle. A vehicle manufacturer could argue before a court that the vehicle was being misused and therefore it should not be found that there was a defect with the vehicle. As above, where a court assesses whether or not a vehicle contained a defect, it will look at all the circumstances of the case. The Consumer Protection Act states that the following should be taken into account:

7.44 "the manner in which, and purposes for which, the product has been marketed, its get-up, the use of any mark in relation to the product and any instructions for, or warnings with respect to, doing or refraining from doing anything with or in relation to the product"

7.45 Where a driver uses a vehicle in a manner which was clearly not intended or ignores a warning then the court might find that the vehicle was not defective. The Act also provides that a court should take into account "what might reasonably be expected to be done with or in relation to the product".

7.46 There is clearly the potential for conflict between these two considerations. Manufacturers may have a somewhat different view of the purposes for which certain features on a vehicle may be used and their limitations compared to the expectations of the general public of those features. A court would need to weigh up these competing considerations based on the facts of any one case but it would be reasonable to assume that a court would expect a manufacturer to have at least considered any reasonably foreseeable misuse of a product.

7.47 Whether a court would accept that a warning against reasonably foreseeable misuse would be sufficient or whether a court would require further safeguards (such as a design feature to prevent such misuse or a failsafe system in the event of such misuse) would depend on the circumstances. Where a court declares that a product is defective, notwithstanding an argument as to misuse of the product, it would be likely that the defendant would raise misuse of the product again in the context of seeking to show the claimant's contributory negligence or another parties' liability and reduce an award of damages or its own liability accordingly.

Potential difficulties for claimants

7.48 As has been described, vehicle manufacturers could face possible legal challenges in the event of a failure of automated vehicle technology. However, an important consideration is the potential difficulty for claimants in proving liability.

7.49 Due to the complexity of the technologies involved, a claimant may need to call on expert evidence. For example, an expert may be needed to prove to a court that a collision could only have happened through a malfunction of the technology and not by any other action of the claimant.

7.50 Equally, establishing exactly what may have been considered to be 'state of the art' at the time of the vehicle's development could again require detailed technical expertise.

7.51 The complexity of the technologies involved, the cost of obtaining expert witnesses and the potential for evidence of any manufacturing defect to be destroyed in a subsequent collision could mean that the chances of bringing successful product liability claims against automated vehicle manufacturers are limited.

Testing of automated vehicle technologies

7.52 The Consumer Protection Act creates liability for manufacturers who have 'supplied' vehicles or components and, as discussed above, there is an express defence for defendants who have not supplied defective products. It is, therefore, unlikely to be relevant to the prototype testing of highly automated vehicles since these vehicles will probably remain the property of the vehicle manufacturer or testing organisation.

7.53 The test driver, the vehicle manufacturer and the vehicle operator may all be held potentially liable in the event of a collision occurring during testing of an automated vehicle. It will be important to have sufficient evidence available to determine the exact circumstances and causes of any specific incident.

7.54 **Action: Specify requirements for data recording. In the event of an incident or collision this data should be made available to the relevant authorities in a format which allows them to conduct analysis of the circumstances leading to the event.**

7.55 **Action: Require that testing is conducted with a suitably qualified test driver who is ready and able to take control.**

7.56 **Action: Require that test drivers are authorised by the organisation responsible for testing and should receive training on the safe use of the vehicle from that organisation.**

Production and marketing of highly automated vehicles

7.57 When vehicles are marketed as having an automated mode in which the driver can 'disengage' from the driving task and engage in other activities, our initial opinion is that liability for the safe operation of the vehicle while in this mode rests with the vehicle manufacturer.

7.58 The crucial consideration is how and when this liability transfers back to the driver. Some highly automated vehicles are expected only to be able to operate autonomously in certain limited driving conditions (particularly when the technology is first introduced). When these conditions are no longer met, they will have to alert the driver to the need to resume manual control. Once manual control is correctly resumed, liability for safe operation of the vehicle would pass back to the driver.

7.59 Our initial opinion is that it would be reasonable to assume that liability would only pass back to the driver when and if the driver willingly chooses to resume manual control. We do not believe it would be appropriate for a vehicle manufacturer to design a system that attempted to switch back to manual control without the driver's consent. If for some reason the driver does not resume control, our opinion is that the vehicle's automated systems would need to be designed to ensure that it could safely bring the vehicle to a halt.

7.60 As automated vehicles gain market share, issues concerning product liability may need to be monitored to ensure that existing legislation is working correctly to protect consumers and the general public. As has been discussed, there may be concerns about the changed nature of liability claims where these are brought as actions about the condition of the vehicle. The impact on the cost and ability to bring claims against vehicle manufacturers will be something to keep very much in mind, particularly if it makes ordinary claims more difficult to bring forward and dependent on a need for expert witnesses. However the nature of any changes would need careful consideration and is outside the scope of this review.

Production and marketing of fully automated vehicles

7.61 In a fully automated vehicle there may be no controls available for an occupant to be able to take manual control. As a result, the question of liability may be simplified. Nevertheless these vehicles may still have an 'emergency stop' button. If it is judged that the occupants of vehicles such as these cannot be held liable in the event of a collision, there is still a question as to whether there is a case for users to bear some form of financial liability. This could be in the form of mandatory insurance.

7.62 At least one company developing such vehicles has suggested that the company itself should be held responsible for any road traffic offences the vehicle may commit.

7.63 Fully automated vehicle use on public roads would clearly require a further comprehensive review and fresh legislation to address some of these fundamental questions over driver versus vehicle liability.

8. Standards for new vehicles

Background

8.1 All road going vehicles are required to comply with safety and environmental standards as a condition of being registered for road use. The standards vary depending on the category of vehicle and are ultimately set by various national and international bodies.

8.2 The majority of new vehicles are subject to the European type approval process prior to registration, and this provides third party verification that the required standards are met. Specialist vehicles intended for limited road use are exempt from this process: for example diggers and excavators, forklift trucks, airport baggage hauling vehicles.

Figure 8.1 – Concept vehicle showing how passengers in automated vehicles could enjoy other activities during the journey

8.3 Type approval is the process whereby a government agency issues certification that a vehicle or range of vehicles complies with legally required safety and environmental standards. The UK Regulations requiring type approval,[15] implement EU legislation (primarily Directive 2007/46/EC for cars) which sets up harmonised EU-wide standards,

15 The Road Vehicles (Approval) Regulations 2009 (S.I. 2009/717).

known as the European Whole Vehicle type approval scheme.[16] Some of these standards in turn refer to international regulations, such as UN Regulations.[17]

8.4 There are alternatives to the European Whole Vehicle Type Approval scheme which is designed for mass production vehicles; such schemes, National Small Series or Individual Vehicle Approval, are specified at the national level and although the requirements under them must be based on the relevant EU rules, certain relaxations are possible where justified, taking into account the needs and capabilities of specialised low volume manufacturers or importers, and bearing in mind the limited effect that permitting these exemptions would have.

8.5 For the initial testing and development of new vehicle technologies, modified versions of existing type approved production vehicles will often be used. However it is recognised that vehicle manufacturers will need to test prototypes of new models they are developing on public roads. For this reason European legislation permits the registration of prototypes without type approval. The need to obtain type approval in such circumstances would be excessively burdensome given the small quantities of vehicles involved, and the iterative nature of the design process.

8.6 The UK uses this derogation, and the DVLA will permit registration of prototype vehicles on condition that they remain under the control of the manufacturer conducting the testing and are designed specifically for tests or trials. This exemption from the process of type approval does not mean that manufacturers have carte blanche. The vehicle must be roadworthy and must meet the national in-service requirements, which are discussed in Chapters 9 and 10, although some exemptions are available to prototypes when necessary.

Testing of automated vehicle technologies

8.7 A highly automated vehicle that is intended to be used for testing purposes, is likely to fit the definition of prototype assuming that the vehicle manufacturer or modifier retains control and oversight of any testing that takes place and therefore can be registered in the UK under the conditions that apply to the registration of prototypes mentioned above.

8.8 Whilst in use the vehicle would have to comply with roadworthiness standards covered in Chapter 9 and be used safely in compliance with Chapter 10.

16 Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles, their trailers, and of systems, components and separate technical units intended for such vehicles (commonly referred to as "the Framework Directive").

17 Regulations made by the United Nations Economic Commission for Europe pursuant to the Agreement of 1958, as amended.

Production and marketing of highly automated vehicles

8.9 Once sufficient testing has been completed, manufacturers are likely to wish to move into the mass production phase and sell or lease highly automated vehicles to the public for domestic or business use. At this stage the vehicle would no longer be a prototype and therefore would require type approval.

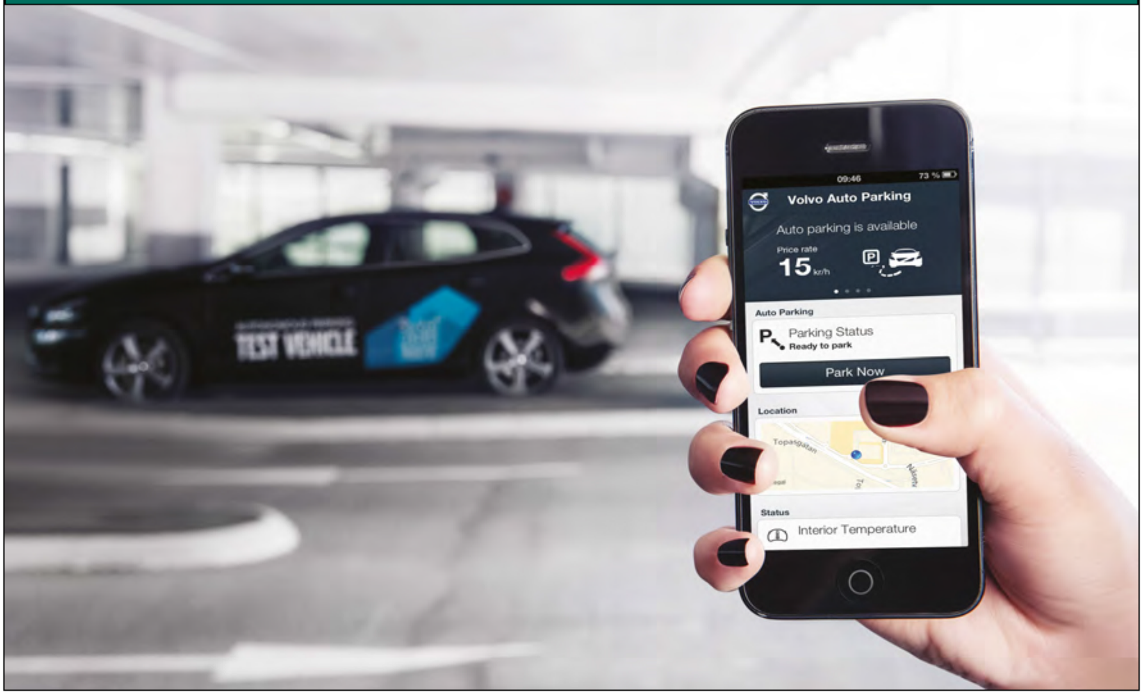
8.10 Our initial analysis suggests that a highly automated vehicle could comply with type approval, with the exception of UN Regulation 79 (Steering systems), which does not permit "Automatically Commanded Steering" (or automated steering) above speeds of 10km/h. In addition, UN Regulation 13 (Braking systems) does cater for "Automatically Commanded Braking" but may require some examination to confirm its suitability. This section of the existing regulation is suitable for particular scenarios rather than routine use, for example:

- Electronic Stability Control (ESC) applying the brakes on selected wheels for stability reasons, or
- Advanced Emergency Braking System (AEBS) automatically braking the vehicle when a collision seems likely.

8.11 Turning to vehicle ergonomics, for mass production it may be necessary to standardise such matters as the warning tone or tell-tale which would be used on highly automated vehicles to inform the driver that he needs to take back control, to avoid confusion amongst the public when moving between different vehicles. This is similar to the way that existing vehicle tell-tales and warning lamps are standardised. It would make sense to start work in the near future on assessing the necessary requirements.

8.12 Manufacturers are thought to be developing applications that deliver full or near-full automation for low speed applications without a driver in the vehicle, such as vehicle parking in tight spaces. Nevertheless the vehicle is a standard vehicle with a full set of controls. Such a vehicle could be tested with a person seated in the vehicle. Existing legislation appears to allow the production and sale to the public of vehicles which can be controlled in this way without a driver in the vehicle. However it may be beneficial to amend legislation to clarify this and examine the need to include additional safeguards for example with restricted speeds and with the driver in close proximity and ultimately with the ability to over-ride the vehicle.

Figure 8.2 – Automated parking system, operated from a mobile phone application



8.13 **Action: Examine the need to amend legislation to clarify when driving is allowed with the driver absent from the vehicle, and the need to include additional safeguards.**

8.14 **Action: Engage the international community, through the European Union and the United Nations Economic Commission for Europe, to examine the vehicle type approval framework and its detailed technical standards to ensure suitability for automated vehicles.**

8.15 **Action: Examine whether standardisation of the warning symbols and system for the driver to re-take control in an automated vehicle is required.**

Production and marketing of fully automated vehicles

8.16 For a fully automated vehicle, the issues are similar to those for high automation, but the vehicle itself is designed to be capable of being in control the whole time rather than some of the time. Essentially the same recommendations apply as for the high autonomy section above, but clearly further detailed analysis of the type approval system and requirements within it would be necessary on a European (EU) and international (UN) level.

List of the relevant primary and secondary legislation

- Road Traffic Act 1988
- Road Vehicle (Approval) Regulations 2009 (S.I. 2009/717)
- Road Vehicles (Authorisation of Special Types) (General) Order 2003 (S.I. 2003/1998)
- Road Vehicles (Construction and Use) Regulations 1986 (S.I. 1986/1078)
- Road Vehicles Lighting Regulations 1989 (S.I. 1989/1796)

9. Vehicle roadworthiness and maintenance

Introduction

9.1 All vehicles used on the road must be roadworthy. This means they must not be in a condition that endangers the driver or other road users (for example by having bald tyres, or brakes that do not work). (See Figure 9.2)

9.2 Before a manufacturer can sell a new design of vehicle to the public, it must be approved (either by type approval or single/individual vehicle approval), as discussed in Chapter 8. Many countries also have a set of requirements regarding roadworthiness. These will detail the characteristics, such as the technical features, specified limits and restrictions that are required to be maintained, and lay down offences and the penalties for contravention of those requirements where a vehicle is operated in an unsatisfactory condition or driven outside of particular parameters.

Figure 9.1 – MOT testing station sign

9.3 In the UK, separate regulations set out requirements for regular testing of most categories of vehicle. Cars over three years old are subject to the "MOT test", an annual roadworthiness test conducted by private or local authority controlled garages.

9.4 Lorries are tested once they are one year old, and thereafter annually, by inspectors from the Driver and Vehicle Standards Agency (DVSA). Operators of lorries used for the carriage of goods are required to conduct regular checks to ensure that their vehicles remain roadworthy at all times as part of their licensing for that activity. Drivers of lighter vehicles not used for the carriage of goods and therefore not subject to operator licensing are not subject to this requirement but are strongly recommended to check their vehicle regularly to ensure that it meets the legislative requirements.

9.5 Prototype vehicles designed and constructed for tests or trials are permitted exemptions from certain roadworthiness requirements, where necessary, under "Special Types" regulations.[18] Where such exemptions are utilised, an exemption from the annual roadworthiness test is available. This does not mean that such a vehicle can be permitted to be in an unsafe or sub-standard condition since all vehicles are subject to regulation 100 of the Road Vehicles (Construction and Use) Regulations 1986. This provides an over-riding requirement for a vehicle to be safe and maintained in a safe condition. This is discussed in more detail in Chapter 10.

Figure 9.2 – Vehicle defects are a factor in about 2% of injury collisions

Testing of automated vehicle technologies

9.6 An automated vehicle under test would have to comply with the existing roadworthiness regulations applicable to all prototype vehicles. Assuming that the vehicle is designed with a full set of manual driver controls our initial analysis has not identified any likely

18 The Road Vehicles (Authorisation of Special Types) (General) Order 2003 (S.I. 2003/1998).

non-compliances. A vehicle undergoing tests or trials could benefit from specified exemptions which are available under the Special Types legislation. Those conducting the tests should examine the applicable provisions carefully to check compliance and whether exemptions are required.

9.7 A highly automated test vehicle which was over three years old would also require an annual MOT test. As automated vehicle technologies are still in development there are no special standards available for testing such vehicles beyond the existing requirements. The annual test verifies the condition of equipment that is required when the vehicle is new under type approval. Since standards for type approval of automated vehicle technologies have not yet been developed, it would be difficult and probably inappropriate to draft specific standards of roadworthiness at this stage.

Production and marketing of highly automated vehicles

9.8 Before highly automated vehicles can enter mass production it is anticipated that EU type approval standards would need to be updated to cover the new technologies and vehicle capabilities and that these would flow through to updated roadworthiness requirements. It would be expected that the EU Roadworthiness Directive 2014/45 would be updated and rules in Great Britain would then be updated in line with this. Ideally they would be drafted with consideration being given to easing the vehicle keeper's task of ensuring that the vehicle is roadworthy, and that it is obvious when the vehicle is not roadworthy.

9.9 Development of type approval standards should ensure that the performance of automated systems within vehicles can be easily and cheaply verified at the annual MOT test. The most common way that problems are currently indicated to the vehicle keeper is via a warning light, the illumination of which indicates that a particular system is not working and needs to be fixed. This is known as a malfunction indicator lamp (MIL). If the system is essential to the driving task the warning light is normally red and the vehicle should in principle not be driven.

9.10 Systems which are enhancements to the basic functionality of the vehicle generally have a yellow warning light, and the vehicle can be driven (with caution) when these systems are in a failed state. Normally such a system will switch itself off when in a failed state, to ensure no adverse effects on the vehicle. In addition regulations normally require such a system to be fail-safe.

9.11 Depending on the exact nature of the fault, it may be possible that a highly automated vehicle, with a defect in the automated systems, could still be driven in a manual mode by a driver. However it would be important to ensure that the automated mode was not accessible and that the driver was alerted to this fact. It would seem sensible to allow a highly automated vehicle to be used as normal, complying with all legal requirements, if the automated systems and technology were switched off, due to self-diagnosis of a malfunction for example. This could allow continued use of a vehicle that otherwise would have to be scrapped due to repair of the automated systems being uneconomic.

9.12 It may be that the current MOT format would be insufficiently sophisticated to cater for highly or fully automated vehicles, so that consideration may have to be given in due course to a system of testing and appropriate certification based on new type approval standards. This would provide reassurance to owners and users that the automated technology and features are working correctly and that the appropriate safeguards are in place in the event of a malfunction. When the new systems are initially offered to the market, it is possible that only manufacturers, main dealers or an independent technical body would have the level of technical expertise and equipment to carry out such testing and to provide the necessary certification.

9.13 **Action: Review existing roadworthiness testing processes and legislation over time to ensure they remain appropriate for highly automated vehicles.**

9.14 **Action: Ensure that malfunction of the automated technology is made clear to the driver and consider allowing use of the vehicle to continue in 'manual mode' only.**

Production and marketing of fully automated vehicles

9.15 In addition to the issues identified above for highly automated vehicles, numerous additional issues may arise with full automation due to the potential for these vehicles to have no manual driver controls such as a brake pedal or steering wheel. This would need a comprehensive review, as a number of regulations relate to and require various vehicle controls, such as brake pedal, handbrake, switches for lighting and so on.

9.16 There is likely to be a level of redundancy and duplication on a fully automated vehicle. There may also need to be self-disabling requirements that prevent a fully automated vehicle being used when certain systems are not functioning, in spite of an owner's wish to use it. There may be a temptation for the owner to send a vehicle on an errand as normal, bearing in mind that they would not personally experience the direct consequences of a collision.

Discussion of long term roadworthiness issues with highly and fully automated vehicles

Costs of repair

9.17 Currently, as vehicles age, repair of the more complex and expensive systems on board can become uneconomic. Often the vehicle is still driveable and may therefore continue to be used, however it is important to ensure that safety is maintained. In 2013 the MOT test was changed to introduce a failure item if a malfunction indicator lamp (MIL) is illuminated for a range of safety related systems, from supplementary restraint systems to electronic stability control. For highly automated vehicles, this issue needs further consideration. If there is a problem with the automation systems, such vehicles may still be able to be used in manual only mode. It will be essential to ensure that safety is maintained, but at the same time it would be preferable to avoid premature scrapping of vehicles, which harms sustainability and negatively affects those who cannot afford new vehicles.

Right to Repair

9.18 As vehicles become more complex, there is increasing concern as to the ability of parties other than franchised dealers to repair them, and this is likely to have an impact on the costs of repair. This sector encompasses everyone from breakdown operators, to fast-fit chains and independent garages. EU legislation regarding Access to Repair and Maintenance Information (RMI) requires that manufacturers commit to making repair information available on a non-discriminatory basis to official dealerships and independent repairers alike, and certain minimum information must be included on websites as part of vehicle type approval.

9.19 An automated vehicle is likely to be particularly complex and utilise proprietary technology extensively so manufacturers may not wish to permit or enable repair by other parties. They may be concerned that their Intellectual Property will be stolen if they reveal programing code and they might also be concerned with the potential for those of criminal intent to gain knowledge that enables them to hack into vehicles. This is certainly a pertinent issue that will need to be addressed as automated vehicles become more prevalent and is discussed in more detail in Chapter 15.

Different ownership models

9.20 There are various alternatives to the conventional ownership of vehicles. One possible option is that automated vehicles could be leased rather than sold to the public, thus allowing the manufacturer to retain control and specify conditions, such as requiring repairs or servicing to be performed only by the manufacturer themselves, or other parties that they specify. After several years of usage and wear, the vehicle could then be taken back from the customer, and refurbished or dismantled and recycled.

9.21 Another option would be for vehicles to be designed on a modular basis with easily exchangeable components, using industry standard communication protocols but controlled by specific software. This could allow easy upgrading of the electronic components and software while leaving the vehicle bodywork and seating unaffected.

9.22 It is beyond the scope of this Review to consider such possibilities in detail. However they need to be borne in mind as regulation develops.

9.23 **Action: Keep the issues of ease of repair and an appropriate vehicle lifetime under review as this area of technology develops.**

List of the relevant primary and secondary legislation

- Road Traffic Act 1988
- Road Vehicle (Construction and Use) Regulations 1986 (S.I. 1986//1078)
- Road Vehicle Lighting Regulations 1989 (S.I.1989/1789)
- Road Vehicles (Authorisation of Special Types) (General) Order 2003 (S.I.2003/1998).
- The Motor Vehicles (Tests) Regulations 1981 (S.I.1981/1694)

10. Safe use of vehicles

Introduction

10.1 As noted in Chapters 8 and 9, vehicles must be designed by manufacturers to be safe, and once a vehicle is in use, the user must maintain the vehicle in a roadworthy condition. In addition to this there is an obligation that the vehicle must not be used in a dangerous condition; in short it must be in a safe condition at all times.

10.2 This does not refer to careless or dangerous driving, which are covered under separate obligations (see Chapter 5), but covers aspects of the vehicle's condition which are in the control of the vehicle user and are not covered by the specific requirements regarding the mechanical condition of a vehicle that exist in type approval and roadworthiness legislation.

Section 40A of the Road Traffic Act 1988

A person is guilty of an offence if he uses, or causes or permits another to use, a motor vehicle or trailer on a road when —

a. the condition of the motor vehicle or trailer, or of its accessories or equipment, or

b. the purpose for which it is used, or

c. the number of passengers carried by it, or the manner in which they are carried, or

d. the weight, position or distribution of its load, or the manner in which it is secured,

is such that the use of the motor vehicle or trailer involves a danger of injury to any person.

10.3 This obligation is covered by a general obligation, contained in Section 40A of the Road Traffic Act 1988, and elaborated further in regulation 100 of the Road Vehicles (Construction and Use) Regulations 1986, and several specific obligations, contained in those Regulations and in the Road Vehicle Lighting Regulations 1989.

Vehicle not to be used in a dangerous condition – general obligation

10.4 The Road Traffic Act 1988 Section 40A makes it an offence for a person “to use, or cause or permit to use, a vehicle in circumstances where its condition, purpose, passengers, or load are likely to lead to a danger of injury to any person”. This would typically be invoked in circumstances where a more explicit offence does not exist but nevertheless the use of the vehicle is deemed to involve a danger of injury to any person (such as a user of the vehicle or another road-user).

10.5 The offence refers to the person “using” a vehicle, and also covers a person “causing or permitting another” to use a vehicle. This is wider than just “driving” a vehicle and therefore even in the case of a fully automated vehicle, it is likely that a person sending a vehicle on an errand could be considered to be “using” the vehicle and thus to be potentially liable. In the case of testing, the person or entity carrying out the testing could be deemed to be “causing or permitting another” to use the vehicle and thus be capable of being charged.

10.6 Regulation 100 of the Road Vehicles (Construction and Use) Regulations 1986 is a broadly similar provision. Again this refers to the condition of the vehicle, its load, and passengers, and contains more explicit provisions concerning the securing of loads, which are less relevant to the testing and operation of automated vehicles.

10.7 It is clear that the testing and operation of automated vehicles must involve safe vehicles and be conducted in a safe manner.

Specific obligations – construction and use

10.8 As well as the general obligations, there are a number of specific Construction and Use regulations setting out certain requirements or prohibitions necessary to avoid danger, as follows:

- A vehicle must be parked as close as possible to the edge of the carriageway (regulation 101).
- A vehicle must not be permitted to stand on the road so as to cause any unnecessarily obstruction (regulation 103).
- A driver must always be in a position to have full control of the vehicle and full view of the road and traffic ahead (regulation 104).
- Doors must not be opened in such a way as to injure or endanger any person (regulation 105).

- A motor vehicle must not be left unattended on a road unless the engine is switched off and the parking brake applied, with exceptions to the former requirement for the Emergency services and when the engine is needed to drive machinery on board or maintain battery charge (regulation 107).
- A prohibition on driving a vehicle where the driver is in a position to see (directly or by reflection) a television set (or other cinematographic apparatus) that is capable of displaying anything other than certain specified information related to the driving task (for example information about the state of the vehicle or the location of the vehicle) (regulation 109).
- A prohibition on the use of a hand held mobile phone or similar device, by a person while driving the vehicle (regulation 110).

10.9 These regulations are generally worded quite broadly, so as to apply to a person causing or permitting an action, or a person in charge of a vehicle, which is wider than purely referring to the “driver”. One or two of them may need to be reworded to make clear that they also apply to a person responsible for an automated vehicle.

Figure 10.1 – In the future drivers of automated vehicles may be permitted to use a hand-held mobile phone

10.10 In principle, the person responsible for the vehicle should be made liable, unless he or she reasonably expected the vehicle to comply automatically. It would be possible for type approval rules to be put in place that require a vehicle manufacturer to fit systems that prevent the vehicle from infringing any particular requirements that would lead to an offence being committed. For example, theoretically the vehicle could be programmed not to permit door opening in the vicinity of other vehicles or pedestrians.

10.11 As well as the above-mentioned safety related obligations in the Construction and Use regulations, there are some related to environmental matters (preventing unnecessary emissions and noise). These are as follows:

- A prohibition on using a vehicle in such a way as to cause excessive noise, which could have been avoided by the exercise of reasonable care on the part of the driver (regulation 97)
- A requirement for the driver of a vehicle to stop the engine when a vehicle is stationary, to prevent noise and emissions. Exceptions are allowed when the vehicle is stationary in traffic or when the engine is needed to operate on-board machinery (for example a concrete mixer) (regulation 98)
- A prohibition on sounding a horn at night on a road in a built-up area (regulation 99)

10.12 Regulations 97 and 98 specifically refer to the driver, which means that they would need modification in the case of fully automated vehicles which may not have a driver. The person responsible for the vehicle should be made liable, as noted above, unless type approval rules are changed to require the manufacturer to fit systems that prevent the vehicle from infringing the particular requirements.

10.13 For example, in the case of regulation 98, "stop-start" systems are now commonplace on cars, to reduce fuel consumption. They switch off the engine when a vehicle is stationary, even in traffic, and fitment of such a device might in practice avoid any possibility of a vehicle infringing this regulation.

10.14 Regulation 99 is written more broadly in order to cover a passenger sounding the horn as well as the driver, but is still restricted to "a person" so would also need rewording in order to prevent a vehicle autonomously sounding its horn at prohibited times. Again, these requirements could be met through vehicle design. However some settings may need to be altered by the dealer immediately prior to the sale of a vehicle depending on local market requirements.

Specific obligations – lighting regulations

10.15 There are a number of obligations related to vehicle lighting systems that apply to the driver and are designed to ensure that the appropriate lighting is used so that the vehicle is visible to others, without dazzling them. These are contained in regulations 24 to 27 of the Road Vehicle Lighting Regulations 1989 and include:

- Ensuring front and rear position lamps (and associated lamps such as rear registration plate lamp and side marker lamps, if any) are switched on at sunset, on a vehicle whether it is in motion or at rest, with the exception of vehicles parked in built-up areas (regulation 24)

- Ensuring headlamps are switched on (in effect) no later than half an hour after sunset, on vehicles in motion (except in built-up areas) (regulation 25)
- Ensuring that headlamps are switched on in conditions of seriously reduced visibility (heavy rain or fog) – unless front fog lamps spaced at least 400mm apart are switched on instead (regulation 25)
- Ensuring that the front and rear fog lamps are switched off, except in conditions of seriously reduced visibility: heavy rain or fog (regulation 27)
- Ensuring that use of any lamp does not cause undue dazzle or discomfort, and that headlamps and front fog lamps are switched off when a vehicle is parked (regulation 27)

10.16 These requirements are expressed in terms of "no person shall use, or cause or permit to be used, a vehicle" and thus are broader than simply referring to the driver. They capture anyone using the vehicle, or causing or permitting its use. This is probably wide enough to cover highly automated vehicles, but again may leave some uncertainty in the case of fully automated vehicles.

10.17 Many of these obligations would be relatively simple to automate, such as adding a light sensor to switch on headlamps in poor lighting conditions, which is common today on many cars. Type approval rules could be revised to include appropriate levels of ambient lighting at which lights may or must be switched on.

Testing of automated vehicle technologies

General obligation for safe use of vehicles

10.18 If a person allowed the use of an automated vehicle on the road without being in control of the vehicle and that vehicle had not been tested to ensure that its use did not involve a danger of injury, it is likely that the person would be in breach of the requirement not to use a vehicle or allow it to be used in a way that causes danger of injury to a person. Therefore there would need to be some evidence of testing conducted safely before such a vehicle could be used on the road.

10.19 In the absence of detailed standards covering these vehicles, it is felt there needs to be greater clarity as to what is considered safe, relating both to those in charge of testing, such as vehicle manufacturers, and those sitting in the vehicle carrying out the testing.

10.20 To facilitate testing and ensure that interested parties have greater clarity on what is meant by 'safe use of vehicles' the Department will draft either guidance or regulations, setting out more specific conditions around the testing of such vehicles, including the acceptable conduct of both test drivers and test operators.

10.21 **Action: Provide clarity on what should be considered 'safe vehicle use' in relation to the testing of automated vehicles.**

Specific obligations

10.22 During testing, an automated vehicle will still have a person supervising the testing who is capable of taking control of the movement and direction of the vehicle, either by choice or necessity in case of malfunction. It would be that person's responsibility to ensure that the relevant specific obligations listed above were complied with. For example, he or she would need to ensure that the correct lights were switched on, if this was not done automatically.

Regulation 104

10.23 Several stakeholders have highlighted that a driverless car may infringe Construction and Use regulation 104. This regulation is designed to ensure that the driver is not in a position where he cannot have proper control of the vehicle or a full view of the road ahead. This regulation would seem to be satisfied when the test driver has access to all necessary controls, even if not actively operating them, and is able to clearly see the road ahead.

Regulation 107

10.24 This regulation prevents a vehicle from being left unattended unless the engine is off and parking brake applied. During testing of an automated vehicle, the vehicle would not be expected to be left unattended, but the eventual introduction of fully automated vehicles would, by definition, allow for the possibility of an unattended vehicle having its engine on and releasing its parking brake, therefore an amendment would ultimately be needed to cater for fully automated vehicles.

10.25 The idea of using a remote control device linked to the vehicle wirelessly is under investigation by vehicle manufacturers, to enable a vehicle to exit from a parking space by remote control, perhaps via a mobile phone, in situations where another vehicle is parked too close to open the door. We do not think that regulation 107 would prohibit such a feature, as long as the person commanding the vehicle movement is in close proximity to the vehicle and thus could be said to be attending it.

10.26 Regulation 110 (see below) which prevents use of a hand-held mobile phone or similar device while driving, might be seen as preventing the marketing and use of such a feature.

10.27 On a separate point, devices to permit the engine to be started remotely and the vehicle to warm up are available. It might be appropriate to amend the Regulations expressly to permit such devices whilst ensuring controls are in place to prevent the vehicle inadvertently moving off, and to minimise fuel consumption and annoyance to others. This might perhaps be done by requiring an automatic shut-off on engine operation after a certain time while the vehicle is stationary.

Regulation 109

10.28 Stakeholders also highlighted Construction and Use regulation 109 as a possible issue. This regulation prohibits drivers from having a view (directly or via reflection) of television sets or other similar display screens. However it does not prohibit screens showing information related to the driving task: four specific criteria are set out which would permit screens which are, for example, displaying maps for satellite navigation systems, showing oil and fuel levels or showing the view from cameras mounted on the vehicle.

10.29 If any display screens are needed for testing purposes, it would be necessary for them to either display permitted information or else be visible only to the passengers in a vehicle.

10.30 The language in this regulation is quite outdated and alongside this, there have been suggestions from some groups that it does not cater for all necessary data display devices. This suggests that a review of this area would be timely.

Figure 10.2 – Volkswagen XL1 fitted with camera monitoring system

Regulation 110

10.31 This regulation prohibits 'driving' (which includes sitting in queueing traffic) whilst using a hand-held mobile phone or similar hand-held communication device. This provision may need amendment to cater for remote control of vehicles in car parks, as described above in the comments on regulation 107. We would suggest safeguards such as a speed limit of walking pace and a "positive control" arrangement such that the user must repeatedly tap a screen for movement, and if the battery in the remote device went flat, the vehicle brakes would be applied automatically.

Conclusions

10.32 There seems to be no inherent reason why a test driver supervising testing of an automated vehicle could not ensure compliance with all the current obligations.

10.33 Testing a vehicle capable of remote operation that is controlled by a hand-held device should be done away from the public highway, until Regulation 110 is amended to permit this.

Production and marketing of highly automated vehicles

General obligation for safe use of vehicles

10.34 Similar considerations apply to those for the testing of automated vehicles – new safety regulations or guidance would be needed. Requirements essential for safety should be incorporated in the vehicle type approval system if they are related to vehicle design. If they are related to vehicle use, then they could also be incorporated in the type approval system if possible, or they could remain as obligations on the user of the vehicle.

Specific obligations

10.35 In the future it may be deemed appropriate for the manufacturers of these vehicles to be obliged to design vehicle control software which ensures that, for example, the vehicle parks correctly, does not stand where it can obstruct traffic, that it turns the engine off when stationary, turns the headlamps on at night, and so on. Regardless of this, there may also need to be modifications to the relevant subordinate legislation to ensure that it remains the ultimate responsibility of the vehicle user to ensure that the vehicle is not used in way that means that it contravenes a legal requirement.

10.36 **Action: Review existing vehicle use requirements in the light of evidence and experience gained from automated vehicle testing. Consider how this should feed into European type approval requirements and domestic 'use' regulations.**

Production and marketing of fully automated vehicles

10.37 In the ultimate scenario of a fully automated vehicle, those responsible for it would have to ensure that it is capable of complying with all of the relevant regulations in terms of both general and specific obligations.

10.38 It seems likely that the vehicle would need to be fully programmed to respect all the specific obligations that are set out in law, as there would not necessarily be a driver on board to ensure this. It would be for the type approval system to impose the required specific standards on the vehicle, although given different in-use rules in different countries, there may need to be some harmonisation and adjustment of domestic legislation to obtain an EU-wide approval standard. Information on those obligations that were not harmonised across the EU could be made available to the vehicle so that it could modify its behaviour based on its geographic location and the rules that applied in that jurisdiction.

10.39 It may also be necessary for the person owning the vehicle to ensure that software is updated where this is necessary to ensure compliance with relevant regulations.

10.40 There may be some difficulty with prosecuting the person ultimately directing the vehicle under existing law for 'causing or permitting' offences, because many of these regulations include the phrase "no person shall drive, or cause or permit another person to drive…". This could be interpreted not to cover the scenario where there is no person driving the vehicle; it might, for example, be difficult to prosecute someone for parking a vehicle illegally when he is several miles away from the vehicle – albeit he is in control of it.

10.41 Clearly a detailed review of the relevant regulations and how legal responsibility is apportioned in relation to the operation of fully automated vehicles would be necessary prior to mass production and sale.

List of the relevant primary and secondary legislation

- Road Traffic Act 1988 Section 40A.
- Road Vehicles Construction and Use Regulations 1986, SI 1986/1078.
- Road Vehicles Lighting Regulations 1989, SI 1989/1789.

11. Vehicle tax, registration and licensing

Introduction

11.1 All vehicles used on the road are required to be registered and licensed by the Secretary of State, and the Driver and Vehicle Licensing Agency (DVLA) is the body which administers this process.

11.2 The register maintained by the DVLA is based on vehicles, and their registered keepers, who are responsible for their use and licensing on the road. It is not a register of legal title to vehicles. The register is essentially maintained to assist in revenue collection, road safety and law enforcement.

11.3 The registration and licensing process involves the applicant or dealer submitting an application, including payment of the appropriate amount of Vehicle Excise Duty (VED). Vehicle dealerships generally register vehicles using the Automated First Registration and Licensing (AFRL) system but a paper application on a V55 form is also possible. A vehicle registration document (V5C) and registration mark (enabling identification of the vehicle) is then issued.

11.4 Various changes to the vehicle, particularly those affecting the VED (for example conversion to electric propulsion) or important features in the appearance of the vehicle (colour, body style), must be notified to the DVLA and a revised V5C document will be issued.

Figure 11.1 – V5C registration document

Testing of automated vehicle technologies

11.5 There is nothing in the registration process that prevents the registration of a vehicle that is capable of highly automated operation. This assumes all of the required documentation can be provided including the type approval certificate (see Chapter 8). Under current regulations any change to a vehicle to incorporate systems capable of enabling automated operation does not need to be notified to DVLA.

11.6 If such vehicles were registered as 'prototypes' (see Chapter 8), as seems likely, then this would be recorded on the system. This would prevent such vehicles being sold on to the general public.

11.7 These prototype vehicles could be registered via the Automated First Registration and Licensing scheme or using the relevant V55 form. The vehicle must be registered in the manufacturer's name.

Production and marketing of highly automated vehicles

11.8 When automated vehicles start being produced and sold it may be desirable to specifically record their automated capabilities on the vehicle register. This could be done using a marker placed on the record to indicate the type of vehicle and tax class. This would necessitate changes to the registration system and DVLA would need to plan these changes in advance.

11.9 **Action: Consider the relative benefits and costs of whether to record the status of automation on the vehicle register.**

Production and marketing of fully automated vehicles

11.10 As noted above, any changes to DVLA computer systems to record these vehicles would need to be planned. More fundamentally, there may be other changes needed involving a more comprehensive review of the register.

List of the relevant primary and secondary legislation

- Vehicle registration and licensing are governed by the Vehicle Excise and Registration Act 1994 (as amended) and the Road Vehicles (Registration and Licensing) Regulations 2002.
- A Prototype vehicle is defined in the Road Vehicles (Approval) Regulations 2009 as a vehicle which has been specially designed and constructed for use on the road under the responsibility of a manufacturer for performing a specific test programme.

12. Road infrastructure standards

Introduction

12.1 This chapter considers how road infrastructure may need to develop to accommodate automated and/or connected vehicles as they come on-stream.

Road operator duties

12.2 There are legal duties for road operators (for example highway or traffic authorities) to consider, including (but not limited to) a duty to maintain the highways. This falls under section 41 of the Highways Act 1980 (“HA 1980”). Two other key duties include ensuring that traffic can move efficiently on their network, and facilitating the movement of traffic on other networks (section 16 of the Traffic Management Act 2004).

12.3 Highway authorities can be sued for damage resulting from failure to discharge their duty under section 41 HA 1980 and will be liable unless they can prove that the defence available under section 58 HA 1980 is applicable.[19]

Road markings, traffic signs and signals

12.4 Effective traffic management and compliance with traffic regulations is dependent on the provision of road markings, traffic signs and traffic signal controls, many of which are also safety critical.

12.5 At present road users take information from various sources. The driver is responsible for examining the road environment, assisted by mirrors and increasingly camera-monitoring systems and sensors. Many car manufacturers are already equipping their vehicles with cameras which recognise road markings and signs, for example, to support lane keeping technology and inform road users of speed limits and other prohibitions, regulations and warnings.

In-vehicle information and cooperative systems

12.6 Increasing amounts of real-time data and other information are now available to road users in different forms. This includes digital mapping

19 See section 58, “ Special defence in action against a highway authority for damages for non-repair of highway”, Highways Act 1980. (Available here: http://www.legislation.gov.uk/ukpga/1980/66)

information shown to the driver through satellite navigation systems, integrated display panels or through personal 'smart devices'. These systems now allow users to share real-time information such as congestion, road closures and weather conditions.

12.7 In the future, it is expected that even more road-related information will become available, and vehicles will have the potential to be connected to other vehicles (V2V) and to the infrastructure (V2I) to form part of an integrated, 'cooperative' traffic system. This offers the possibility of maximising the benefits of connectivity and information exchange to dramatically improve traffic management, as well as safety.

12.8 There are currently many standards and protocols in place to encourage road operators and highway authorities to liaise with map providers to deliver correct and up-to date map provisions.

12.9 The use of external information sources for automated decision-making, rather than driver judgement, may create liability issues that extend to information providers or suppliers of systems that provide advice to drivers or inform decisions by automated vehicles. This is complicated by the fact that it may be difficult to determine whether information failure was a contributing or determining factor in the case of a road traffic collision.

12.10 Testing of automated vehicles should help to examine and inform further debate about the potential technical, policy and liability issues around this. Nevertheless automated vehicles are likely to have a broader range of potential information sources available to them than human drivers of conventional cars.

Figure 12.1 – Connected vehicles will let drivers know traffic light status in advance

Testing of automated vehicle technologies

12.11 As noted in Chapter 5, Driver behaviour, we expect that for testing of automated vehicles, the driver will remain responsible for the safe operation of the vehicle at all times. This includes ultimate responsibility for navigating infrastructure legally and safely, complying with traffic regulations and responding to the road lay-out, traffic signs and signals.

12.12 The expectation is that during the testing phase the test driver will retain responsibility for the vehicle and no bespoke road infrastructure will be necessary. That being the case, the level of care required from highway authorities to discharge their duties under section 41 HA 1980 is unlikely to significantly differ from the legal standards currently required. Nevertheless, we recommend that organisations planning to undertake such testing first inform, consult with and seek the advice of the relevant authority or authorities before undertaking testing as it is possible that the particular circumstances of the road concerned may require a higher level of care and maintenance than would normally be expected from the highway authority.

12.13 Testing of automated vehicles will be a valuable chance for local highways authorities to get a first-hand insight into the possible future path of vehicle development. This is likely to reveal opportunities for improving both safety and traffic flows, while optimising the efficiency with which our road networks can be used.

12.14 Any specific infrastructure requirements that are considered necessary to support testing, including traffic signing, will need to be agreed with the appropriate authorities responsible for the roads and considered as part of the costs of the testing activity.

12.15 For the purposes of testing, any data or digital mapping required for trial purposes would be expected to be procured by the entity responsible for the trial.

12.16 **Action: Make clear that organisations planning to undertake automated vehicle testing should consult with the relevant highway authorities well before starting to test.**

Figure 12.2 – Connected vehicles will give advance warning of possible hazards

Production and marketing of automated vehicles

12.17 The introduction and sale to the public of highly or fully automated vehicles will not alter the continuing need for road infrastructure – including design, marking, signage and signalling, and associated standards – to cater for the existing 'non-automated' vehicle fleet.

12.18 The ability of automated vehicles to comply with and respond to the rules and regulations of the road ahead of them will be an important factor in the safe and legal operation of these vehicles. It is difficult to predict how technology might develop, but road markings, signs and signals are expected to play a vital role for the foreseeable future.

12.19 Consequently, as the technology evolves there may be a need for additional infrastructure – beyond existing requirements – to enable the adoption and operation of automated vehicles, for example if required to provide for wireless connectivity between vehicles and infrastructure.

12.20 While current driver assist lane keeping technology is generally dependent on visual recognition of road markings, it is not yet clear how highly automated vehicle technologies will develop. It would be reasonable to assume that vehicle manufacturers will ensure their products are robust to typical road conditions.

12.21 The standard that passes as "reasonable" now may or may not be enough when fully automated vehicles are part of the equation and that will very much depend on the proven capabilities of the new technology being developed. If there are deficiencies in that technology, it is possible that highway authorities would need to update and improve their standard practices (for example in relation to the maintenance of road markings) in order to avoid liability in future. Alternatively, any legal uncertainties as to liability could be addressed through new legislation – see paragraph 12.28 below.

12.22 Any requirements or standards for relevant infrastructure for automated vehicles are likely to be considered at European or international level, and government – in conjunction with road authorities, infrastructure providers, and vehicle manufacturers – will need to engage at the appropriate levels to represent UK interests.

12.23 **Action: Keep under review the need for and provision of standards and requirements for additional roadside infrastructure to enable the sale and operation of automated vehicles on public roads.**

12.24 **Action: Government to continue to engage at European and international level in the development and setting of regulations, standards and specifications in relation to the development and introduction of automated vehicles.**

12.25 As the technology develops, both government and road operators will need to consider the longer term implications this may have for future road infrastructure standards and investment needs – given the timescales associated with infrastructure delivery and life cycles. For example, there may be a need for additional infrastructure to support the widespread adoption of these vehicles, or the potential to reduce roadside infrastructure (and associated costs) as they become widely adopted.

12.26 In the longer term, technological development and market penetration may allow a fundamental review of how the road infrastructure is designed, constructed and operated.

12.27 Increasing vehicle automation and connectivity are not the only technology trends that will influence the future provision, design, construction, operation, management or use of road infrastructure. Any long term changes will also need to take account of other strategic and technological trends, such as climate change and uptake of ultra-low emission vehicles.

12.28 **Action: Government – in conjunction with road operators, vehicle manufacturers and other stakeholders – to keep road infrastructure design standards and long term roads policy under review in light of strategic and technological trends, including developments in automated vehicle technologies.**

Figure 12.3 – Road signs covered by snow

13. Insurance

Introduction

13.1 The insurance industry is keen to recognise and reward technologies that will make vehicles safer. In 2013, human error was a factor in 94 per cent of all recorded road injury collisions in Great Britain. (See paragraph 6.21 and Figure 13.1) The financial costs to the insurance industry and the wider costs to society of road collisions are substantial. The potential safety benefits of automated vehicles are significant and the responsible development of this technology should be promoted and encouraged.

Figure 13.1 – 94% of road injuries/deaths in 2013 involved human error

European requirements

13.2 European Union (EU) law on motor insurance is contained in Directive 2009/103/EC ('Motor Insurance Directive'). This directive obliges the use of all vehicles in the EU to be insured against third party liability and sets minimum thresholds for personal injury and property damage cover. Determination of who is responsible for a collision is not covered by the Directive; that is decided according to the rules on civil liability in the member state in which it occurs.

Current UK Law

13.3 The Motor Insurance Directive is implemented in the UK by Part VI of the Road Traffic Act 1988. Section 143 of the Act requires a person who uses a vehicle on a road or in a public place to have, or ensure that there is in place, a policy of insurance to cover the use of that vehicle by that person. Furthermore a person must not cause or permit any other person to use a vehicle without the required cover being in force. That policy must comply with the requirements set out in Part VI. Each vehicle has to be specifically named on an insurance policy since the introduction of Continuous Insurance Enforcement (CIE) in June 2011. Section 144, as an alternative, also allows self-insuring by means of provision of a deposit with the Supreme Court against claims.

13.4 Section 145 of the Road Traffic Act requires that a policy of insurance must cover the liability for injury to third parties or damage to their property which may be incurred by the person insured caused by, or arising out of, the use of the vehicle. The cover has to be unlimited for personal injury and up to £1 million for property damage.

13.5 The liability for injury or damage is a matter of civil law. If a person suffers injury or damage to their property because of the negligence of another person they are entitled to compensation from the person at fault, designed to restore the injured party to the position they would be in had the damage not been suffered. Claims are usually dealt with on behalf of policyholders by their insurers and the vast majority of claims are settled out of court. Ultimately it is the courts that determine issues of liability or amount of claim that cannot otherwise be resolved and are the final arbiters of where liabilities lie. With limited exceptions, an insurance company is required to pay any compensation awarded by a court against its policyholder.

Testing of automated vehicle technologies

13.6 The requirements in the Road Traffic Act on the holding of insurance will apply whilst a vehicle is being tested. The manufacturer or company conducting the testing will either itself be using the vehicle and so need to be insured or be vicariously liable for its test driver. Although the expectation is that these vehicles will be marketed to the public as allowing drivers to undertake other activities while in autonomous mode, for the purposes of testing, the test driver must be continuously monitoring the road environment, and remain alert and ready to resume control. The test driver should be in overall charge of the safe operation of the vehicle at all times and likewise be covered by insurance.

13.7 Discussions with the insurance industry indicate that, given the nature of the testing, companies testing such vehicles should be able to obtain suitable insurance from the existing market. British insurers are world leaders in being able to provide corporate cover for innovative enterprises such as the testing of automated vehicles.

Production and marketing of highly automated vehicles

13.8 Under current law and with existing driver assistance technologies, a user of a vehicle must maintain proper control at all times. However a highly automated vehicle is one which has been specifically designed to allow the driver to disengage from the driving task and undertake other activities in certain situations.

13.9 Where the user of a highly automated vehicle opts to maintain manual control of the vehicle, it is clear that the current civil liability position will apply and the Road Traffic Act will require the user to have, or ensure there is, appropriate insurance for this type of operation.

13.10 When a vehicle is operating in an autonomous mode the issue arises of what responsibility lies with the driver, manufacturer and owner of the vehicle? It is clear that the obligation to ensure insurance cover is in place remains for anyone who is the user of the vehicle or causes or permits its use, and if there are issues as to who this is, resolution would lie with the courts. We anticipate manufacturers may bear responsibility to ensure that third party liability cover is in place as discussed in the chapter on product liability, when autonomous operation is engaged. Over time, as automation technology develops and drivers increasingly utilise autonomous modes, the insurance risk profile for manual driving is expected to reduce. There may still be opportunities for motor insurers to provide liability cover for manufacturers rather than drivers when technology has developed to the extent that vehicles rather than humans are responsible for collisions.

13.11 Before highly automated vehicles can be marketed to the public, there needs to be further clarification of how and when liability passes between the manufacturer and the vehicle user and driver, especially when switching between autonomous mode and manual control.

13.12 **Action: Review existing legislation and provide clarity on how liability passes between the driver and the vehicle manufacturer according to mode of operation.**

13.13 It is likely that when automated vehicles are marketed, they will be fitted with event data recorders. This technology will indicate whether a vehicle was operating autonomously or was in manual control at the time when a collision occurs. It will also record how soon prior to any collision the mode of operation changed, for which there may well be no other or better source of evidence. This data will be a compelling source of material as to what occurred and must be available to the relevant authorities in order to determine liabilities and insurance responsibilities.

13.14 A highly automated vehicle user may realise that a collision is imminent while in autonomous mode and take manual control to try to avoid it. If the avoiding action fails and a collision occurs, then it may not be appropriate to assume that fault lay with the vehicle user. Equally a highly automated vehicle user may realise that a collision is imminent, and refuse to take control of a vehicle when it might be considered to be reasonable and possible for him to do so. In both cases it would be necessary for the relevant authorities to assess the data from the event data recorder to determine where fault lay.

13.15 If a highly automated vehicle user refuses to resume manual control when the vehicle indicates that this is necessary then the vehicle may need to come to a halt autonomously. If the vehicle stops in a potentially unsafe position (for example the fast lane of a motorway), there will be an onus on the user to take reasonable steps to move the vehicle to a safe stopping place under the existing law of negligence and road traffic laws. If the user does not do so and a collision occurs, it remains an evidentiary issue whether they have acted unreasonably and whether their own conduct was a contributory factor.

Figure 13.2 – Diverse heavy traffic in London

Compliance with EU requirements

13.16 The position would be that, in the event of an accident caused by a vehicle, the manufacturer would be liable if the vehicle was being operated autonomously. The user's insurance policy would cover liability of the user whilst the user is in control of the vehicle. Although this would ensure there is compulsory cover for personal liability there is not at present a compulsory insurance cover requirement on manufacturers for their liabilities.

Fund of last resort

13.17 A key focus of the EU Motor Insurance Directive is ensuring that injured victims of vehicle collisions receive compensation. The Directive sets out the requirement for each Member State to have a fund of last resort to compensate victims in the event of uninsured collisions caused by uninsured or untraced drivers. With the change in who or what is controlling the vehicle, the cause of collisions will shift away from human error caused by drivers, as they have less and less to do with controlling the vehicle, and move towards vehicle manufacturers when components or systems fail.

13.18 The UK has a fund of last resort (the Motor Insurers Bureau), which is paid for by a levy from UK motor insurers to handle claims from the civil liability of uninsured or untraced drivers of vehicles. Development of automated vehicle technology raises the question of how such compensation would be paid in respect of vehicles without drivers, or where there is no liability on the part of the driver.

Production and marketing of fully automated vehicles

13.19 The availability of fully automated vehicles will raise further questions regarding insurance. For example would the user of a fully automated vehicle which has no driver controls fitted still need to hold an insurance policy? If the vehicle was privately owned, then the owner would presumably still wish to have insurance against theft, but it may be that only the vehicle manufacturer would need insurance covering risk of injury to third persons.

13.20 If a fully automated vehicle did have manual driving controls fitted to allow the user to choose to take manual control if they wished then would all users be obliged to have insurance covering this possibility even if they had no intention of taking manual control?

13.21 **Action: Work with the insurance industry to develop requirements governing insurance of highly and fully automated vehicles and engage with the EU over their plans for automated vehicles.**

List of relevant primary and secondary legislation

13.22 The primary legislation for motor insurance is contained in part VI of the Road Traffic Act 1988, as amended.

13.23 Secondary legislation includes:

- The Motor Vehicles (Third Party Risks) Regulations 1972
- Motor Vehicles (Compulsory Insurance) (No 2) Regulations 1973 (SI 1973 No 2143)
- The Motor Vehicles (Third Party Risks Deposits) Regulations 1992 (1992 No 1284)

- The Motor Vehicles (Compulsory insurance) (Information Centre and Compensation Body) Regulations 2003 (SI 2003 No 37)
- The Motor Vehicles (Insurance Requirements) Regulations 2011 (SI 2011 No 20)

14. Data protection and privacy

Introduction

14.1 Modern vehicles have increasing levels of communications abilities built into them. Some have embedded SIM cards to enable phone calls to be made directly from the vehicle itself, whilst others have the ability to link up with the occupant's mobile phone. Both approaches can also enable connection with the internet. This offers many opportunities for transmission of useful data to and from the vehicle.

14.2 Any processing of data collected by an automated car should, where an individual can be identified, comply with data protection rules. These are provided in Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data. In addition Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 covers the processing of personal data and the protection of privacy in the electronic communication sector (Directive on privacy and electronic communications). These have been implemented into UK law through the Data Protection Act 1998 and the Privacy and Electronic Communications Regulations 2003.

14.3 These laws are designed to ensure that privacy is protected and, generally speaking, that personal data is used in line with the reasonable expectations of those the data is about. Individuals should be informed when their personal data is collected, of how it is going to be used. The data should not, for example, be sold on to others for purposes such as marketing, without the individual's consent. The Data Protection Act also requires that personal data be used proportionately, that it is kept secure, and kept for no longer than necessary.

14.4 There are various devices capable of recording data that could be linked to an individual. The vehicle's own electronic control units (ECUs) may have the facility to record and store data. Devices known as Event Data Recorders (EDR) can also be used to record selected information. The increasing number of sensors on a vehicle means that a wide range of different datasets could be collected which can provide information about how and where the vehicle was driven. This information can potentially be sent from the vehicle via the internet to remote server storage. To comply with the fair processing requirements of data protection legislation, drivers and the registered keepers of vehicles should be made aware of the data that their vehicle is collecting, and the uses to which it might be put.

Event or collision data recorders

Definition of technology

14.5 The Road Safety and Transport Agency and eSafety Forum Working Group (2005) defines Event Data Recorders (EDRs) as follows:

14.6 "The accident data recorder is an on-board event recorder. In case of accidents (or events) data on the vehicle's speed, acceleration, brake use, etc. just prior to, during and after the accident are recorded. These data can subsequently be downloaded from the accident data recorder and used to analyse how the vehicle was driven at the time of the accident. This knowledge can serve scientific, technical and legal purpose".[20]

Safety Impacts

14.7 According to the European Commission-funded project VERONICA (Vehicle Event Recording based On Intelligent Crash Assessment), driver behaviour is improved when there is an awareness of accident data recorders. The report suggests that drivers are influenced by this technology and in consequence they drive more carefully. This change of behaviour also reputedly reduces the risk and severity of accidents.[21] There is evidence from other sources however that this effect can be short-lived as the driver becomes accustomed to the presence of the system and returns to his or her previous driving style.

14.8 In addition, VERONICA found that EDRs could be used as a valuable research tool to monitor or validate new safety technology, to record impact speeds and to analyse the stored data for accident reconstruction purposes.[22]

Technical requirements

14.9 The technical requirements recommended in project VERONICA include a minimum storage capacity of three collision-events which result in harmful or serious consequences. These requirements also propose that the OBD connector could be used to download the data recorded at the EDR, and that manufacturers could record other data relating to events without harmful consequences if this was for safety purposes.[23]

14.10 The VERONICA project recommended that Europe should have higher recording requirements for frequency, accuracy, resolution and crash

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20 European Commission, Cost-benefit assessment and prioritisation of vehicle safety technologies, January 2006. (Available here: http://ec.europa.eu/transport/roadsafety_library/publications/vehicle_safety_technologies_final_report.pdf)

21 European Commission, Vehicle Event Recording based on Intelligent Crash Assessment, November 2006. (Available here: http://www.veronica-project.net/index.php?option=com_docman&task=doc_download&gid=244&Itemid=27&mode=view)

22 European Commission, Mobility and Transport, In-vehicle data recorders. (Available here: http://ec.europa.eu/transport/road_safety/specialist/knowledge/esave/esafety_measures_known_safety_effects/black_boxes_in_vehicle_data_recorders_en.htm)

23 European Commission, Veronica II project details. (Available here: http://ec.europa.eu/transport/road_safety/projects/doc/veronicaii.pdf)

phases than the US NHTSA requirements. A large number of the EDR signals are standardised by the SAE J1939-71 standard, but there is still a need to standardise the common interface. It is essential that the data can be downloaded not only by the vehicle manufacturer, but also by others with the permission of the vehicle owner or a legitimate need, such as duly authorised law enforcement bodies.

14.11 It is understood that he European Commission is funding further research on EDRs. The results of this research will be important additional information to help inform policy on this technology.

Testing of automated vehicle technologies

14.12 During the testing phase of automated vehicles, those developing and implementing this technology will need to ensure that the technology is capable of supporting compliance with existing data protection requirements as outlined in paragraphs 14.2 to 14.4.

14.13 As a wide range of data obtained during testing will be valuable for safety and development purposes, some form of vehicle data recorder is very likely to be fitted as standard and data logged in a comprehensive manner. In the event that a collision were to occur during testing, it will be important to have data to inform the subsequent analysis of the exact sequence of events that led to the event. This data should allow actions attributable to the automated vehicle systems and the test driver to be clearly separated and understood.

14.14 In the US, NHTSA recommends that the data collected by EDRs should be restricted with security standards to maintain its integrity and that best practice should be established to fully protect the privacy of vehicle owners and operators.[24] The state of Nevada specifies that autonomous vehicles are required to capture 30 seconds of data before a collision occurs in a read-only mechanism and such data must be preserved for three years after the date of the collision.[25]

24 Comments of the Electronic Privacy Information Center et al to the National Highway Traffic Safety Administration, 11 February, 2013. (Available here: http://epic.org/privacy/edrs/EPIC-Coal-NHTSA-EDR-Cmts.pdf)

25 Florida Highway Safety and Motor Vehicles, Autonomous Vehicle Report, 10 February, 2014. (Available here: http://www.flhsmv.gov/html/HSMVAutonomousVehicleReport2014.pdf)

The situation in the USA

NHTSA estimates that approximately 96 percent of model year 2013 passenger cars and light-duty vehicles are already equipped with EDR capability. These devices are located in the vehicle and require special hardware and software to copy the information. A crash or air bag deployment typically triggers the EDR, which collects data in the seconds before and during a crash. The data collected by EDRs can be used to improve highway safety by ensuring NHTSA, other crash investigators and automotive manufacturers understand the dynamics involved in a crash and the performance of safety systems.

14.15 The requirements of the data protection legislation mentioned in 14.2 and 14.3 mean that similar consideration will need to be given to the secure and proportionate use of the data stored in data recorders used in the UK. In addition it will be important that test drivers know, before they drive a vehicle fitted with a data recorder, what data it will collect and the purposes for which it could be used.

Production and marketing of highly automated vehicles

14.16 The fitment of EDRs to vehicles in mass production would help in establishing liability in the event of a collision. A vital piece of information is whether the driver or the vehicle was in control at the time of the collision. Data on the actions of the driver or vehicle immediately prior to the incident will help in apportioning liability for insurance purposes, for criminal purposes if applicable, and product liability. Therefore there is a strong case for requiring EDRs on highly automated vehicles.

14.17 Data is likely to be constantly recorded in a volatile memory with no access to it unless there is a collision or similar event. The debate will be primarily around whether all of the parameters that were recorded during the testing phase should still be recorded on mass produced vehicles.

14.18 The public may expect that this data will not be made available unless there is a collision, although manufacturers and insurance companies (among others) have a legitimate interest in obtaining data which is not limited to a short period prior to a collision, albeit in anonymised form. Insurance companies have responded saying that they are keen to obtain such data, in anonymised form, in order to help calculate risk and thus insurance premiums, whilst manufacturers are keen to obtain data in order to obtain a better understanding of the performance of their vehicles in collisions, ultimately to help improve vehicle safety.

14.19 Devices that would be fitted to the vehicle during production fall under the European type approval system, whereas member states have a degree of flexibility in regulating devices retro-fitted to vehicles that are in use. In the case of EDRs, the functionality is increasingly likely to be “built in” to vehicles rather than provided as a “bolt-on” device. It would be undesirable for the UK to develop its own unilateral standard as this could lead to a fragmented situation for manufacturers: instead we should participate in harmonisation activities at the European level. These should involve the participation of privacy advocates.

14.20 **Action: Participate in EU harmonisation activities to produce a standard for data recording for automated vehicles, and work with stakeholders on privacy issues**.

Production and marketing of fully automated vehicles

14.21 For fully automated vehicles, the use of EDRs and possibly also video camera recording equipment is more likely to become compulsory, to help determine liability. Since these vehicles will operate autonomously for most or all of the time, vehicle manufacturers are very likely to want to utilise EDRs to provide evidence in the event that there is a collision.

15. Theft and cyber security

Introduction

15.1 This chapter will consider issues relating to both vehicle theft and cyber security. Attention has been paid to the risks of automated vehicles being "hacked". Recognising that these vehicles have a high level of computer technology on board and are likely to be "connected" to the internet, other vehicles and their surroundings in the future, security issues need to be carefully considered during the introduction of this new technology.

Vehicle theft

15.2 Today the security of a vehicle is established under European type approval, the assessment of a new vehicle prior to sale and first registration. All new cars must comply with UN Regulation 116 (Protection of motor vehicles against unauthorised use), which requires both a mechanical anti-theft device (in practice normally a steering lock, which if it is not overcome will prevent a driver from steering), and an electronic immobiliser.

15.3 The introduction of an immobiliser from 1998 was in response to increasing car crime in the 1990s. Car crime then started to decrease, because overcoming the immobiliser required specialist equipment and expertise. In addition there were efforts by organisations like The Motor Insurance Repair Research Centre to encourage or incentivise manufacturers to fit extra measures over the minimum set down in regulation.

15.4 The trend from traditional "mechanical" keys to opening the vehicle via electronic means ("keyless entry", with door unlocking via radio frequency communication, either controlled from a key fob or simply due to proximity) has meant that thieves have also changed their methods over time.

15.5 'Right to repair' legislation has been developed in Europe, under the umbrella of the Block Exemption. EC Regulation 715/2007 requires manufacturers to provide access to Repair and Maintenance Information (RMI) for independent garages in the same way as to franchised dealers. This has led to some confusion and ambiguity about the measures that can be taken by manufacturers to prevent security breaches.

Cyber security

15.6 Going beyond the simple issue of a single vehicle and the question of whether it can be stolen, the introduction of greater connectivity into vehicles, accompanied by increasing levels of electronic control and automated operation capabilities, leads to potentially more complex security issues.

15.7 In the past vehicles had mechanically connected throttle and steering controls and hydraulically operated brakes were typical. Modern vehicles have "drive by wire" throttle control, and some now feature "brake by wire". In 2014 the first car with a "steer by wire" system came to market. Vehicles with these systems accelerate, brake and steer in response to an electrical signal.

15.8 Vehicle manufacturers are also starting to introduce vehicles with the capability to connect to the internet as well as other vehicles and surrounding infrastructure – often termed "Connected Cars". Increasing use of electrical control systems and connectivity has raised the possibility of increasing opportunities for malicious intervention.

15.9 Vehicle features such as remote key fobs or keyless access, Bluetooth connectivity, Wi-Fi and mobile internet connections, and even tyre pressure monitoring systems could theoretically allow access to vehicle control systems making them vulnerable to malicious intervention. In this context such features are known as the 'attack surface'.

15.10 In 2014 a report was published which sought to highlight potential weaknesses in existing production vehicles' cyber security[26]. It examined the available 'attack surfaces', network architectures and automated capabilities of a selection of vehicles and attempted to assess how 'hackable' they might be. The authors noted significant differences in the approaches taken by different makes and models and indicated some could be more vulnerable than others.

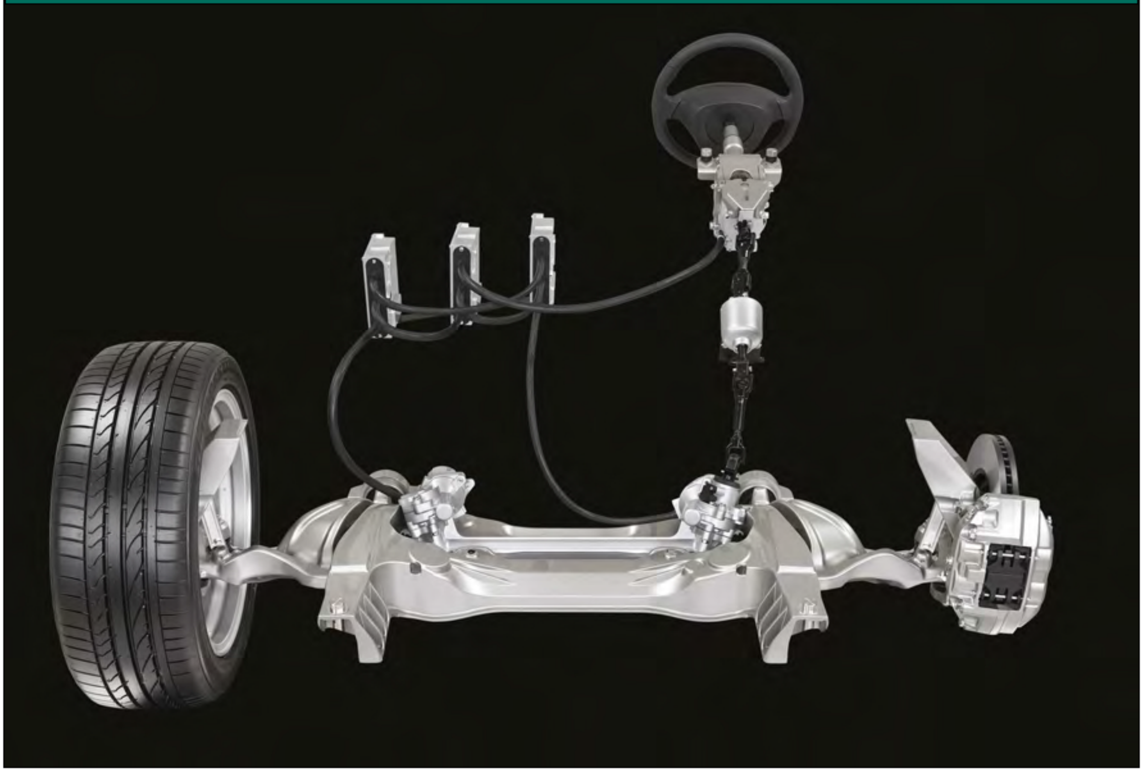
15.11 Vehicle manufacturers design safety critical electronic control systems to ensure that they are 'fail safe'. For example electronic braking systems still allow full manual braking in the event of a failure. The first steer by wire system on the market retains a conventional mechanical steering column which engages in the event that the electronic system fails (see Figure 15.1). It also features three electronic controllers (two being 'redundant' safety back-ups).

15.12 It should also be noted that even conventional vehicles are vulnerable to malicious intervention. For example simple mechanical techniques could be used such as severing hydraulic brake lines or loosening or disconnecting steering gear. However cyber-attacks could be

26 Adventures in Automotive Networks and Control Units – Dr. Charlie Miller & Chris Valasek, 2014.

conducted remotely and could potentially affect a number of vehicles at the same time.

Figure 15.1 – “Steer by wire” system with redundant electronic control modules and back-up mechanical steering column



15.13 There should be a strong incentive for vehicle manufacturers to ensure that their vehicles are robust and secure against cyber-attack and other malicious interventions. No manufacturer would want their products to be perceived to be vulnerable by their customers. Vehicle manufacturers will need to continue to ensure that their electronic systems do not have unintended vulnerabilities and are robust to the latest cyber-crime techniques.

15.14 UN Regulation 116 is formulated to ensure that vehicle manufacturers put in place measures to prevent unauthorised use. If it is felt that further regulation is required to ensure that manufacturers adequately address cyber security issues then it may be appropriate to update this.

15.15 Given the data that may be collected by a vehicle, such as GPS data and camera recordings, there may also be concerns that information on the movements of a vehicle or its location could be extracted without authorisation. This would have implications for privacy issues, and potentially facilitate criminal activities.

Testing of automated vehicle technologies

15.16 As one of the conditions of conducting trials, it will be important to minimise any risk of test vehicles being vulnerable to hacking or other malicious intervention. The manufacturers providing vehicles for testing will need to ensure that all prototype automated controllers and other vehicle systems have appropriate levels of security built into them. Such safeguards should be in addition to the vehicle continuing to meet all existing requirements regarding measures to prevent unauthorised use.

15.17 **Action: Liaise with manufacturers and stakeholders to ensure an appropriate level of protection from unauthorised access, control or interference for automated vehicles engaged in testing.**

Production and marketing of highly automated vehicles

15.18 As has been explained, highly automated vehicles with increasing levels of connectivity could potentially bring new or increased risks of hacking or other malicious intervention.

15.19 Regulators will need to carefully consider whether and what form of regulation might need to be considered to address this whilst minimising burdens and allowing the market to flourish.

15.20 Manufacturers would be expected to be acutely aware of the need to ensure their products are robust to these challenges. This is particularly true when new technologies are being introduced.

15.21 **Action: Consider how the existing regulatory framework may be developed to ensure both automated and connected vehicle technologies are protected from possible cyber threats.**

Production and marketing of fully automated vehicles

15.22 Fully automated vehicles capable of operating completely autonomously may rely to a greater extent on connectivity. Some may also lack any facilities for manual override by a human occupant. As a result the safety and security aspects outlined above could become more critical. Vehicle manufacturers should be aware of this and should design their systems accordingly. Nevertheless Government will remain vigilant to the need for regulatory intervention to ensure the public's safety if necessary.

16. Summary of responses to the consultation

Introduction

16.1 A consultation was held from 4 August to 19 September 2014. The consultation called for comments and views on any regulatory or other issues that may need to be addressed in considering the testing of cars with advanced automated safety systems on public roads, and the areas where new regulation may be necessary in order to maintain road safety and provide the appropriate safeguards in the introduction of this novel technology.

- To ease the task of analysing comments, those responding were asked to organise their responses in the form of answers to 20 questions, which covered the most relevant themes, such as insurance, product liability and so on.

16.2 In total 38 written responses were received. These ranged from people responding on an individual basis, to organisations representing the opinions of many thousands of members nationwide. Responses included representatives from:

- Academia
- Automotive industry
- Motoring organisations
- Emergency services
- School children
- Disability groups
- Members of the general public
- Vehicle insurers
- Legal organisations
- Specialist organisations working in the field of intelligent transport systems and computing.

16.3 Responses varied from full and detailed answers to all questions to a shorter response highlighting a specific potential issue. All responses have been reviewed and a brief summary of some of the key themes to come from the call for evidence is provided here. A more in-depth summary of the responses to individual questions can be found in Annex C: Responses to the consultation (full summary).

Liability issues

16.4 The major theme throughout many of the questions posed to stakeholders was liability. Respondents were concerned about how liability would be apportioned in the event of a collision and who would take responsibility for this if the vehicle was in control at the time.

16.5 While many felt the existing liability regime would be sufficient for testing to go ahead, almost equal numbers foresaw problems and the need for changes to be made.

16.6 There was general agreement that vehicle manufacturers should continue to be held strictly liable for mechanical and system failures as is already the case for emergency braking and cruise control systems. It was suggested that vehicle manufactures should also accept liability for the software in their vehicles.

16.7 Many respondents focused on the difficulty of establishing whether the driver or the automated system was in control of the vehicle at the time of a collision or other event. The use of independent event data recorders and camera systems were recommended to address this.

16.8 It was suggested that thought should be given to the wider liabilities, for example road maintenance and information providers.

Insurance

16.9 Insurance associations highlighted the importance of being able to identify who was in control of the vehicle at the time of a collision or criminal offence. Again, it was suggested this could be done with an event data recorder and camera monitoring system. It was recommended that for insurance purposes, a regulation should dictate a minimum amount of data feeds that should be collected and who is permitted access to it to prevent it being stolen or tampered with.

16.10 For insurance companies to make a fair assessment of risk and provide competitive insurance products, it was identified by stakeholders that they should receive information on:

- Safety related test data.
- Knowledge from manufacturers on the safety benefits of their technology and how it works.
- Costs of automated vehicles and repairs.

16.11 Stakeholders saw no concern with obtaining insurance for prototype automated vehicles, as insurance products for this purpose already exist. One response identified that some manufacturers may choose to self-insure, as often they are the best at understanding the risks.

16.12 It was suggested that at some point there may be a time when there is no need for driver-based insurance premiums. However, whenever a driver can still take manual control, conventional insurance would be required.

16.13 Initially, it is believed, that the cost of insurance premiums may be high due to the lack of historical data on the risks associated with automated vehicles.

16.14 It was suggested that insurance policies should become void if the owner fails to keep their vehicles software up to date to prevent cyber threats.

Driver requirements for testing and beyond

16.15 There was strong general agreement amongst stakeholders that drivers involved in testing automated vehicles should have high levels of experience and skill. Stakeholder opinion on exactly what this means was varied and included:

- A clean licence.
- Minimum number of years driving experience, with the ability to anticipate situations.
- An engineer familiar with the technology and the process of switching between control modes.

16.16 Stakeholders that looked to the future suggested that when vehicles with high automation are offered for sale to the general public, they should be easily used by any qualified driver, possibly with a new licence category.

16.17 There was strong agreement that during testing of automated vehicles on public roads, drivers should conform to the normal set of requirements for driver behaviour. This was considered to be important to ensure safety and to avoid alarming other road users. The driver should be alert at all times but it was accepted that they may not have their hands on the steering wheel.

16.18 A majority of stakeholders supported a requirement for a second person to be present in the vehicle during the testing phase. It was suggested the second person's role would be to monitor the systems under development, allowing the driver to focus on retaking control of the vehicle if necessary. An alternative to this was the suggestion for data, video and audio to be recorded and analysed later. A respondent representing the views of motor manufacturers suggested safeguards such as emergency cut-off switches and failure tell-tales could be an alternative to requiring a second person.

16.19 In the longer term for fully automated vehicles capable of making journeys without any driver intervention, regulations may need to be reviewed to determine whether existing driver restrictions should still apply.

Infrastructure requirements

16.20 It was highlighted that the need for special infrastructure may be dependent on the technology fitted to the vehicles.

16.21 Several stakeholders felt that highly automated vehicles should be developed to work on the existing road network with no additional infrastructure required. Implementing additional infrastructure would be expensive and time-consuming, increasing the length of time it would take to get automated vehicles on the road.

16.22 Those stakeholders who anticipate automated vehicles communicating with special road infrastructure, identify benefits in safety and reduced congestion.

16.23 Security issues were raised, with claims that cyber-attacks could lead to disruption, damage or loss of life.

Vehicle identification and public education

16.24 Stakeholder opinion on the need for vehicles to have some form of visible marking indicating their automated capabilities was divided almost equally for and against.

16.25 Some stakeholders argued that identification of automated vehicles would help public understanding and acceptance of them, particularly if it was noticed that the driver was not holding the steering wheel. Suggested identification methods varied from small signs attached to the front and rear to highly visible signage all round combined with flashing lights.

16.26 Arguments against markings include the potential for them to create unrepresentative test conditions by changing or influencing other road users' behaviour. This might be through alarming or distracting another road user, or a road user choosing to 'test' the automated vehicle by reckless manoeuvres or behaviour.

16.27 It was believed that it would be beneficial to develop educational materials due to the strong public interest in the subject, helping increase understanding and acceptance of automated vehicles. It was suggested the information should:

- Target all road users nationwide.
- Not unduly influence the reactions of other road users.
- Not raise public expectation that automated vehicles are close to market ready.

16.28 Concern was expressed about an automated vehicle's abilities to respond to poor driving by other road users and detect other road users such as children, pedestrians and cyclists.

16.29 It was suggested that those wishing to conduct tests should specify the actions taken to mitigate adverse behavioural effects of other road users and log any situations identified where automation may have triggered such an effect.

Regulations and regimes

16.30 Stakeholders provided a mixed response as to whether prototype highly automated vehicles comply with existing type approval or construction regulations. The general agreement amongst stakeholders is that some regulations may need to be modified as highly automated vehicles develop. These include:

- Article 8 of the Vienna Convention 1968. (UK has not ratified).
- Road Vehicle (Construction and Use) Regulations 104 and 109 (Driver in control and improper use of displays).
- UN Regulation 13H and 79 (Steering and braking equipment).
- Road Traffic Act 1988 Section 41D (Use of mobile phone while in control of a vehicle).

16.31 New regulations, recommended by stakeholders, included:

- Defining how much stimulus on controls is required to regain control.
- Need for in-field evaluation of sensors and control technology.
- Regulation of the software, cybersecurity, networks and external communications of the vehicles.
- Regulations to control the collection, preservation, access and analyses of data for liability in the event of a crash.
- Regulation to make Advanced Emergency Braking (AEB) mandatory on all highly automated vehicles, and consider other emerging automated safety systems for future regulation.

16.32 There is concern for the protection of data collected by an event data recorder. Some stakeholders believe the Data Protection Act 1998 is suitable whereas others went into more detail about the specific ways data should be handled.

16.33 Stakeholders are split on whether to amend regulations or create a special set of regimes for automated vehicles. However, they do agree whatever regulations or regimes are put forward should be appropriate and clear. They state that amending regulations may take too long, however they appreciate existing regulations were never intended for this new technology and now would be a good opportunity to update them.

16.34 It was suggested that the best outcome would be to support the UK's ambition to lead the field in automated vehicles technically, and that any changes should not be for the sole purpose of encouraging others to come to use the UK as a test track.

Vehicle registration, tax and roadworthiness

16.35 The majority of stakeholders felt automated vehicles should be registered with DVLA in the conventional way, but that there could be a marker on the Police National Computer to identify vehicles which can drive themselves.

16.36 Opinion was divided on how automated vehicles should be taxed. Some stakeholders saw a benefit in taxing automated vehicles in the same manner as conventional vehicles, highlighting this would provide equality and hopefully improve the public's perception of automated vehicles. Others suggested giving tax incentives to operators of automated vehicles to increase popularity.

16.37 The overwhelming response from stakeholders regarding the roadworthiness regime for automated vehicles was that they should comply with the current MOT requirements. It was highlighted that some special methods of testing automated features may need to be developed without compromise to safety, with a new roadworthiness test being developed when automated vehicles are commonplace.

16.38 There was concern amongst stakeholders that as automated vehicles age, they will be more expensive to maintain and repair than a conventional vehicle. They believe this could potentially result in skimping on maintenance and consequent safety concerns. Stakeholders suggested it should be the owner's responsibility to ensure automated components are maintained in safe working order.

PART 3: Delivering the pathway to driverless cars

Contents

17. Options for delivery

Introduction

17.1 Chapters 4 to 15 of this review analysed the existing legal and regulatory situation for the testing, production and marketing of highly and fully automated vehicles, with Chapter 16 summarising the findings of our public consultation. The conclusion is that real-world testing of automated vehicles is possible in the UK today, providing a qualified test driver is present and takes responsibility for the safe operation of the vehicle; and that the vehicle can be used compatibly with road traffic law.

Testing of automated vehicles

17.2 Organisations wishing to conduct tests of highly automated vehicles would need to comply with all existing laws.

17.3 The Road Traffic Act 1988 and the Road Vehicle (Construction and Use) Regulations 1986 both require that vehicles used on a public road are in a safe condition, are used safely and do not cause danger. There are a number of largely quantitative requirements (in areas such as braking, lighting, and steering) which society has deemed constitute a safe vehicle. However automated vehicle technologies are not specifically covered at present.

17.4 All vehicles will need to comply with the legal requirements for insurance, registration and licensing.

17.5 Existing legislation has developed on the assumption that a driver is always present in the vehicle and responsible for its behaviour. The driver is in principle liable for the behaviour of the vehicle and its consequences, unless a vehicle system malfunctions in which case liability may rest with the vehicle manufacturer, or repairer or maintainer under product liability laws.

Options to promote safety during testing

17.6 Public safety is paramount during the development of highly automated vehicles through public road testing. The primary responsibility must rest with those organising and conducting the testing. However Government also has an important role to play. This review has considered several possible approaches that the Government could take:

- **Vehicle certification** – Create a test and certification system for automated vehicles.
- **Permit system** – Establish a permit system for allowing testing.
- **Code of Practice** – Publish guidance in the form of a code of best practice which the Government would expect organisations to follow.
- **No action** – Allow testing of automated vehicles on public roads with no further guidance or action.

Each of these four options is considered in more detail below.

Option 1 – Vehicle certification

17.7 This option would require that the Government draws up a set of standards for highly and fully automated vehicles. Any organisation wishing to test such a vehicle on public roads would need to present the vehicle for certification during which it would be assessed against these standards. This process could be introduced either via new legislation or as a voluntary system.

17.8 A problem with this approach is that few, if any, guidelines or standards currently exist against which such vehicles could be tested and the technologies involved are evolving rapidly. Creating a standard at this time is therefore considered premature and may stifle innovation in this field.

17.9 Inappropriate or outdated standards or requirements could have the unintended consequence of reducing achievable levels of safety.

17.10 This option would also take significant time for the UK Government to undertake independently. It is likely to be more efficient for the UK to engage with coordinated actions to establish such standards at a higher level. For example, the European group RESPONSE 4 anticipate some guidelines being prepared by mid-2017.

Option 2 – Permit system

17.11 Several American states operate a paper-based permit regime. These systems have been established through the introduction of legislation to give the relevant authorities the necessary powers. They do not test the vehicles in question but instead they request vehicle operators to submit documentary evidence to certify that certain conditions are met. For example:

- Evidence of accumulated test mileage on closed roads or test tracks.
- Submission of a safety or risk management plan.
- Submission of a test driver training programme.
- Evidence of a surety bond for insurance (in most cases $5 million).

In this way vehicle operators and testing organisations must generally satisfy the state authorities that the testing will be conducted safely.

17.12 This approach avoids the problem of drawing up specific standards relating to the vehicles themselves. It also excludes those parties who have not done sufficient prior testing or have insufficient resources or knowledge and experience to ensure safety.

17.13 However it might be considered necessary for legislation to be introduced in order to give the Department the powers to issue permits and specify the rules. This would create a significant delay before testing could commence.

17.14 In addition, by explicitly authorising testing via the issue of permits, it could be argued by claimants that this amounts to the Government assuring the fitness of vehicles and their testing, and assuming liability for the outcome if this turns out to be misplaced.

Option 3 – Code of Practice

17.15 Under this option, Government would publish non-statutory guidance in the form of a Code of Practice. This could be developed in collaboration with a range of stakeholders to ensure that it is informed by existing best practice and experience. The aim would be to achieve a light-touch non-regulatory approach which provides the clarity industry needs to invest in further research and development while ensuring safety.

17.16 The advantage of this approach is that a Code of Practice could be prepared and introduced relatively quickly. It would also have the advantage that it could be periodically reviewed, which is particularly beneficial in a field where the technology, and our understanding of its benefits and limitations, is developing rapidly.

17.17 As guidance issued by Government following engagement with stakeholders we consider a Code of Practice would be an effective means of setting out the standards to be met by responsible manufacturers and testing organisations and their test drivers in the unusual circumstances of carrying out testing of automated vehicles.

17.18 Similarly to *The Highway Code*, a failure to follow the guidance in a Code of Practice would be a clear indicator of negligence. A Code of Practice that reflects good and responsible practice with regard to the safety of other road users would carry considerable weight on any issue of liability. By involving industry stakeholders in developing the code we expect them to act in accordance with it. Those involved in the three trials jointly funded by Government will be required to comply with the Code.

17.19 Finally this option would enable testing organisations to plan and implement the requirements of the Code in a timetable which best suits their needs. They would not be dependent on the Government scheduling and conducting vehicle certification tests or assessing applications and issuing permits.

Option 4 – No action

17.20 The fourth alternative would be for the Government to take no action in respect of guiding the nature of automated vehicle technology testing on public roads in the UK. This would permit industry the maximum of flexibility.

17.21 As has already been stated, the results of the review of existing legislation and regulation set out in Part 2 of this document indicate there are no legal impediments to the testing of automated vehicles. This situation is in contrast to many other European countries where it would appear existing legislation currently prevents such testing.

17.22 None of this is to say that new circumstances will not arise to be addressed before British courts to resolve issues of criminal responsibility and civil liability and setting precedents for future cases. Testers will need to comply with all existing legislation even though these laws were written without anticipating the nature and potential capabilities of highly automated vehicle technologies. There may be risks therefore associated with relying on a legal framework not written with these technologies in mind to ensure safety.

17.23 The combination of a clear message that such tests, conforming to current law, are legal on UK roads with the knowledge of restrictions in other countries, may result in an increase of vehicle manufacturers, technology suppliers and other organisations coming to the UK to conduct public road tests of automated vehicles.

17.24 On the other hand, a lack of any guidance from Government on appropriate safety measures which should be put in place, combined with uncertainty due to lack of legal precedents may hold back interested parties from conducting testing.

Comparison of the options to promote safety during testing

17.25 When considering selection of an appropriate way forward from these options it is important to establish by what criteria a decision will be made.

17.26 In terms of facilitating the research and development of new technology it is important to ensure that an appropriate balance is struck between safeguarding public safety while allowing society to benefit from advances in science and technology. In the case of automated vehicle technologies it should be remembered that perhaps the most important expected benefit of this technology coming to market is a significant improvement in road safety.

17.27 Overly restrictive or time-consuming requirements implemented to ensure safety during the prototype testing phase might result in a negative overall impact on safety if they delay the development and introduction of a technology which improves safety once available on the market.

17.28 Equally, introducing requirements which are difficult to amend and become outdated or inappropriate may have a negative impact on safety if they force technological developments down a path which results in sub-optimal solutions.

17.29 Government also has a duty to use public funds wisely. It is important to ensure that the approach chosen achieves the stated aims in the most cost effective and resource efficient way.

17.30 Thus four selection criteria can be used to assess what the most appropriate approach should be for Government to take:

- Safety
- Time to implementation
- Ease of updating
- Cost and resource implications

17.31 Table 17.1 sets out the four alternative options which were previously identified against these four criteria. While it is not possible to generate objective measures of how each option would perform against each criterion, it is possible to make a subjective estimate. This has been done using a rating of one to five stars, where one is the worst score and five is the best.

Table 17.1 – Comparison of options for automated vehicle testing phase

Option	Safety	Time to implement	Ease of updating	Cost/ resources	Overall
Vehicle certification	***	*	*	*	**
Permit system	***	**	**	**	**
Code of Practice	***	****	***	****	****
No action	*	N/A	N/A	N/A	*

17.32 Importantly, for the over-riding consideration of maintaining public safety, it cannot be assumed that a more prescriptive and regulatory approach would result in an overall improvement in safety in comparison to a less rigid and more flexible approach.

17.33 On this basis, establishing a Code of Practice which sets out a series of recommendations which should be followed during public road testing of automated vehicle technologies seems to represent the best available option. The recommendation of this review is therefore to proceed with this approach.

Implementation of a Code of Practice

17.34 Based on this analysis, the primary overall recommendation of this review is that the Government should start drafting a Code of Practice for the public road testing of automated vehicle technologies as soon as possible.

17.35 To obtain wide acceptance, the Code of Practice should be developed in collaboration with interested parties. In this way the Code of Practice would benefit from their expertise as well as taking into account best practice from around the world. This should include careful analysis of any conditions imposed in other countries and of the legislation introduced by American states, as well as guidance and recommendations from safety and industry bodies.

Mass production and sale to the public

17.36 After a period for testing highly automated vehicles and proving their readiness for sale to the public, it is anticipated that manufacturers would wish to incorporate highly automated systems into their mass produced vehicles, and make these available to the public for purchase.

Vehicle standards

17.37 Depending on the nature of the system in question, it is unlikely that it would fully conform to current European rules on vehicle type approval. Therefore changes to European regulations would need to have been agreed and implemented by this time, as has been recommended in Chapter 8. The changes are anticipated to cover standards on safety, security and possibly data recording requirements.

17.38 It may be possible to use domestic legislation to approve highly and fully automated vehicles, if approval was not possible under European law. This is a less attractive option for vehicle manufacturers, who operate on an international basis and are reluctant to fundamentally redesign vehicles for different countries. However it might be an option for early low-volume production whereby small numbers of vehicles are sold or leased to the general public, as a first step to gain acceptance prior to full mass production and widespread sale.

17.39 At this time it seems premature to amend domestic legislation as the standards to be applied to such vehicles clearly do not exist. These would be best created at the European or international level. When draft international standards are approaching maturity it would be possible to permit national approval based on these drafts, in order to allow vehicles to enter service more quickly rather than wait for the formal adoption process. This practice has been followed in the past in introduction of novel technology, for example with hydrogen vehicles when international standards were close to being finalised, and for LED (Light Emitting Diode) headlamps in the same situation.

17.40 Chapter 10 has identified some necessary changes to secondary legislation on the safe use of vehicles. Annex B: Innovative personal transport has identified that some changes to regulation on low speed and remote control vehicles would be helpful, again involving secondary legislation.

Other regulations

17.41 There are a number of other areas of domestic legislation where we believe that changes to the regimes currently in operation would be advisable, primarily to define the boundary between the driver and the vehicle being in control, and clarify respective responsibilities and potential liabilities.

17.42 Work on planning and defining policy in these areas could start straight away. Chapter 18 lists the recommended areas for review and possible action.

17.43 There are also a number of areas, such as product liability, where changes to domestic or European legislation should be considered but as a lower priority. In these areas the situation should be kept under review.

17.44 For fully automated vehicles the person responsible for the vehicle's conduct, although not driving, may sometimes be remote from the vehicle rather than on board, and therefore arguably more onus will need to be placed on the manufacturer to ensure that the vehicle does not contravene any laws. In addition there may be extra responsibilities placed on the owner to ensure correct maintenance and so on.

Figure 17.1 – Daimler Mercedes driving on the road at CES 2015 in Las Vegas

18. Action Plan

Introduction

18.1 The actions from the Chapters reviewing the existing regulatory situation can be divided into four main types:

- Actions to ensure safe testing of automated vehicles;
- Actions to create or amend domestic legislation;
- Actions to engage with international bodies with a view to creating or amending international standards or legislation; and
- Other actions: for example to monitor testing and carry out further research.

Actions to promote safe testing

18.2 As set out in Chapter 17, the primary action from this review is for the Government to publish a Code of Practice, to promote safety and set clear guidance to be followed in responsible testing. We will work closely with stakeholders to finalise the Code of Practice in spring 2015 and it will then be reviewed on an ongoing basis.

18.3 The Code of Practice will address several of the individual actions identified in the chapters covering driver behaviour, other road users, product liability and safe use of vehicles. It will be developed in collaboration with key stakeholders and other interested parties in order to benefit from their expertise and ensure their views are taken into account.

18.4 It will also be informed by best practice from around the world. This will include careful analysis of conditions imposed in other countries and of the legislation introduced by American states, as well as guidance and recommendations from safety and industry bodies.

Actions to amend domestic legislation

18.5 There are a number of actions for changes to domestic legislation in order to cater for production and marketing of highly automated vehicles, with possible further changes necessary for fully automated vehicles. It may also be necessary to amend domestic legislation to incorporate the new international rules on these vehicles.

18.6 The chapters covering driver behaviour and insurance suggest that primary legislation is likely to require amendment to cater for the situation where a driver has delegated control to the vehicle and is no longer concentrating on the driving task. This work would need to consider how liability would be decided if that vehicle is subsequently involved in a collision.

18.7 Considerations concerning safe vehicle use (Chapter 10) may require changes to secondary legislation. It will be important to establish the extent to which the person in charge of the vehicle can be held responsible for certain prohibited actions, even when he or she is not actually driving the vehicle.

18.8 Annex B has identified that there may be some actions required in relation to regulations on electric personal vehicles and “remote control” vehicles. These could be undertaken in parallel with other changes to this legislation identified in the previous paragraph.

18.9 The target for making these amendments to domestic legislation is summer 2017.

Actions to amend international legislation

18.10 The chapters covering vehicle standards, data protection and cyber security recommend that international action is needed on type approval standards, in the areas of safety, ergonomics, event data recording and security.

18.11 Given the need to work with international partners, a precise timeline cannot be defined for this work, but it should be initiated as soon as possible, once agreement is reached across government as to the main objectives. The UK Government believes the target should be for updates to international legislation to be finalised by the end of 2018 to facilitate the introduction of highly and fully automated vehicle technologies to the marketplace.

Other actions

18.12 The chapter on driver licensing recommends that some consideration should be given to the need to revise existing licensing regulations. This might include changes to the driving test to provide some awareness of highly automated vehicles. This should take place after experience of these vehicles has been gained, and ideally prior to mass production being permitted.

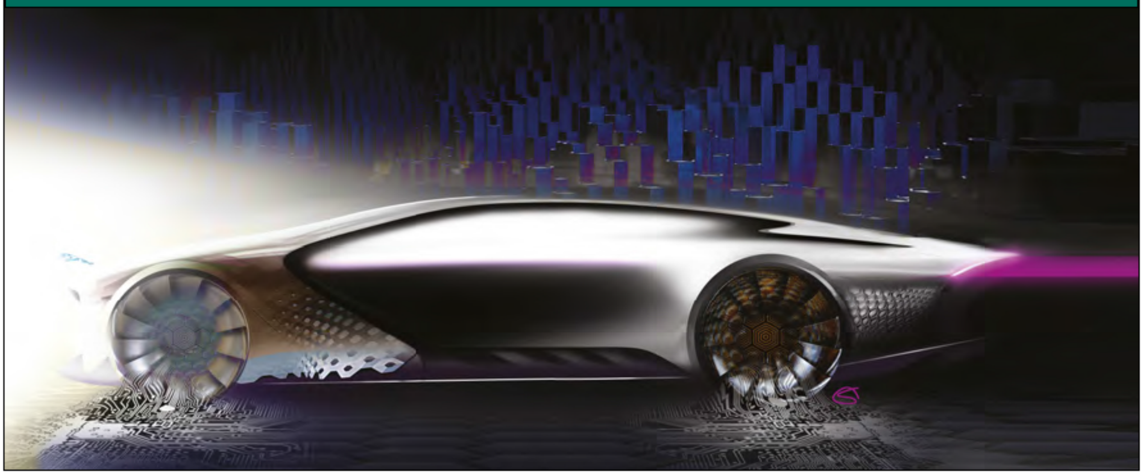
18.13 Chapter 7 has identified some potential issues with product liability law. This links with the insurance situation and should be kept under review. No immediate action is necessary, but if it is felt that product liability considerations are unnecessarily delaying the introduction of highly and fully automated vehicles, and hence the safety improvements they are expected to bring, then consideration should be given to examining the relevant legislation. This may need to take place at a European level.

18.14 Chapter 11 has identified that recording the identity of automated vehicles on the DVLA database would require a policy decision by the Department for Transport and funding to be made available. A timely decision should be made in order to permit DVLA to schedule the work appropriately, to minimise the costs. The change to the database is not urgent and could be done at any time prior to mass production being permitted.

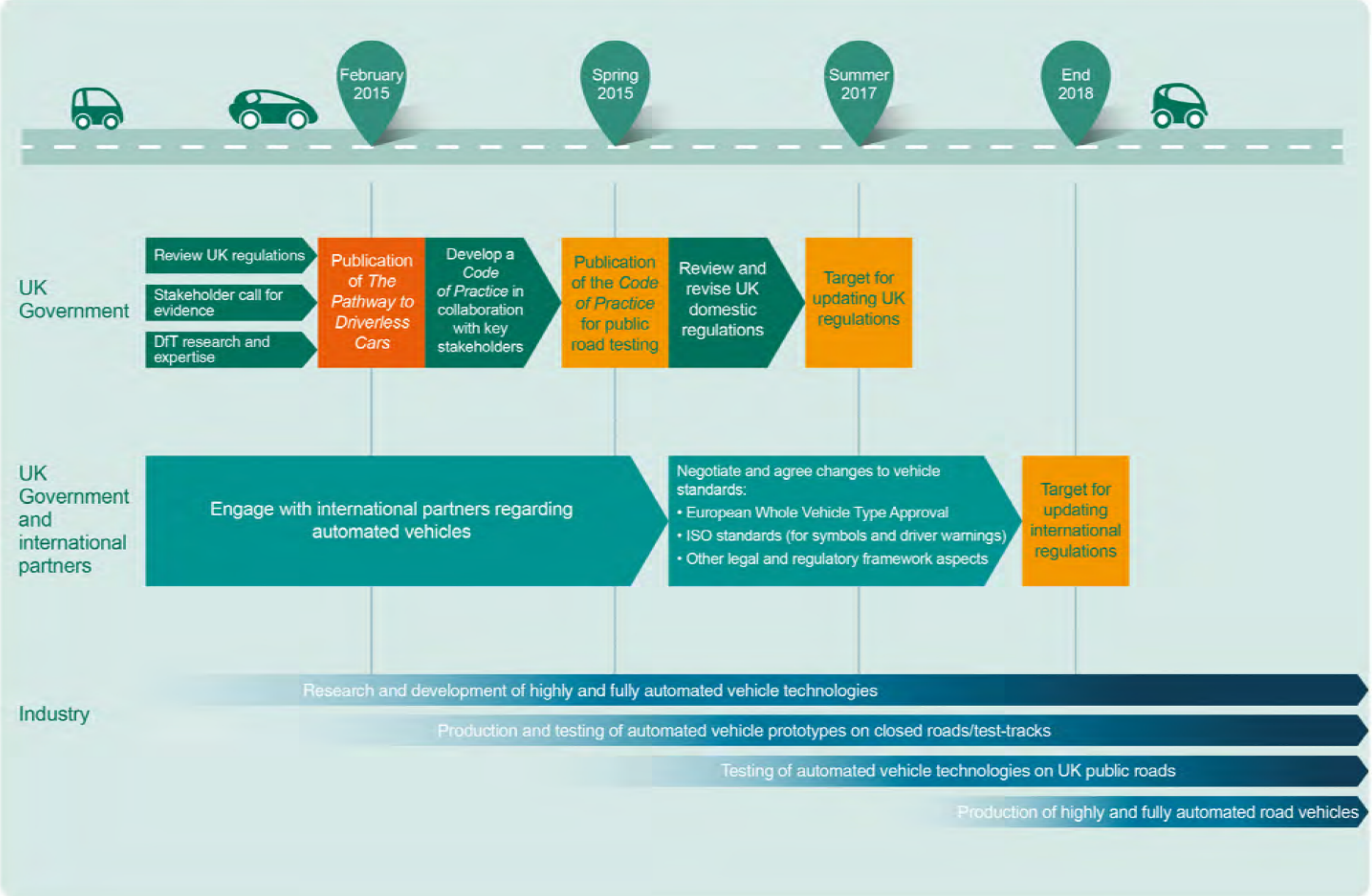
Conclusion

18.15 This review has identified a series of 31 specific actions for Government to take to facilitate the testing, development and eventual marketing of highly and fully automated vehicles. These actions are targeted to be completed over the course of the next four years as shown in the following timeline diagram. A full list of all 31 actions and their target completion timings is given in Annex D.

Figure 18.1 – Jaguar Autonomous Concept Vehicle Image



Timeline for the development of highly and fully automated vehicles



19. Summary

Introduction

19.1 This review has examined the compatibility of existing legislation, covering both vehicles and drivers, in relation to highly and fully automated vehicles.

19.2 It has also examined the developing regulatory environment in this area for other European countries, North America, and Asia.

19.3 The views of stakeholders have been sought in a 'call for evidence'. Responses from the automotive and insurance industries, the legal profession, technical institutions, and groups representing a wide range of road users, from children and disabled people to drivers, motorcyclists and cyclists have been taken into account.

19.4 The aim has been to provide a clearer understanding of how our existing legislation supports the development of automated vehicle technologies and to set out a plan of action to ensure that the UK continues to develop its place in this field as a leading automotive nation attracting investment from across the globe.

Findings

19.5 The main conclusion is that our legal and regulatory framework is not a barrier to the testing of highly automated vehicles on public roads. Real-world testing of automated technologies is possible in the UK today, providing a test driver is present and takes responsibility for the safe operation of the vehicle; and that the vehicle can be used compatibly with road traffic law.

19.6 In many other countries it would appear existing legislation currently prevents such testing. Those countries that have made arrangements to allow tests of automated vehicles have generally done so in a limited geographical region and require those wishing to conduct testing to apply for permits. Four states in America have introduced legislation to permit testing of automated vehicles, but fifteen are reported to have rejected bills related to automated driving.

19.7 The UK would therefore appear to be uniquely positioned to become a premium location globally for the development of these technologies. Those wishing to conduct tests are not limited to the test track or certain geographical areas, do not need to obtain certificates or permits, and are not required to provide a surety bond (provided they have insurance arranged).

Plan of action

19.8 The Government recognises the importance of facilitating the development of automated vehicle technologies given the numerous benefits that they are expected to bring. The rate of technological progress in this area is high and it is important that this innovation is not stifled.

19.9 The Department does not believe that new regulation or a permit system for testing is appropriate at this early stage. Instead the recommendation is to utilise a light-touch non-regulatory approach which provides the clarity industry needs to invest in further research and development, while maintaining safety.

19.10 This will be done through the publication of non-statutory guidance, in the form of a Code of Practice, in spring 2015. This will be developed with input from stakeholders to ensure that it is informed by existing best practice and experience. A Code of Practice would be an effective means of setting out the standards to be met by responsible manufacturers and testing organisations and their test drivers in the unusual circumstances of carrying out testing on automated vehicles.

19.11 In addition Government will commence work on amending national and international legislation to facilitate the production and marketing of highly and fully automated vehicles. It is envisaged that national legislation can be amended by 2017 and there should be an aim to finalise amendments to international regulations by the end of 2018.

Conclusion

19.12 The UK is uniquely positioned to help develop automated vehicle technologies and bring these to market. The Government is developing a light touch, non-regulatory approach to the testing and development of these technologies through the use of a Code of Practice. This will facilitate long distance and large area public road testing of these technologies.

19.13 The UK has some of the most challenging and diverse traffic, road and weather conditions in Europe and London is Europe's only 'Megacity'. This makes the UK the ideal centre for testing and developing these technologies.

Annexes

Contents:

Annex A: International situation

Introduction

A.1 The growth in interest in automated vehicle technologies has led many countries around the world to review their regulatory requirements with a view to amending them where necessary. It is important to ensure that existing legislative frameworks, written with conventional vehicles having a driver in mind, do not prevent development of automated technologies.

A.2 Industry needs certainty regarding the legislation, regulations and clarity of responsibilities in order to make significant investment decisions. Some countries have already taken steps to review and amend their regulatory requirements and a few have passed new legislation.

A.3 However there are risks associated with legislating when technologies are still in development. Legislating too early can restrict and limit the technologies which can be used, leading to sub-optimal solutions.

A.4 Europe has recognised the importance of ensuring the regulatory environment is suitable to allow the development of driverless cars and automated vehicle technologies. Automated and autonomous transport technologies are recognised as enablers to meeting Europe's target of a 60% reduction in transport CO_2 emissions and "vision zero" – where nobody is killed in road collisions – by 2050.[27]

Vienna Convention

A.5 In June 2013, senior automotive and transport officials in Europe held the first seminar to discuss the implications of automated driving.[28] Aside from Member State's national rules and regulations, the Vienna Convention on Road Transport was identified as a key barrier to the introduction of automated vehicles as it states that 'Every driver shall at all times, be able to control his vehicle'. This has been interpreted slightly differently in different Member States, nevertheless it is seen as a potential problem.

27 European Commission, Digital Agenda for Europe, Smart Mobility/Intelligent transport. (Available here: http://ec.europa.eu/digital-agenda/futurium/en/content/smart-mobility-intelligent-transport)

28 EurActive press release, Seminar explored policy and legal implications surrounding the adoption of autonomous driving in Europe, 4 July 2013. (Available here: http://pr.euractiv.com/pr/adoption-autonomous-driving-europe-debate-starts-eu-level-97552)

A.6 In March 2014, the United Nations Working Party on Road Traffic Safety discussed a proposed amendment to the convention submitted by the Governments of Austria, Belgium, France, Germany and Italy. The amendment would allow vehicle systems to influence the way in which vehicles are driven (i.e. control acceleration, braking and steering), when they are:

"in conformity with the conditions of construction, fitting and utilization according to international legal instruments concerning wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles", or "can be overridden or switched off by the driver".[29]

A.7 While the UK is a signatory to the Vienna Convention, it has not ratified it (and neither has Spain). As a result the convention is not considered to be a barrier for driverless vehicles in the UK.

European research projects

A.8 Europe has also initiated a number of research projects examining the potential for automated vehicles. These include:

- SARTRE (SAfe Road TRains for the Environment) – a Framework 7 programme which ran from 2009-2012 and aimed to develop strategies and technologies to allow vehicle platoons to operate on normal public highways. The 'road trains' are made up of a lead vehicle with a human driver, followed by a convoy of automated vehicles.
- HAVE-it – Highly Automated Vehicles for Intelligent Transport (HAVE-it) was a Framework 7 Programme (FP7) project which was aimed at realising highly automated driving for intelligent transport. The project began in February 2008 and ran until June 2011 and involved Continental, Haldex, Volkswagen and Volvo as well as SMEs, research institutes and universities.[30] The final event included seven demonstration vehicles.
- Citymobil – A Framework 7 programme (FP7) which ran till December 2011 and examined the integration of automated transport systems in the urban environment.[31] The project focused on real-life implementations of automated transport systems in three sites: a Personal Rapid Transit (PRT) system at Heathrow Terminal 5 in the UK; a hybrid guided bus/tramway in Castellon in Spain; and a Cybernetic Transport System in Rome.

29 United Nations Economic Commission for Europe, Working party on road traffic safety sixty-eighth session. (Available here: http://www.unece.org/fileadmin/DAM/trans/doc/2014/wp1/ECE-TRANS-WP1-145e.pdf (Annex) and http://www.unece.org/fileadmin/DAM/trans/doc/2014/wp1/ECE-TRANS-WP1-2014-1e.pdf)
30 HAVEit, About HAVEit. (Available here: http://www.haveit-eu.org)
31 CityMobil, Project summary. (Available here: http://www.citymobil-project.eu)

- Citymobil 2 – This follow-on FP7 project started in September 2012 and runs for four years. It is setting up a pilot platform for automated road transport systems. In May 2014, seven European towns and cities were selected to be sites to run large and small-scale demonstrations and showcases of automated road transport systems.[32]
- V-CHARGE – A four year FP7 project which will conclude in 2015, working on fully automated parking and charging for electric cars at public car parks.[33] The project held successful tests at Stuttgart airport in 2014.[34]
- AdaptIVe (Automated Driving Applications and Technologies for Intelligent Vehicles) – A project co-funded by the European Commission as part of the FP7 and supported by the European Council for Automotive R&D, EUCAR.[35] The project began in January 2014 and will run until the end of June 2017. The consortium, led by Volkswagen, consists of ten major automotive manufacturers, suppliers, research institutes and universities and small and medium-sized businesses.[36] The project develops various automated driving functions for daily traffic by dynamically adapting the level of automation to situation and driver status. Further, the project addresses legal issues that might impact successful market introduction.[37]

A.9 Older projects such as CyberCars and CyberCars-2 (2006-2008) developed and evaluated vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) technologies which are also relevant to automated driving.

A.10 As well as these European funded projects, many individual Member States have each been taking action to address the legal and regulatory challenges posed by driverless cars. The following section reviews the countries where it is known that developments or announcements have been made.

Differences in legal systems

A.11 It is important to note that the regulatory and legal actions that different countries take in respect of driverless cars will be dependent on the nature of their existing regulations and, in particular, the way

32 CityMobil2, Press release May 2014. (Available here: http://www.citymobil2.eu/en/upload/Dissemination_materials/CityMobil2%20press%20release_May2014_final.pdf)
33 V-Charge, Automated valet parking and charging for e-mobility. (Available here: http://www.v-charge.eu)
34 European Commission, EU develops new driverless car parking system. (Available here: http://europa.eu/rapid/press-release_IP-14-894_en.htm)
35 AdaptIVe, Press releases. (Available here: http://www.adaptive-ip.eu/index.php/press_releases.html)
36 AdaptIVe, Downloads, Deliverables and papers. (Available here: http://www.adaptive-ip.eu/index.php/deliverables_papers.html)
37 AdaptIVe, The project, Objectives. (Available here: http://www.adaptive-ip.eu/index.php/objectives.html)

their legal system functions. Most nations follow one of two main legal traditions: civil law; and common law.[38]

Civil law

A.12 Sometimes known as 'continental European law', this is a 'codified' system. A civil law system requires a comprehensive set of legal codes and statutes designed to cover all eventualities. This sets out what matters can be brought before a court, together with the applicable procedure and appropriate punishment for each offence. The judge's role is to establish facts and interpret the law.

A.13 The civil law system developed in parallel in continental Europe and its origins trace back to Roman times – in particular the extensive reform and bringing together of codified documents in AD 592 under Emperor Justinian. It is the most widespread system of law globally.

A.14 Countries with a legal system based on 'civil law' are normally sub-divided into four separate groups:

- French civil law (or Napoleonic Code): Belgium, France, Italy, Luxembourg, the Netherlands, Romania, Spain and former colonies of those countries.
- German civil law: Austria, Estonia, Germany, Greece, Japan, Latvia, Portugal and its former colonies, Switzerland, Turkey, and former Yugoslav republics.
- Scandinavian civil law: Denmark, Norway and Sweden, with Finland and Iceland also inheriting the system.
- Chinese law: a mixture of civil law and socialist law in use in the People's Republic of China.

Common law

A.15 This is sometimes described as 'judge-made law'. While common law systems do include extensive use of legal statutes, much of the law is based on 'precedent' – the decisions made by judges in similar previous cases. This 'case law' is regarded as the most important source of law.[39] Common law is therefore generally 'uncodified' and judges have a more important role in determining and developing the law.

A.16 The 'common law' tradition emerged in England in the middle-ages. Judges started to apply laws from Westminster rather than local laws or traditions. This was the first time that a nationalised legal system started to come about – a "common" law. The system spread and was applied in British colonies.

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38 University of California at Berkeley, School of Law, The Robbins Collection, The Common Law and Civil Law Traditions. (Available here: https://www.law.berkeley.edu/library/robbins/CommonLawCivilLawTraditions.html)

39 The Economist, What is the difference between common and civil law? 16 July 2013. (Available here: http://www.economist.com/blogs/economist-explains/2013/07/economist-explains-10)

A.17 Countries with a legal system based on English common law include: Australia, Canada, United States, Hong Kong, New Zealand and Singapore, as well as Ireland and Wales.

A.18 As legal systems have evolved, many countries are now effectively operating under a hybrid of these two systems. Countries operating with a 'common law' tradition may find that there is less requirement to introduce new legislation in respect of driverless vehicles than those operating under a 'civil law' tradition.

Finland

A.19 The Ministry of Transport and Communications in Finland is currently preparing an amendment to their Road Traffic Act. This would allow automated vehicles to drive within restricted testing areas at certain times on public roads, once they have been issued with a permit. The intention is to introduce experimental legislation which would be in force for five years starting from the beginning of 2015.

A.20 The Finnish Transport Safety Agency would issue permits for testing in defined areas and within limited time periods. A press release issued by the Ministry specifies that this would allow testing of the Google driverless car in Finland.[40] The information learned from these trials will inform the development of possible permanent legislation.

A.21 Finland's second generation Intelligent Strategy for Transport published in February 2013 also states that between 2013-2015 they will assess the business potential, legislative requirements and potential profitability for the transport sector of driverless vehicles.[41] This will be a joint project between the Finnish Transport Agency, the Ministry of Transport and Communications, the Ministry of Employment and the Economy, the Transport Safety Agency (TraFi), research institutes and the corporate sector.

France

A.22 France is one of the five countries which pressed for the amendment to the Vienna Convention. President Francois Hollande included driverless cars in a 10-year "roadmap" for the future.[42] The CEO of Renault-Nissan, Carlos Ghosn has been named as leader of the

40 Ministry of Transport and Communications, MINTC to launch an experiment that would allow for robotic cars, 26 May 2014. (Available here: http://www.lvm.fi/pressreleases/4404066/mintc-to-launch-an-experiment-that-would-allow-for-robotic-cars)

41 Ministry of Transport and Communications, Towards a new transport policy, Intelligence in transport and wisdom in mobility, page 33. (Available here: http://www.lvm.fi/docs/en/2497124_DLFE-20007.pdf)

42 Le portail de l'économie et des finances, La Nouvelle France Industrielle, 10 July 2014. (Available here: http://www.economie.gouv.fr/nouvelle-france-industrielle#34%20plans)

automated vehicles project. In July 2014 his roadmap for automated vehicles was published.[43] This included:

- Identification of pilot zones for automated vehicles and plans for cooperation with China and Korea in 2015.
- Studies into the impact and acceptability of targeted automated vehicle use in 2015-2020.
- The launch of R&D projects targeted in the field of embedded intelligence, HMIs, human factors and connectivity, creation of competitions and targeted interventions to support key investment companies in the years 2014-2018.
- Targeted R&D projects examining security, provision of suitable test facilities and demonstrations of improved security in 2015-2018.
- Adaptation and deployment of the necessary infrastructure to provide connectivity (2018-2020).
- Establishment of a special automated vehicle insurance fund in 2018.
- Changes in driver training.
- Development of regulatory requirements to support testing of automated vehicles and their entry into the market.

A.23 An inter-ministerial team has been established and is working with UTAC in order to examine the regulatory issues which may inhibit testing of automated vehicles. The team is examining:

- Le Code de la Route (the French Highway Code) and the texts which it follows, for example the Vienna Convention on Road Traffic.
- Technical regulations of the vehicle, the systems and associated subsystems (for example steering, braking, lighting, etc.).
- Vehicle type approval.
- Technical standards.
- General Product Safety (GSP).
- Criminal and civil liability for violations, accidents and disputes.
- Insurance rules.
- Data ownership when collected and stored by an automated vehicle, IT and freedom of information.

43 La Nouvelle France Industrielle, Point d'étape sur les 34 plans. (Available here: http://proxy-pubminefi.diffusion.finances.gouv.fr/pub/document/18/17721.pdf#page=12)

A.24 The team is targeting authorisation of experimental testing of partial to highly automated vehicles (SAE levels 2, 3 and 4[44]) at the beginning of 2015.

A.25 French companies have a strong interest in automated vehicles. Renault's Next Two automated vehicle demonstrator allows the driver to delegate driving functions in congested traffic up to 30kph on main roads.[45] French company Induct claims to have produced the first commercially available automated vehicle with its Navia product (now renamed NAVYA) which it launched in the US market in January 2014.[46] It is aimed to complement public transport, carrying up to eight passengers and using LIDAR (Light Detection and Ranging) sensors to navigate autonomously on routes it has been 'taught' at speeds up to 12.5 mph.

A.26 The Université Blaise Pascal in the French city Clermont Ferrand has been involved in automated vehicle projects such as CityVIP (which saw tests of small two-seat, low speed electric pods in pedestrian environments in 2011) and Citymobil. Clermont Ferrand is also home to part of France's National Research Institute of Science and Technology for Environment and Agriculture (IRSTEA) which has published research in 2014 examining the potential for automated vehicle use in agriculture.[47]

Germany

A.27 In 2012, the Federal Highway Research Institute (BASt) published a report entitled "Legal consequences of an increase in vehicle automation". This summarises the situation with respect to automated vehicles and current German regulations.[48]

A.28 It states that existing levels of automation available in current production vehicles have a distinctive feature of 'the permanent attention of the driver to the task of driving as well as the constant availability of control over the vehicle'. As a result it concludes these are therefore compatible with German regulatory law. However it states higher and full automation is NOT currently compatible with German law for the following reasons:

44 OICA, Automated Driving, Definition for Levels of Automation, Side 3, 14 March 2014. (Available here: http://www.oica.net/wp-content/uploads//WP-29-162-20-OICA-automated-driving.pdf)
45 Renault, Autonomous driving, Renault NEXT TWO, for an affordable, hyperconnected mobile lifestyle, 6 February 2014. (Available here: media.renault.com/download/media/specialfile/54698_1_5.aspx)
46 Navya Technology, News. (Available here: http://navya-technology.com)
47 IEEE Xplore Digital Library, Adaptable robot formation control: Adaptive and predictive formation control of autonomous vehicles, 11 March 2014. (Available here: http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=6740018)
48 Bundesanstalt für Straßenwesen, Legal consequences of an increase in vehicle automation, Part 1. (Available here: http://www.bast.de/DE/FB-F/Publikationen/Download-Publikationen/Downloads/F-legal%20consequences.pdf?__blob=publicationFile)

- Paragraph 1 of the German Road Traffic Code (Strassenverkehrs-Ordnung or StVO) requires 'constant care and mutual respect' of drivers.
- Section 18 of the German Road Traffic Act (StVG) defines a driver's duty to compensate in the case of a collision unless the driver can prove it was not their fault (strict liability of the driver). This may no longer be appropriate in the situation of high levels of automation that allow the driver not to be fully attending to the task of driving.

A.29 Examining existing legislation the report comments that in the German Road Traffic Code the obligation of the driver to control the vehicle is explicitly found only in relation to the vehicle's speed.

A.30 It also highlights that UN ECE Regulation 79 does not currently permit partially automated steering at motorway speeds. It states "the control action shall be automatically disabled if the vehicle speed exceeds the set limit of 10 km/h by more than 20 per cent […]."[49]

A.31 The report concludes that:

- Further behavioural psychology research is needed to determine whether hands-free driving would hinder the driver in the execution of permanent caution as required by the German Road Traffic Code (StVO).
- For partially automated systems, their intended range of use must be closely and unmistakeably defined. Users' expectations must be properly managed to ensure safe use.
- Higher degrees of automation which no longer require the driver's permanent attention would mean every collision has the potential to result in product liability for the manufacturer. The report comments that this "might only be excluded in case of breach of traffic rules by a third party or in case of overriding/oversteering by the driver.

A.32 In November 2013 a roundtable on automated driving was inaugurated which includes representatives from Government Ministries, research facilities, and the Automotive and Insurance Industry. This has three working groups looking at:

- Law
- Driver/Car
- Research

A.33 They are tasked with determining the status quo, identifying open questions/inconsistencies, and elaborating work objectives/proposed

49 United Nations Economic Commission for Europe, Addendum 78: Regulation No. 79 Revision 2. (Available here: http://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/r079r2e.pdf)

solutions.[50] The roundtable is due to report first findings at the end of 2014.

Public road testing in Germany

A.34 Currently each Federal State (Bundesländer) in Germany can grant exemptions from the technical requirements of the German Road Traffic Licensing Regulations (Straßenverkehrs-Zulassungs-Ordnung or StVZO). This can allow a vehicle to operate autonomously on public roads provided there is a driver in the driver's seat. This driver has full legal responsibility for the safe operation of the vehicle.

A.35 As a result a number of tests of automated vehicles have already been conducted on German roads:

- In June 2011 AutoNOMOS labs' modified VW vehicle was the first vehicle to be certified for automated driving in the states of Berlin and Brandenburg. It has covered thousands of kilometres driving in both Berlin city centre and the autobahn.[51] The driving permit has been issued on condition a driver is behind the wheel during the tests. If the driver touches the brake pedal all computers disconnect and the driver can take control of the vehicle. The permit is described as an "exceptional permission to test autonomous functions in real traffic situations".[52] In August 2012 the German Minister for Education and Research took a trip in the vehicle which included being driven with nobody in the driving seat on a private test track.[53]
- In January 2012 BMW demonstrated an automated 5-series capable of slowing for traffic, accelerating up to speed and performing lane changes when necessary on a German autobahn. However the technology required the vehicle to be provided with highly accurate mapping of the road in advance.[54]
- In January 2014, BMW announced it intends to conduct a fleet trial of its 'highly automated driving' technology in 2015.[55] Some current production BMW vehicles feature 'Traffic Jam Assist' capable of automated steering, acceleration and braking up to 25 mph.[56]

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50 Federal Ministry of Transport and Digital Infrastructure, Automated driving – the legislator's perspective, 5 March 2014. (Available here: https://www.itu.int/en/fnc/2014/Documents/S2P2_Julia_Pullen.pdf)

51 AutoNOMOS Labs, Autonomous cars from Berlin. (Available here: http://www.autonomos.inf.fu-berlin.de) and Youtube, Mission Brandenburger Tor: Autonomous car in Berlin. (Available here: https://www.youtube.com/watch?v=YZqL6j2D5H4)

52 AutoNOMOS Labs, MadeInGermany. (Available here: http://autonomos-labs.com/vehicles/made-in-germany)

53 Youtube, First autonomous state limousine. (Available here: https://www.youtube.com/watch?v=nX-Ie6JSU5g)

54 Autoblog, BMW takes its autonomous 5 Series onto the autobahn, 26 January 2012. (Available here: http://www.autoblog.com/2012/01/26/bmw-takes-its-autonomous-5-series-onto-the-autobahn)

55 BMW Group PressClub USA, BMW at the Consumer Electronics Show (CES) in Las Vegas 2014, 7 January 2014. (Available here: https://www.press.bmwgroup.com/usa/pressDetail.html?title=bmw-at-the-consumer-electronics-show-ces-in-las-vegas-2014&outputChannelId=9&id=T0163066EN_US&left_menu_item=node__5238)

56 BMW, Safety in the BMW i3. (Available here: http://www.bmw.co.uk/en_GB/new-vehicles/bmw-i/i3/2013/safety.html)

- In September 2013, Mercedes ran an S-Class 'Intelligent Drive' autonomously for 60 miles from Mannheim to Pforzheim in Germany, negotiating pedestrians, traffic lights, and roundabouts on rural and urban roads.[57]

A.36 In January 2015, Germany's transport minister announced that the A9 autobahn between Munich and Berlin would be fitted with technology to allow driverless cars to use the road and communicate with other vehicles and the road infrastructure. It is also worth noting that Audi is amongst the most advanced of the OEMs in offering driver assistance technologies on its range of vehicles.

Italy

A.37 In principle, driverless transport systems in Italy may be considered legal if they are certified according to a technical standard which has been developed for rail systems. However, a legal study is currently being undertaken.

A.38 The Artificial Vision and Intelligent Systems Laboratory (VisLab) of the University of Parma is heavily involved in the research and development of automated vehicles.[58] In 2010, they launched an 8,000 mile test drive of their driverless vehicle technology from Italy to China during three months.[59] The aim was to assess the technology in a wide variety of traffic, weather and road conditions, including off-road and with no maps available for some of the route. The test format utilised two automated small electrically driven vans in a 'leader'/'follower' formation. The leader vehicle required some human intervention but the aim was for the follower vehicle to track the same route with no intervention.[60] The test successfully reached Shanghai.[61]

A.39 The University followed this up with the BRAiVE (BRAin drIVE) vehicle which incorporated a range of their technologies into a more conventional saloon car.[62]

A.40 In 2013, the University ran a test specifically aimed at demonstrating their technology on public urban roads – the PROUD (Public ROad Urban Driverless car test).[63] The test utilised an open road route with a mix of rural, freeway, and urban traffic. The test was carried out with a police escort at all times and a passenger ready to use the brake pedal in case of any emergency situations.

57 Youtube, Mercedes-Benz TV: Autonomous long-distance drive. (Available here: https://www.youtube.com/watch?v=CKqJccK_EkM)
58 VisLab. (Available here: http://vislab.it)
59 The VisLab Intercontinental Autonomous Challenge: 13,000 km, 3 months,… no driver. (Available here: http://www.ce.unipr.it/people/cattani/publications-pdf/itswc2010.pdf)
60 The VisLab Intercontinental Autonomous Challenge: 13,000 km, 3 months,… no driver. (Available here: http://www.ce.unipr.it/people/cattani/publications-pdf/itswc2010.pdf)
61 IEEE Xplore Digital Library, VIAC Expedition Toward Autonomous Mobility – Bertozzi, M et al. (Available here: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6016589)
62 http://www.braive.vislab.it
63 VisLab, BRAiVE. (Available here: http://vislab.it/proud-en)

A.41 Italy is also involved with the European FP7 project Citymobil 2. This includes a trial test of two driverless buses running during July and August 2014 along the beach of Torre Grande near the village of Oristano in Sardinia.[64] [65]

Netherlands

A.42 The Netherlands is another European country which is actively planning for testing of driverless cars on public roads. In June 2014 the Dutch Minister for Infrastructure and the Environment announced the desire to allow large-scale testing of self-driving on Dutch roads, but acknowledged that to make this legally possible, existing legislation must be amended.

A.43 In January 2015 a proposal to extend exemption rules to allow 'large-scale' testing of self-driving cars and trucks was approved. A spokesperson stated that testing would start in summer 2015 once parliament approved the necessary legislative changes. The Dutch Vehicle Approval Authority (RDW) would be enabled to grant these exemptions.[66]

A.44 The announcement also included a desire to initiate amendments to regulations at an international level, building a network between countries to further the development of driverless cars. The Dutch have EU Presidency in 2016 and have stated they intend to organise an international event on the subject. They have also launched a study into the potential issues such as liability, driving skills requirements, data traffic and the possible impact on infrastructure.[67]

Proposed self-driving truck trial

A.45 An industry group has submitted an application to start delivering goods from Rotterdam to other cities in the Netherlands using self-driving trucks within five years. The application has been put forward to the Netherlands parliament by the Ministry for Infrastructure and the Environment citing benefits of reduced road space requirements, and improved safety and environmental impacts. The application includes a plan with initial tests by computer simulation, followed by physical tests on a closed track before a pilot on public roads, with first demonstrations planned for early next year. While similar trials have taken place elsewhere, this one is claimed to be unique due to the

64 CityMobil2, 1st demonstration launched in Oristano. (Available here: http://www.citymobil2.eu/en/News-Events/News/1st-demonstration-launched-in-Oristano) and Tiscali in Sardegna, Oristano, a Torregrande arriva il bus senza autista per City Mobil 2, 14 May 2014. (Available here: http://notizie.tiscali.it/regioni/sardegna/articoli/14/05/19/oristano-bus-senza-conducenti.html)

65 CityMobil2, Newsletter No. 3, June 2014. (Available here: http://www.citymobil2.eu/en/upload/Dissemination_materials/citymobil2%20newsletter%20n%C2%B03%20.pdf)

66 Ministry of Infrastructure and the Environment, Large scale testing of self driving vehicles in the Netherlands, 2 October 2014. (Available here: http://www.connekt.nl/uploads/2014/10/davi-selfdriving-vehicles-in-the-netherlands-davi-dag.pdf)

67 Government of the Netherlands, Schultz advocates large-scale testing of self-driving cars on Dutch roads, 16 June 2014. (http://www.government.nl/news/2014/06/17/schultz-advocates-large-scale-testing-of-self-driving-cars-on-dutch-roads.html)

backing of the Dutch Government to bring this to market within five years.[68]

Spain

A.46 Apart from the United Kingdom, Spain is the only other EU member that has signed but not ratified the Convention on Road Traffic, also known as the Vienna Convention (1968). The Spanish Road Code was updated in May 2014, but it still contains the statement: 'Drivers should be at all times in a condition to control their vehicles' (§1 Article 11 Paragraph 1)[69], which could be problematic for automated vehicles.

A.47 In 2012, Spain allowed an open road platooning test of three Volvos and a semitrailer on a highway near Barcelona under the FP7 project SARTRE.[70] In addition, several Spanish cities (Castellon, Leon and San Sebastian) have been involved with the European FP7 projects Citymobil and Citymobil 2 hosting demonstrations of automated transport over a period of several days in their cities.[71]

A.48 The Spanish Government were also supportive of the CSIC's (Spanish National Research Council) Platero vehicle project. In 2012, it completed an open road test without the input of a driver for approximately 60 miles on a highway near Madrid. The vehicle was escorted by the police at all times.[72]

A.49 In February 2014, the Spanish Government invested 10 million Euros in the CTAG (Automotive Technology Centre of Galicia) to build 0.7 hectares of offices and 1.5 hectares of outdoor test tracks, where 350 employees will be involved in investigation and testing of the most recent advanced driving technologies.[73]

A.50 Finally, Scania is working in collaboration with IDIADA (Spanish proving grounds and research laboratory) to test their entire platooning system on Spanish roads during the autumn of 2016.[74]

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68 Traffic Technology Today.com, Consortium applies to trial autonomous trucks in the Netherlands (Available here: http://www.traffictechnologytoday.com/news.php?NewsID=59967)

69 Agencia Estatal Boletín Oficial del Estado, Código de Tráfico y Seguridad Vial, 19 January 2015. (Available here: https://www.boe.es/legislacion/codigos/codigo.php?id=020_Codigo_de_Trafico_y_Seguridad_Vial&modo=1)

70 Engadget, Volvo's driverless road train in Spain is public mainly on the plain. (Available here: http://www.engadget.com/2012/05/28/volvo-driverless-road-train-hits-public-roads-in-spain)

71 CityMobil2. (Available here: http://www.citymobil2.eu/en)

72 CSIC, El CSIC experimenta la conducción de coches del future, 10 June 2012. (Available here: http://documenta.wi.csic.es/alfresco/downloadpublic/direct/workspace/SpacesStore/4b09d1d8-b276-44c0-b9d3-7ae771c26711/Nota%2520de%2520prensa.pdf)

73 PorriñoDigital.es, El CTAG inaugural su división de electronica para coches inteligentes, 20 February 2014. (Available here: http://www.porrinodigital.es/index.php/porrino-digital-noticias/categorias/porrino-digital-actualidad/506-el-ctag-inaugura-su-division-de-electronica-para-coches-inteligentes.html)

74 Scania Press Info, Scania leads European research project on vehicle platooning, 11 December 2013. (Available here: http://www.scania.com/Images/wkr0006_tcm40-403171.pdf)

Sweden

A.51 Testing of highly automated vehicles on public roads has already commenced in and around Gothenburg as part of the Volvo 'Drive Me' project. The vehicles are currently being driven and developed by test engineers, but it is planned to provide members of the public with 100 driverless cars for use on public roads in Gothenburg in 2017.[75] The project aims to include all key players: legislators, transport authorities, a major city, a vehicle manufacturer and real potential customers.[76]

A.52 According to one report, the use of automated operation will be limited to a specific region within Gothenburg, which will be mapped for the trial. Updates to the mapping information will be set to the vehicles through mobile communications systems.[77]

A.53 In May 2014 a workshop was held to discuss automation of the transport system. Representatives of the Swedish Transport Agency reported on a preliminary study of the legal aspects of automated driving. Initial findings are that current traffic laws would allow for testing vehicles with a higher degree of automation (equivalent to NHTSA Level 3). However, it was stated that "vehicle legislation, driver's licence rules and liability rules may need to be adjusted".[78]

A.54 Existing vehicle regulations and roadworthiness testing would need to be amended to cover the hardware and software used for automated operation to ensure that it meets technical requirements and is well maintained.

A.55 New drivers' licences could be introduced for those with impairments to license use of fully automated vehicles only.

A.56 The study also highlighted the importance of an accurate, easily accessible registry of all national and local traffic regulations. Sweden's existing online registry was criticised for missing and poor quality information.

A.57 According to the Swedish Ministry of Transport, the automation of transport involves both technological and social development and will

75 Volvo Car Group Global Newsroom, Volvo Car Group's first self-driving Autopilot cars test on public roads around Gothenburg, 29 April 2014. (Available here: https://www.media.volvocars.com/global/en-gb/media/pressreleases/145619/volvo-car-groups-first-self-driving-autopilot-cars-test-on-public-roads-around-gothenburg)

76 Volvo Car Group Global Newsroom, Volvo Car Group initiates world unique Swedish pilot project with self-driving cars on public roads, 02 December 2013. (Available here: https://www.media.volvocars.com/global/en-gb/media/pressreleases/136182/volvo-car-group-initiates-world-unique-swedish-pilot-project-with-self-driving-cars-on-public-roads)

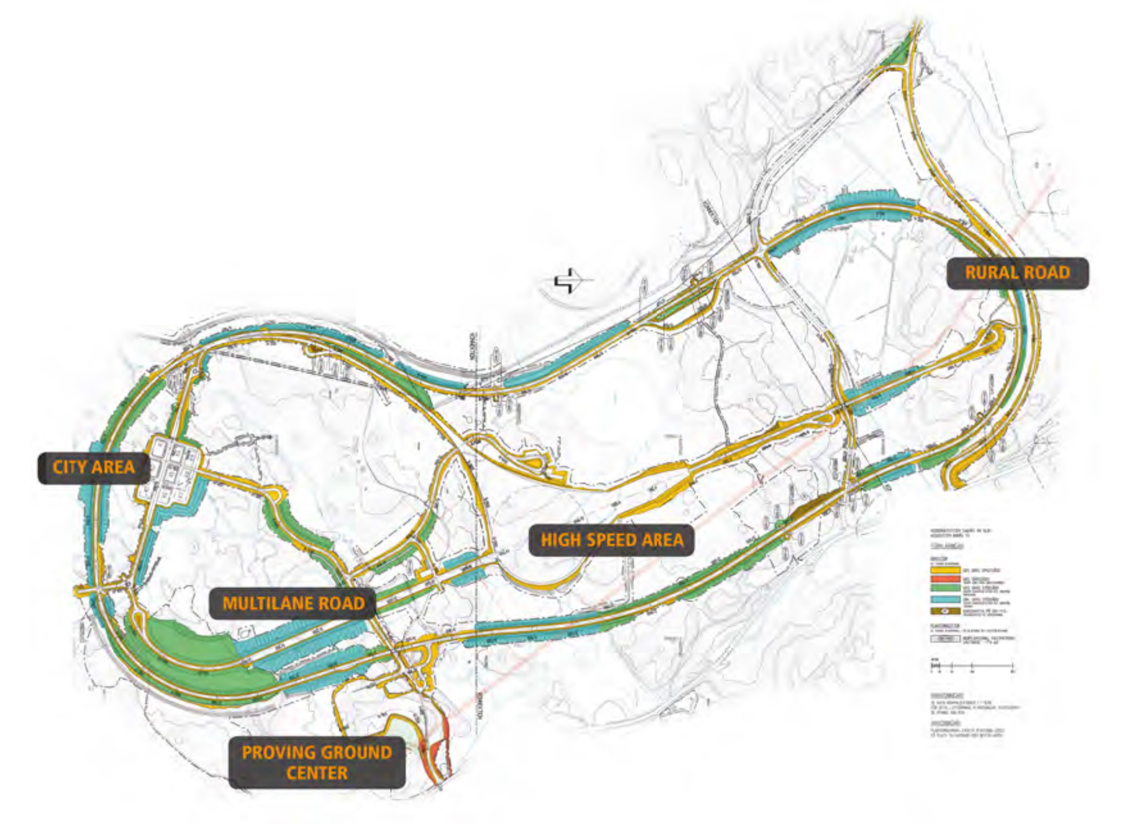
77 Driverless car market watch, The race for leadership in autonomous cars in on: Volvo to deploy 100 self-driving cars by 2017, 19 December 2013. (Available here: http://www.driverless-future.com/?p=579)

78 VRA, Swedish workshop on "Automation of the transport system", 22 May 2014. (Available here: http://vra-net.eu/swedish-workshop-on-automation-of-the-transport-system-22052014)

therefore take time, but certain types of vehicles may perhaps be automated faster than others.[79]

A.58 In August 2014 a 200 hectare test track opened near Gothenburg. The facility is named AstaZero (Active Safety Test Area and Zero, referring to Sweden's 'Vision Zero' for road safety).[80] It is owned by SP Technical Research Institute of Sweden and Chalmers University of Technology and has been publicised as "the world's first full sized safety test track for driverless vehicles".[81] The facility has motorway, rural and urban road environments and has an aim to function "as an international arena open for vehicle manufacturers, suppliers, legislators, universities and colleges from throughout the world".[82]

Figure A.1: AstaZero test track facility near Gothenburg, Sweden



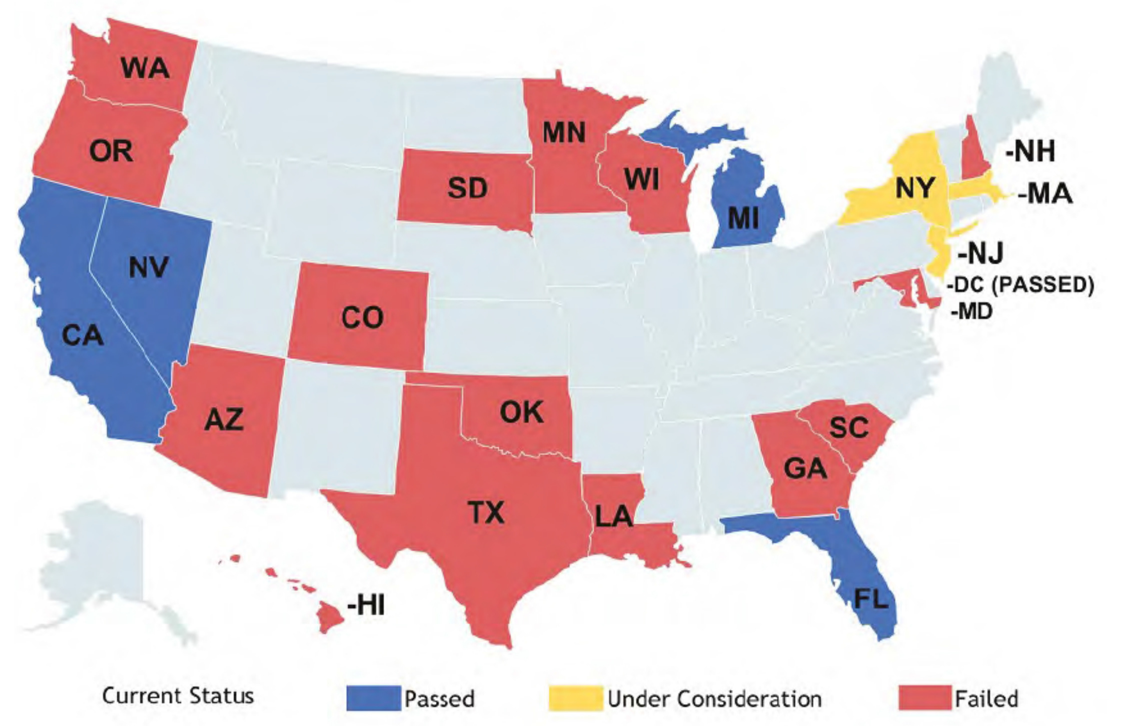
79 VRA, Swedish Workshop on "Automation of the Transport System" 22 May 2014. (Available here: http://vra-net.eu/swedish-workshop-on-automation-of-the-transport-system-22052014)
80 AstaZero. (Available here: http://www.astazero.com)
81 The Institution of Engineering and Technology, View from Brussels – Move over Google as Gothenburg pioneers driverless vehicle projects, 26 June 2014. (Available here: http://www.theiet.org/forums/blog/blogpost.cfm?catid=396&threadid=58238)
82 AstaZero, About. (Available here: http://www.astazero.com/about-astazero/about)

USA

A.59 America is generally considered to be leading the way in terms of legislating for driverless vehicles. To date, four states in America including Nevada, Florida, California and Michigan have already passed laws concerning driverless cars and California will start giving out licenses this autumn (2014).

A.60 However state-by-state laws vary significantly and according to one source no state has fully determined how existing traffic laws should apply to automated vehicles.[83] Both California and Florida have taken the approach that automated driving is already legal but unlike Florida, California has introduced specific safety requirements for automated vehicles and their use.

Figure A.2: Current status of legislation in US by state



National Highway Traffic Safety Administration (NHTSA) position

A.61 In May 2013 NHTSA issued a 'preliminary statement of policy concerning automated vehicles'.[84] This sets out:

- Potential benefits of the technology and NHTSA's role.
- Definitions of the various levels of automation, up to NHTSA Level 4 – 'full self-driving automation'.

83 Wired, Europe demands driverless cars be drivable, 30 May 2014. (Available here: http://www.wired.co.uk/news/archive/2014-05/30/eu-embrace-self-driving-cars)

84 NHTSA, U.S. Department of Transportation releases policy on automated vehicle development, 30 May 2013. (Available here: http://www.nhtsa.gov/About+NHTSA/Press+Releases/U.S.+Department+of+Transportation+Releases+Policy+on+Automated+Vehicle+Development)

- NHTSA's research plan for automated vehicles, detailing key areas considered to need further research.

A.62 It also includes recommendations which NHTSA has developed for states wishing to proceed with tests of automated vehicles. NHTSA's recommendations are aimed at level 3 and 4 automation and are stated as being provisional and subject to revision. NHTSA recognises the potential long term safety benefits of automation, but has considerable concerns about states creating detailed regulation at this time.

A.63 Importantly it makes clear it does not recommend permission to operate self-driving vehicles for anything other than testing purposes at the moment. The recommendations therefore assume that the driver of the vehicle will be employed for the purposes solely of testing.

A.64 In summary the recommendations are:

- **License drivers to operate self-driving vehicles for testing** – License endorsements should be issued subject to testing, training or proof of experience to ensure the driver understands how to safely operate such a vehicle. Any training courses should be pre-approved by the license issuing authority.
- **Require proof of safe operation of self-driving vehicles** – Before issuing permits for public road testing, NHTSA recommends that states should require proof from businesses of experience operating these vehicles safely including:
    a. Certifying that a minimum number of miles have been achieved without incident.
    b. Submission of data from previous testing.
    c. Submission of a plan detailing how risks will be minimised.
- NHTSA also strongly recommends that a properly licensed driver be seated in the driver's seat, ready to take control if necessary whilst the vehicle is operating on public roads.
- **Limit tests to locations suitable for self-driving vehicles** – Vehicle manufacturers should specify the type of operating conditions they wish to test in, and submit test data to demonstrate that their self-driving vehicles are capable of operating in such conditions with limited driver intervention. States should consider tailoring regulations to limit the use of the self-driving mode to conditions conducive to safe operation in that mode.
- **Establish reporting requirements to monitor self-driving technology performance** – NHTSA encourages states to require businesses testing self-driving vehicles to "submit certain information including:

a. instances in which a self-driving vehicle, while operating in or transitioning out of self-driving mode, is involved in a crash or near crash.

b. incidents in which the driver of one of their self-driving vehicles is prompted by the vehicle to take control of the vehicle while it is operating in the self-driving mode because of a failure of the automated system or the inability of the automated system to function in certain conditions."

- **Ensure that the process for transitioning from self-driving mode to driver control is safe, simple and timely** – NHTSA highlight the importance of a driver being able to quickly and easily retake control of the vehicle from the automated system for example by:

  a. providing a button located within the driver's reach.

  b. ensuring that the automated functions automatically defer to the driver's input to brakes, accelerator pedal or steering wheel.

  c. requiring the self-driving vehicle to alert the driver when the driver must take control.

- **Require self-driving vehicles to have the capability to detect, record, and inform the driver that the automation system has malfunctioned** – The vehicle should be able to detect malfunctions, failures or degradations in operations and inform the driver to allow the driver to safely retake control. These occurrences should be recorded so that the causes can be established.
- **Ensure that self-driving vehicle technologies do not disable any required safety features or systems** – Some safety features and systems are required by law and it is therefore important to ensure that the installation and operation of self-driving technologies does not disable these. This could be verified by requiring self-certification. In general NHTSA notes there should be no degradation of the safety performance of the vehicle.
- **Ensure that all information about the status of the automated control technologies is recorded in the event of a crash or loss of vehicle control** – NHTSA recommends that 'self-driving test vehicles should record data from the vehicle's sensors, including sensors monitoring and diagnosing the performance of the automated vehicle technologies, in the event of a crash, or other significant loss of vehicle control'. The recording should also note whether the automated technology system was in control of the vehicle at the time of the crash. States should also consider ensuring that the vehicle owner makes available to the state all data recorded by the vehicle's event data recorder in the event of a crash.

Nevada

A.65 On 17 June 2011, Nevada enacted a bill making it the first state in America to pass legislation that automated vehicles may be operated legally on public roads. The legislation defines "autonomous vehicle" as "a motor vehicle that uses artificial intelligence, sensors and global positioning system coordinates to drive itself without the active intervention of a human operator."[85]

A.66 The act required that Nevada Department of Motor Vehicles (NDMV):

- Establishes a driver's license endorsement for operation of automated vehicles on the highways of the state which recognises that a person is not required to actively drive an automated vehicle.
- Sets forth requirements that an automated vehicle must meet as well as requirements for the insurance that is required to test or operate an automated vehicle on a highway.
- Establishes minimum safety standards for automated vehicles and their operation;
- Provides for the testing of automated vehicles;
- Restricts the testing of automated vehicles to specified geographic areas

A.67 State regulations drawn up by the Nevada Department of Motor Vehicles took effect in March 2012. These require a person who wishes to operate an automated vehicle in automated mode to obtain a driver's license endorsement. The regulations also require an automated vehicle to capture and store at least 30 seconds of data before a collision. Applicants wishing to operate automated vehicles on public roads must also provide a surety bond or deposit of $1 million to $5 million depending on how many vehicles they wish to test.[86]

A.68 Nevada also requires manufactures to report crashes involving automated vehicles to the state within 10 days.

A.69 In June 2013, the act was amended to state that "the manufacturer of a motor vehicle that has been converted to an autonomous vehicle by a third party is not liable for an injury that results from that conversion unless the defect that caused the injury was present in the vehicle as originally manufactured."[87]

A.70 Anyone wishing to apply for a license to test automated vehicles in Nevada is required to provide proof "that one or more of your

85 Nevada Legislature, Committee on Transportation, Assembly Bill No. 511, 28 March 2011. (Available here: http://www.leg.state.nv.us/Session/76th2011/Bills/AB/AB511.pdf)
86 Nevada Legislature, Adopted Regulation of the Department of Motor Vehicles, 1 March 2012. (Available here: http://www.leg.state.nv.us/register/2011Register/R084-11A.pdf)
87 Nevada Legislature, State Bill No. 313, 18 March 2013. (Available here: http://leg.state.nv.us/Session/77th2013/Bills/Amendments/A_SB313_R1_698.pdf)

autonomous vehicles have been driven for a combined minimum of at least 10,000 miles, a complete description of your autonomous technology, a detailed safety plan, and your plan for hiring and training your test drivers."

A.71 The Department issues special red license plates which feature an 'infinity' symbol to indicate the vehicle is capable of automated operation. Their website states "When autonomous vehicles are eventually made available for public use, motorists will be required to obtain a special driver license endorsement and the DMV will issue green license plates for the vehicles."[88]

Florida

A.72 Florida followed Nevada's lead, introducing a bill which was enacted in April 2012. It took the view that automated vehicles were already road legal, affirming that "the state does not prohibit or specifically regulate the testing or operation of autonomous technology in motor vehicles on public roads" and specifying that "[a] person who possesses a valid driver license may operate an autonomous vehicle in autonomous mode".

A.73 However the act establishes conditions for testing of automated vehicles. These include:

- safety mechanisms for engaging and disengaging the technology.
- indicators inside the vehicle that show when the vehicle is in automated mode.
- a means of alerting the operator to a technology failure.

A.74 It also requires the presence of a human being and creates insurance requirements of $5 million worth of cover for testing automated vehicles.[89] The act directs the state Department of Highway Safety and Motor Vehicles (DHSMV) to prepare a specific report for the legislature by February 2014. The act also addresses the question of who is in charge of an automated vehicle:

"a person shall be deemed to be the operator of an autonomous vehicle operating in autonomous mode when the person causes the vehicle's autonomous technology to engage, regardless of whether the person is physically present in the vehicle while the vehicle is operating in autonomous mode."[90]

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88 Department of Motor Vehicles, Official website of the State of Nevada, Autonomous Vehicles, Application for testing. (Available here: http://www.dmvnv.com/autonomous.htm)

89 Florida Highway Safety and Motor Vehicles, Autonomous Vehicle Report, 10 February 2014. (Available here: http://www.flhsmv.gov/html/HSMVAutonomousVehicleReport2014.pdf)

90 Florida Legislature, The 2014 Florida Statutes, Chapter 316.85 Autonomous vehicles; operation. (Available here: http://www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0300-0399/0316/Sections/0316.85.html)

A.75 The report from DHSMV has been published and recommends that "the State of Florida establish working relationships with motor vehicle manufacturers and technology developers to encourage these business opportunities" concluding:

"Autonomous technology has potential to significantly improve highway safety by reducing crashes and saving lives. In order to encourage innovation and foster a positive business environment toward that end, the Department proposes no changes to existing Florida laws and rules at this time."[91]

A.76 This is despite the fact that it is recognised that the state does not have a mechanism to deny a manufacturer's request to test even if they have a poor safety record in another state.

A.77 In July 2014, Audi announced that it will be conducting trials of its Traffic Jam Assist technology at up to 40 mph on an Expressway in Tampa, Florida.[92]

California

A.78 California introduced a bill which was chaptered in September 2012.[93] The act defined the meanings of automated technology, vehicle and operator, and required the Californian Department of Motor Vehicles to adopt regulations as soon as practicable, but no later than January 2015.

A.79 Regarding data collection the act specified that "The manufacturer of the autonomous technology installed on a vehicle shall provide a written disclosure to the purchaser of an autonomous vehicle that describes what information is collected by the autonomous technology equipped on the vehicle."

A.80 Regulations for testing by manufacturers on public roadways were adopted by the Californian Department of Motor Vehicles on 19 May 2014, becoming effective 16 September 2014.[94]

A.81 An application for 'General Operation of Autonomous Vehicles on Public Roads' requires eight specified mandatory certifications regarding safety systems, the requirement to have an event data recorder and evidence of testing.[95]

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91 Florida Highway Safety and Motor Vehicles, Autonomous Vehicle Report, 10 February 2014. (Available here: http://www.flhsmv.gov/html/HSMVAutonomousVehicleReport2014.pdf)

92 Audi USA, Audi shows Piloted driving will soon be ready for the road with Florida demonstration, 25 July 2014. (Available here: http://www.audiusa.com/newsroom/news/press-releases/2014/07/audi-piloted-driving-ready-for-road-soon-florida-demonstration)

93 Official California Legislative Information, Senate Bill No. 1298 Chapter 570. (Available here: http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_1251-1300/sb_1298_bill_20120925_chaptered.pdf)

94 California Department of Motor Vehicles, Testing of autonomous vehicles. (Available here: https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/testing)

95 California Department of Motor Vehicles, Public workshop autonomous vehicles, 11 March 2014. (Available here: http://apps.dmv.ca.gov/about/lad/pdfs/auto_veh_nontest/agenda_03_11_wksp.pdf)

A.82 The operator must also provide evidence of insurance, self-insurance or a bond with a minimum value of $5 million.

A.83 The act authorises the Department to impose additional requirements if the application seeks approval for automated vehicles where there is no person in the driver's seat and requires the Department to notify the Legislature if it receives such an application.

A.84 It is a requirement of the manufacture to provide proof of prior tests and report the test results before the Californian Department of Motor Vehicles will approve a vehicle for on-road testing.

A.85 The automated systems should not in interfere with any other required safety functions.

A.86 California also requires manufactures to report crashes involving automated vehicles to the state within 10 days.

Michigan

A.87 Michigan's bill was enacted in December 2013.[96] It too provides various definitions, including 'automatic mode' in which a vehicle can operate "without any control or monitoring by an operator". It also defines "upfitter" as "a person that modifies a motor vehicle after it was manufactured by installing automated technology in that motor vehicle to convert it to an automated vehicle."

A.88 The act expressly permits testing of automated vehicles by certain parties under certain conditions. It also addresses liability of the original manufacturer of a vehicle on which a third party has installed an automated system.

A.89 The act directs Michigan's Department of Transport, in consultation with the Secretary of State and various experts to submit a report on "transportation and economic development" by February 1, 2016. The report should make recommendations for any additional legislative or regulatory action that may be necessary for the continued safe testing of automated motor vehicles and automated technology installed in motor vehicles.

A.90 There is a requirement for the testing of prototype cars in Michigan to display a manufacture pre-production license plate. However, this is a requirement for testing all types of functionality and not restricted to automated technologies.

96 Michigan Legislature, Senate Bill 0169 Public Act 231 of 2013, 27 March 2014. (Available here: http://www.legislature.mi.gov/(S(jspwxp45jfde0wr1jbdkqm55))/mileg.aspx?page=getobject&objectname=2013-SB-0169&query=on)

Columbia District

A.91 The District of Columbia also introduced regulations to allow use of automated vehicles, enacted in January 2013.[97]

Other states

A.92 In January 2015, Stanford University's assessment of the progress of US state legislative and regulatory action relating to automated driving showed 15 states have had bills introduced which have failed, with one other under consideration.[98]

Development of automated vehicles in USA

A.93 Perhaps the most well-known and influential proponent of automated vehicles is Google.[99] Based in Silicon Valley, the technology company was instrumental in pushing for legislation to allow testing on public roads. In 2014 Google introduced their own design for a self-driving vehicle – a small, two-seat, low speed device with no steering wheel or other controls other than a stop button. However, due to California's requirement for an individual to be able to "immediately take control of the vehicle's movements", Google has been forced to redesign the vehicle to include driver controls prior to public road testing in California.

A.94 However other American companies involved in developing the technology include Intel, General Motors and Autoliv Inc.

Japan

A.95 The first public road test of an automated vehicle on a Japanese highway was conducted in November 2013 with Prime Minister Shinzo Abe in the car.[100] The vehicle was a Nissan Leaf and was awarded a license plate to allow its use on the public road in September 2013. As well as lane keeping and adaptive cruise control it was fitted with systems to allow:

- Automatic exit
- Automatic lane change
- Automatic overtaking slower or stopped vehicles
- Automatic stopping at red lights

97 Council of the District of Columbia, Autonomous Vehicle Act of 2012, B19-0931. (Available here: http://dcclims1.dccouncil.us/lims/legislation.aspx?LegNo=B19-0931)

98 CIS Stanford University, Automated Driving: Legislative and Regulatory Action. (Available here: cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action)

99 Forbes, Google dominates autonomous cars influence as automakers lag behind, 23 July 2014. (Available here: http://www.forbes.com/sites/brucerogers/2014/07/23/google-dominates-autonomous-cars-influence-as-auto-makers-lag-behind)

100 BBC, UK government paves way for driverless cars, 5 December 2013. (Available here: http://www.bbc.co.uk/news/technology-25230483)

A.96 The Leaf drove on the Sagami Expressway in Kanagawa prefecture, near Tokyo with the prefecture's Governor in the car.

A.97 Japan has argued that European regulations need to be updated to allow further development of automated vehicle technologies. In particular ECE Regulation 79 currently limits use of 'automatically commanded steering' to speeds of 10 km/h or less. In September 2014 Japan and Sweden submitted a proposal to amend this.[101]

A.98 However, Japan does not appear to have plans to review or introduce new regulations regarding automated vehicles. Some Japanese manufacturers seem to have a less enthusiastic view of fully automated vehicle technologies than appears to be prevalent in Europe.

A.99 In March 2014 the Japanese Ministry of Economy, Trade and Industry published an information journal setting out the current situation for automated driving.[102] This included a four-step definition of levels of autonomy together with short articles from leading companies in the field.

A.100 Toyota states that its effort is focused on 'an infrastructure-cooperative type of automated driving' but also admits it has recently started developing automated driving by the vehicle using on-board sensors. It mentions a public road experiment in Japan is being initiated.[103] Toyota's 'Automated Highway Driving Assist' is planned for market in the 'mid 2010s' and has already been trialled on the Shuto Expressway near Tokyo in 2013.[104]

A.101 Honda demonstrated automated vehicles at the ITS World Congress in 2013 in Tokyo but highlighted that "many people seemed to demand automobiles that offer optimum support according to the state of driving, rather than allowing completely unattended driving".

A.102 Nissan appears to be more positive with an aim to be a leader in the introduction of automated features. In 2016 it has stated it will introduce fully automated parking systems as well as traffic-jam pilot across much of its range and in 2018 this will be augmented by more advanced features allowing the automation of complicated manoeuvres on multi-lane highways.[105] It has also stated it will be

101 United Nations Economic Commission for Europe, Proposal for amendments to UN Regulation No.79, 16-19 September 2014. (Available here: http://www.unece.org/fileadmin/DAM/trans/doc/2014/wp29grrf/GRRF-78-14e.pdf)
102 Ministry of Economy, Trade and Industry, Autonomous driving, Creating and optimal relationship between people and automobiles! (Available here: www.meti.go.jp/english/publications/pdf/journal2014_03a.pdf)
103 Ministry of Economy, Trade and Industry, Autonomous driving, Creating and optimal relationship between people and automobiles! Page 4. (Available here: www.meti.go.jp/english/publications/pdf/journal2014_03a.pdf)
104 Toyota USA Newsroom, Toyota to launch advance driving support system using automated driving technologies in mid-2010s, 10 October 2013. (Available here: http://corporatenews.pressroom.toyota.com/releases/toyota+advanced+driving+support+system+technology.htm)
105 The Car Connection, Nissan reveals new details about autonomous car features & arrival dates, 21 July 2014. (Available here: http://www.thecarconnection.com/news/1093392_nissan-reveals-new-details-about-autonomous-car-features-arrival-dates)

marketing more than one type of fully automated vehicle by 2020. Nissan is also building a dedicated automated drive proving ground at Oppama, Japan.[106]

A.103 Denso states that it will start a demonstration experiment of automated driving controlled by a control centre in 2014. This will be with the cooperation of Kumejima Town, Okinawa Prefecture.

China

A.104 China is another country that has not ratified the Vienna Convention. This review was unable to find any official plans for testing of driverless vehicles in China. However Baidu, the Chinese internet search engine group has been reported to have started development of a 'highly automated' (rather than fully driverless) car in 2014.[107] Baidu currently operates cars fitted with cameras similar to Google's "street-view" vehicles and is aiming to use its mapping data and database of locations and road conditions to assist the project.

A.105 In September 2014 it was reported that Baidu has signed an agreement with BMW to research driverless car technologies, aiming to develop a semi-automated vehicle within three years.

A.106 The roadmap for automated vehicle development published by the French government includes plans for cooperation with both China and Korea in 2015.[108]

A.107 Organisations wishing to conduct public road testing of automated vehicles in China would need to ensure that the vehicles have a Chinese number plate and the test drivers have a Chinese driving license as these are required by Chinese regulations.[109]

Singapore

A.108 In August 2014, the Land Transport Authority (LTA) in Singapore announced it is setting up the Singapore Autonomous Vehicle Initiative (SAVI) in collaboration with the Agency for Science, Technology and Research (A*STAR).

A.109 The announcement included plans for public road testing to commence in January 2015. The LTA "will work towards a framework

106 Youtube, Nissan LEAF with advance driver assist get Japan license for road test. (Available here: https://www.youtube.com/watch?v=WXPgn12_Hus)
107 Financial Times, China's Baidu follows Google steer with self-driving car, 28 July 2014. (Available here: http://www.ft.com/cms/s/0/8b87c5f4-163b-11e4-93ec-00144feabdc0.html#axzz3DYreJd00)
108 La Nouvelle France Industrielle, Point d'étape sur les 34 plans. (Available here: http://proxy-pubminefi.diffusion.finances.gouv.fr/pub/document/18/17721.pdf#page=12)
109 IEEE Xplore Digital Library, VIAC Expedition Toward Autonomous Mobility – Bertozzi, M et al. (Available here: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6016589)

that will allow the testing of autonomous vehicle that meet safety standards to be tested on our public road network".[110]

A.110 A 200-hectare area which contains a cluster of research facilities and business park space has been named as the first area for public road testing, with designated light and heavy traffic test routes identified. Each route will be reviewed to "ensure that necessary safety measures are in place before the proposal is approved for actual testing".

A.111 The announcement invites interested parties to come forward but states that companies wishing to test vehicles must have "safety procedures including immediate manual overwrite to take full control of the vehicle at any point in time" as well as comprehensive third party insurance.

A.112 Currently the National University of Singapore (NUS) is testing a fleet of automated golf buggies as a car-sharing concept, as well as a driverless car, in collaboration with Massachusetts Institute of Technology. Nanyang Technological University is also testing and optimising a driverless Induct NAVYA shuttle that can seat up to 10 people.[111] Two further trials of automated vehicle technology are currently ongoing in Singapore.[112]

South Korea

A.113 The South Korean automobile industry is the fifth largest in the world and South Korea is active in the field of automated vehicle technologies. Hyundai-KIA, Renault Samsung and GM-Daewoo are all believed to be actively researching automated vehicle technologies. Hyundai-Kia Motors started a biennial competition for automated vehicles in Korea in 2010.[113]

A.114 SsangYong Motor has also signed a memorandum of understanding with the Korea Automotive Technology Institute (KATECH) to develop a self-driving car, stating "the self-driving system has emerged as one of core competences for future automobile industry."[114]

A.115 In July 2014 Hyundai released a video, taken at their proving ground, demonstrating the adaptive cruise control, lane keeping assist and automated emergency braking technology fitted to their production

110 Land Transport Authority, Joint release by the Land Transport Authority, JTC & A*STAR – A savi step towards autonomous transport, 27 August 2014. (Available here: http://app.lta.gov.sg/apps/news/page.aspx?c=2&id=29525082-5265-4139-bc3b-0241a4639d46)

111 Nanyang Technological University, NTU to trial Singapore's first driverless vehicle on the roads, 16 August 2013. (Available here: http://media.ntu.edu.sg/NewsReleases/Pages/newsdetail.aspx?news=635afd55-4f9b-484a-a658-2187e2bb788d)

112 Land Transport Authority, Ongoing AV research and development trials in Singapore. (Available here: http://app.lta.gov.sg/data/apps/news/press/2014/20140827_AV-Annex.pdf)

113 Netherlands Enterprise Agency, Automobile + IT, Korean cars drive smart. (Available here: http://www.rvo.nl/sites/default/files/Korean%20cars%20drive%20smart.pdf)

114 Automobile Technology, Ssangyong partners with KATECH for development of self-driving car, 27 June 2014. (Available here: http://automobiletechnology.automotive-business-review.com/news/ssangyong-partners-with-katech-for-development-of-self-driving-car-270614-4304141)

Genesis model. The combination of these technologies allowed a convoy of these vehicles to circulate the test circuit with no driver present as well as emergency brake to a standstill safely.[115]

A.116 Research is ongoing at the public research university, the Korea Advanced Institute of Science and Technology (KAIST). The EureCar project at KAIST is developing a self-driving car and is currently on its second-generation 'EureCar Turbo' version which features lower cost sensors. The aim is for this latest vehicle to demonstrate safe automated operation in a dense urban environment where GPS signals may be unreliable as well as at speeds of up to 110 km/h (68 mph).[116]

A.117 The Electronics & Telecommunications Research Institute (ETRI) in Korea is also researching Automatic Vehicle Guidance Systems (AVGS).[117]

115 Youtube, Hyundai Genesis, The Empty Car Convoy (Available here: https://www.youtube.com/watch?v=YjPmLB2imzU)

116 National Instruments, EureCar, KAIST Self-Driving car, 11 July 2014. (Available here: https://decibel.ni.com/content/docs/DOC-37101)

117 Netherlands Enterprise Agency, Automobile + IT, Korean cars drive smart. (Available here: http://www.rvo.nl/sites/default/files/Korean%20cars%20drive%20smart.pdf)

Annex B: Innovative personal transport

Introduction

B.1 The scope of the main body of this report covers conventional road going vehicles, primarily cars. However the first commercially available fully automated vehicles are low speed, do not resemble conventional cars and are used primarily in segregated areas, on private land or in pedestrian precincts. An example is the ULTra Personal Rapid Transport (PRT) shuttle service between a car park and a terminal at Heathrow airport. Such driverless airport shuttles were traditionally rail-based, resembling trams or trains, but the ULTra system navigates autonomously on dedicated guideways instead of rails.

B.2 There are also vehicles of this nature that run without a physical guide way, which are instead programmed to stay within 'virtual' guide ways, and stop if an obstacle is detected in their path. Such vehicles are sometimes known as cyber cars or driverless shuttles, an example being the Navya (formerly Navia), a driverless eight seat personal transporter with a maximum speed of 12.5 mph, shown in Figure B.1. If such vehicles are able to run on unsegregated routes they can provide savings in infrastructure costs compared to conventional guided vehicles.

B.3 There are other forms of innovative personal transportation, such as electric personal transport vehicles, which find their use restricted or even prohibited. Being powered vehicles they are not permitted for use on pavements or cycle ways, but since they do not conform to established definitions of road vehicle they are also not permitted to use the road. The Segway personal transporter is an example.

B.4 The main report has also flagged issues that may restrict or hinder innovative or novel designs, such as vehicles which can be controlled remotely, which are driverless in the sense that there is no driver in the vehicle. There is currently some uncertainty over the legitimate use of these vehicles so there is potential for clarification.

B.5 This annex examines some of the potential changes to legislation that would be necessary to modernise it, to permit or regulate some of the innovative types of low speed personal transportation that may become more common in the future.

Figure B.1: Navya driverless shuttle

Basic principles of highway legislation

B.6 Legislation has developed over many years and roads and footpaths existed long before any written legislation. Where legislation has been introduced it has, in general, codified existing practice. Technology is now developing at a rate not seen before and this poses new challenges. It is important that there is the opportunity for innovation to flourish but also necessary to ensure that safety and environmental concerns are addressed.

B.7 A piece of road open to public use, over which the public has a right of way, is known as a highway. This is physically divided into the carriageway (used by wheeled vehicles) and the footway (used by those on foot), more commonly known as the road and the pavement. It is normally obvious which section is intended for wheeled vehicles and which for pedestrians from the design.

B.8 In general, wheeled vehicles, whether motorised or pedal powered, are not permitted on the footway (according to section 72 of the Highway Act 1835) whilst, in principle, all users, including those on foot, are permitted on the carriageway. In many areas (for example country lanes) there is no footway at all. There are some exemptions to these general rules which are mentioned below.

Low speed vehicles on carriageways

Licensing and registration

B.9 It is a fundamental principle, laid down in the Road Traffic Act 1988, that all motor vehicles used on the road are licensed. This means motor vehicles must be registered with DVLA and display a number plate. A vehicle excise duty payment must also be made for most registered motor vehicles.

B.10 There is an exception for low power electric cycles, defined in Regulations as Electrically Assisted Pedal Cycles (EAPC) where the electrical power assistance cannot drive the vehicle at speeds exceeding 15 mph.[118] These do not have to be registered and are not subject to vehicle excise duty. They are essentially treated as pedal cycles as long as they meet certain criteria. One criterion is the requirement of pedals by which the cycle can be propelled; this requirement precludes the application of the EAPC requirements to certain other novel designs of low power vehicle.

B.11 It would be possible to create other categories of vehicle exempt from licensing but, at least for some current innovations, this would require primary legislation to be amended in order to remove the obligation of licensing and of mounting a registration plate. This might be seen as appropriate for low speed vehicles, by analogy with the relaxation of requirements regulations for EAPCs.

Construction and type approval

B.12 When applying for registration, proof of approval is required for those vehicles that are in scope of the type approval regime. Even if approval is not required, construction regulations still apply.

B.13 Vehicles excluded from type approval include various low speed vehicles: vehicles with four wheels and a maximum speed of less than 25 km/h (15.5 mph), and vehicles with three or two wheels with a maximum speed less than 6 km/h (4 mph). Also exempt are most EAPCs, which in any case are not treated as motor vehicles and thus are not subject to registration as noted above.

B.14 EAPC are subject to similar rules on construction as pedal cycles, and the Department has recently consulted on de-regulating in this area and to harmonise with EU rules.

B.15 Construction requirements for other low speed vehicles that are exempt from type approval are generally based on the requirements for conventional vehicles. These may be inappropriate, particularly for vehicles of innovative, novel or unconventional design.

B.16 EU Regulation 168/2013 sets out approval requirements for two and three-wheeled vehicles and quadricycles. However the Regulation

118 The Electrically Assisted Pedal Cycles Regulations 1983 (S.I. 1983/1168).

specifies that self-balancing vehicles and vehicles not equipped with at least one seating position are out of its scope. On this basis, Member States are permitted to apply their own national standards and are not required to accept these vehicles based upon a standard adopted in another country.

Self-driving motor vehicles

B.17 A low speed self-driving four wheeled "pod", "driverless shuttle" or similar vehicle would be exempt from type approval if its maximum speed was below 25 km/h (15.5 mph). It would still need vehicle excise duty, to be registered with DVLA, and to comply with the relevant motor vehicle construction regulations.

Vehicles capable of being controlled remotely

B.18 Vehicles exist which possess the capability for remote operation. A typical example of this is a Self-Propelled Mobile Transporter, used for transporting very large or heavy objects. These can be controlled either by a driver on board or by someone walking beside the vehicle and operating it via a cable. The legislation does not explicitly cater for such vehicles and it is currently difficult to determine the appropriate construction requirements.

B.19 A step beyond cable operation is using a remote control device linked to the vehicle wirelessly. This exists for construction vehicles used for laying road surfaces. Vehicle manufacturers are also investigating enabling a vehicle to manoeuvre, enter or exit from a parking space for example, by remote control, perhaps via a mobile phone. However, the current prohibition on use of a mobile phone or similar hand held device whilst driving contained within Regulation 110 of the Road Vehicles (Construction and Use) Regulations 1986 could prove an obstacle to such systems.

B.20 There is nothing explicit in law to say that a vehicle cannot be driven by someone not in the driver seat. Regulation 104 and 107 of the Construction and Use Regulations are pertinent here. These are discussed in more detail in Chapter 10. They require a driver to be positioned where they can control the vehicle and have a full view of the road, and not to leave the engine running while the vehicle is unattended. It would arguably be possible for a driver outside the vehicle to be in a position both to control it and see the road ahead of the vehicle but, depending on the precise circumstances, the view requirement might not be met. It is not clear how a court may interpret the requirement for a vehicle to be "attended" when a "remotely positioned driver" is controlling it, but it is arguable that a person does not have to be sitting in a vehicle in order to "attend" it.

Review of construction requirements for low speed vehicles

B.21 It is sometimes suggested that low speed vehicles are not suitable for carriageway use but are better suited to other environments, such as campuses or pedestrian precincts. This view does not take into account the potential for the usage of such vehicles in urban areas (perhaps with 20 mph speed limits) and in rural areas where there is no pavement and where pedestrians will already be using the carriageway together with motor vehicles.

B.22 Given the potential for wider use of innovative electric personal transport vehicles, for remote control operation and for self-driving vehicles, it seems that it would be necessary to review and possibly amend domestic regulations in order to facilitate their uptake.

Roadworthiness testing

B.23 Under the latest EU rules on roadworthiness testing, EU Directive 2014/45, vehicles with a maximum speed of less than 25km/h are exempt from annual roadworthiness testing.

Vehicles using tracks alongside the highway

B.24 Cycle tracks are a right of way for cyclists usually created by constructing a new highway or converting a footway or footpath. Whether or not to install a cycle track is for the local authority to decide. The most common way of converting a footway to a cycle track is to make an order under the Highways Act 1980.

B.25 Cyclists are not allowed to cycle on footways or footpaths, although police should use discretion in applying this law. On the other hand pedestrians can lawfully use the cycle track regardless of the presence of any segregating feature. *The Highway Code* advises cyclists to take care when passing pedestrians, and be prepared to slow down and stop if necessary.

B.26 Cycle lanes are part of the carriageway, and indicated by road markings and signs. They can be advisory (drivers may enter them) or mandatory (drivers must not enter them). Rule 140 of *The Highway Code* gives advice to drivers on this.

B.27 Opening up cycle tracks or cycle lanes to electric personal transport vehicles with a similar speed capability to bicycles is a possible option to provide for these vehicle's use. However if such vehicles continue to be excluded from use on footways and roads, then this may be of limited benefit since existing cycle ways alone often do not provide complete routes for journeys.

B.28 The possible impacts of such a move on cyclists would also need to be considered. The Government's aim, as expressed in the draft Cycling Delivery Plan, is to increase the levels of cycling and walking in England so that they become the natural choice for shorter journeys.

Any opening up of cycle tracks or cycle lanes would need to support this aim and ensure cyclists and pedestrians are not negatively impacted.

Vehicles on pavements

B.29 As noted above, neither motor vehicles nor self-propelled vehicles (pedal cycles) are permitted on the footway. The only exemption that exists is for disabled persons' vehicles (known in the legislation as invalid carriages) which meet certain criteria, including carrying only one person, a weight limit and a maximum speed of 4 mph whilst on the footway. (They are permitted to travel at 8 mph on the public road). The rationale behind this is that it gives people with reduced mobility similar access to the footway as non-disabled people.

B.30 Opening up access to the footway for other low speed vehicles is a controversial matter. Some pedal cyclists use the pavement today, as do riders of scooters (both children and adults), skateboarders and roller skaters. Generally these users interact safely with pedestrians and give way to them. If they do not, they become liable to prosecution, either for riding on the footway or for the more severe offence of "wanton or furious driving".[119]

B.31 Legalising the low speed use of electric personal vehicles on the footway might be considered, perhaps together with rules emphasising that priority must be accorded to pedestrians. However there may be opposition from pedestrian groups. Such a move might also result in calls for legalising use of pedal cycles on the footway.

Vehicles on guide ways on public land

Trams

B.32 Creating a tramway on public land is likely to involve obtaining a number of permissions and powers. These can be granted by an Order under the Transport and Works Act 1992 (TWA) which, for example, will permit the alteration of rights of way and give powers for compulsory purchase of land. Setting up the infrastructure for a permanent system such as a tramway or railway is expensive. The prospect of compact self-driving vehicles which are electronically guided and do not need infrastructure but run on existing pathways or precincts is therefore an attractive one.

Other guided transport

B.33 The TWA specifies the types of guided system for which permission can be obtained to utilise public land through an Order. There is a requirement that vehicles are guided "by means external to the vehicle" (for example by running on rails or a guideway) and therefore certain forms of self-guided transport may not be permitted to take

119 Offences Against the Person Act 1861, section 35.

advantage of the process. It would however be possible to review the current criteria and widen the scope to include novel forms of self-guided transport (which were not envisaged at the time of the TWA), by changing the relevant primary legislation.

Vehicles on private land

B.34 When considering the use of vehicles on private land that is not open or accessible to the public, the land owner has wide discretion because most road traffic regulations are not applicable. There are no legal impediments to use of novel or innovative vehicles on private land, although there would be issues of personal liability in the case of collision or injury.

Recent DfT Consultations

B.35 The Department consulted on various issues relating to Electric Personal Vehicles (EPV) and Electrically Assisted Pedal Cycles (EAPC) in 2010. The results of the consultation found some consensus on changes to the EAPC regulations and this is now being taken forward by the preparation of amending legislation.

B.36 A consultation on this amending legislation for EAPCs took place recently, asking for comments on proposals to de-regulate GB regulations by increasing power to 250kW, remove weight limits on such vehicles and permit 4 wheeled EAPCs.[120]

Conclusions

B.37 Many countries have already responded to the commercial availability of electric personal vehicles and other innovative personal transport vehicles by defining construction and use requirements in their national laws. While the safety of the vehicle users and other road users has to be considered carefully, there is a need to address this issue in GB regulations.

B.38 Innovative personal transport and electric personal vehicles offer the potential to address issues such as increasing congestion in urban areas and the need to improve air quality and reduce carbon emissions. As a result there is likely to be increasing pressure to provide solutions to facilitate their use.

B.39 Currently there does not appear to be consensus on how or where these vehicles should be allowed to be used. However as innovative transportation solutions result in an increasing multi-modal approach to

120 Gov.uk, Electrically assisted pedal cycles: changes to regulations, 3 November 2014. (Available here: https://www.gov.uk/government/consultations/electrically-assisted-pedal-cycles-changes-to-regulations)

journey making, there is a need for the regulatory environment to be sufficiently flexible to address this.

B.40 Establishing construction standards for such vehicles would help define the problem of where it would be appropriate for their use to be permitted. This would appear to be a useful first step. However this would require the amendment of primary legislation.

B.41 There also appears to be some benefit from examining the construction standards for vehicles capable of remote control. A necessary change to C&U regulation 110 (mobile telephones) has been identified and other legislative changes may provide a clearer and more appropriate regime to facilitate the wider use of such vehicles.

Actions

B.42 Consider introducing or amending primary legislation to facilitate the introduction of innovative road transport applications such as electric personal vehicles and similar devices, potentially as a power for the Secretary of State to make provision specifically for their use.

B.43 Establish construction standards for emerging new classes of innovative personal transportation to ensure safety and provide greater clarity on their appropriate use.

Annex C: Responses to the consultation (full summary)

General comments

C.1 Definitions – several responses highlighted the need to ensure consistency. In particular it was suggested that the term 'driverless car' needed to be qualified as during the initial phases of testing it is expected that a 'driver' will be present, seated in a driving seat and with normal driving controls available.

C.2 Test track phase for testing – several stakeholders highlighted the value of preliminary testing and prove-out of automated vehicle technologies on closed test tracks prior to any public road testing.

C.3 Emergency issues – one stakeholder highlighted the need to ensure that an automated vehicle would not impede emergency services vehicles operating under blue lights and sirens. Here it may be necessary for a human driver to be prepared to take control. If an automated vehicle were to be involved in a collision consideration needs to have been given to any potential risks that the automated systems might pose to emergency services personnel and any risks should be minimised through 'fail safe' systems.

C.4 Benefits to blind and visually impaired road users – The Guide Dogs for the Blind Association recognised the potential benefits of highly and fully automated cars for blind and partially sighted people in the UK. However they highlighted the importance of considerate driver behaviours and audible detection being programmed into these vehicles for situations where they interact with pedestrians.

C.5 Fully automated vehicles and breakdowns – in the longer term concern was raised about the safety of occupants in the event of a breakdown of a fully automated vehicle. This might be a particular concern for the blind or partially sighted, children or disabled people.

Q1. Should any special training/testing or a minimum number of years of driving experience be specified for drivers involved in testing driverless cars with high automation?

C.6 There was strong general agreement amongst stakeholders that drivers involved in testing automated vehicles should have high levels of experience and skill. This was deemed necessary so that the driver would be able to anticipate situations in which intervention might be necessary and do so successfully.

C.7 A variety of issues to consider were suggested with regard to test drivers. Some respondents suggested the driver should have a clean licence with no convictions or suspensions and be a minimum age of 25 or 26 and a maximum 70. Others suggested a minimum number of years of relevant driving experience although it was pointed out that this does not necessarily equate to better cognitive ability or reaction times. Other suggestions included that the driver should be a qualified driving instructor or have other advanced driving qualifications.

C.8 The driver being an engineer familiar with the technology utilised on the vehicle was suggested as a requirement. A particularly important aspect will be training or familiarisation with the process of switching between ‘driver control’ and ‘automated control’ and vice versa.

C.9 Depending on the exact aim of the specific phase of testing it was suggested that it may be appropriate to have drivers of differing skill sets and this would need to be carefully considered and safely handled. If the aim was to assess suitability of a vehicle for the market, then a representative cross-section of the general public would be more appropriate.

C.10 It was pointed out by some respondents that in the future when automated vehicles are offered for sale to the general public, they should be easily used by any qualified driver. Others suggested a new licence category may be necessary for driving automated vehicles.

C.11 When fully automated vehicles are developed and made available for sale then it may be necessary to revise legislation to allow the vehicle to be operated without a qualified driver or even any occupants present. However, at least one response suggested there should always be a driver present and able to take over in such vehicles.

Q2. Should a second person be required to be present, as an observer?

C.12 A strong majority of stakeholders supported the presence of a second person in the vehicle during the testing phase for automated vehicles. Some pointed out that this is a requirement in other countries. Many responses highlighted that in experimental or prototype vehicles it may be necessary to monitor the systems under development. Respondents felt it would be inappropriate for the person sitting in the driver's seat to take on that task as well as being ready to resume driving control if necessary.

C.13 However some respondents pointed out that data could be recorded and logged without human supervision or even remotely and that as a result it may not be necessary to have a second person. The Society of Motor Manufacturers and Traders, suggested there should be no requirement for a second person, but that other safeguards could be put in place such as emergency cut-off switches and failure tell-tales. Some respondents suggested audio and visual recording equipment could be used. Several suggested it may be possible to shift to this approach after using a second person in initial stages.

C.14 One response highlighted the importance of defining specific roles if two people were present. Others pointed out that a second person could be helpful in spotting potential hazards and helping to provide evidence of what happened in the event of a collision. One respondent felt the number of occupants should however be limited to no more than two.

Q3. Do you believe that the normal set of requirements for driver behaviour should still apply or are any exemptions from these required, if so please specify?

C.15 There was strong agreement amongst stakeholders that drivers testing automated cars on public roads should conform to the normal set of requirements for driver behaviour. This was considered to be important to ensure safety and to avoid alarming other road users. A few respondents suggested stricter requirements should be applied, for example zero tolerance on alcohol.

C.16 It was accepted by most stakeholders that testing may involve the person in the driving seat not having any hands on the steering wheel and that this should be allowed if necessary for test purposes. Suggestions included having defined areas where a test driver could rest their hands.

C.17 Some respondents highlighted Google's statement that their highly automated vehicle can exceed the posted speed limit by up to 10mph. However it was agreed that initial test vehicles should comply with speed limits.

C.18 It was suggested that provision for some type of statutory defence might be considered in the event that the automation malfunctions in a way that does not give the driver time or the ability to take control and correct it. Some emphasised that the test driver must remain alert at all times, whilst others pointed out that human beings are poor at monitoring automated systems for long periods of time and it may therefore be unreasonable to prosecute.

C.19 Several stakeholders suggested areas of existing regulation where they felt exemptions may be needed to allow testing to proceed. These are reviewed in question 10 and 11 of the consultation.

C.20 In the longer term for fully automated vehicles capable of making journeys without any driver intervention, regulations may need to be reviewed to determine whether existing restrictions should still apply.

Q4. Are any new requirements or constraints necessary?

C.21 Association of Chief Police Officers recommended a clear set of guidelines should be produced for the companies and organisations conducting these tests.

C.22 SMMT suggested that protection from prosecution would be required should local enforcement authorities consider that the vehicle is being operated outside of their understanding or interpretation of the legal requirements. SMMT suggested similar rules to those adopted in Sweden and some US states.

C.23 Concern was raised regarding the need to clarify liabilities in the event of a collision and the importance of differentiating between driver control and system control was also highlighted.

C.24 Several respondents recommended the use of an event data recorder to ensure that information is recorded, and in the event of a collision, can be used to determine whether the driver had manual control or not, amongst other things. However it was pointed out that in aviation, the remit of accident investigators specifically excludes apportioning blame or liability.

C.25 One respondent highlighted experiences from the pharmaceutical industry where there have been concerns that only the data from successful clinical trials are published. It may therefore be necessary to require the release of data relating to both collisions and near misses.

C.26 One stakeholder felt it should not be left to a third party to have to fight a test case to establish the assignment of responsibility between the manufacturer/operator and the vehicle supervisor. They highlighted that UK law does not provide for strict liability for software, unlike the product liability case law surrounding physical products. They recommended that vehicle manufacturers accept that the software in their vehicles attracts the same liability as the physical components in the vehicle.

C.27 One respondent recommended that driving simulators and instrumented vehicles running on repeatable routes should be used to test and validate both the technology and drivers prior to testing on open public roads.

C.28 The need for cyber security and software trustworthiness was also raised.

Q5. Do you have any suggestions for an indication to other road users that the vehicle is operating autonomously, or capable of autonomous operation?

C.29 Stakeholder opinion on the need for vehicles to have some form of visible marking indicating their automated capabilities was divided. Almost equal numbers of respondents were in favour and against with strong opinions expressed on both sides.

C.30 Various suggestions for markings were made, from small signs attached to the front and rear to highly visible signage all round combined with flashing roof mounted lights. Some suggested roof lights could be used to indicate when automated driving systems are engaged, helping public understanding particularly if the driver was seen not to be holding the steering wheel.

C.31 Those in favour of marking suggested it might help warn other road users that the vehicles are under test. It was also suggested that making the vehicle look attractive or interesting might help improve public acceptance.

C.32 Arguments given by respondents against markings included:

- Potential for markings to result in unrepresentative test conditions by changing or influencing other road users' behaviour, whether consciously or unconsciously.
- Likelihood of distracting or alarming other road users and potentially reducing public acceptance of such vehicles.
- Risk of other road users 'testing' automated vehicle capabilities by performing reckless manoeuvres, or deliberately trying to confuse sensor systems.
- Risk of automated vehicle operators potentially becoming targets for insurance fraud.

Q6. Should educational materials be developed to advise other road users about the testing of highly autonomous cars?

C.33 There was almost unanimous agreement that it would be beneficial to develop educational materials amongst those who responded to this question, with some seeing it as essential. Strong public interest in the subject was noted, but also some misunderstandings. It was felt that education or 'information sharing' would improve public understanding and acceptance and could be used to explain what is expected of other road users.

C.34 However it was noted that it would be important for information provided not to unduly influence the reactions of other road users since the aim of testing is to evaluate automated vehicles under normal road conditions. It was also noted the information should not raise public expectations that highly or fully automated vehicles are close to market ready.

C.35 It was highlighted that a media strategy could also be developed not just for locations where the vehicles are to be tested but nationwide to ensure that any people visiting the test locations would also have an understanding of the nature of these vehicles. All road users, not just other car drivers, should be included in such a media strategy. Comparison was made to materials developed explaining managed motorways and the Dartford free flow tolling campaign.

C.36 It was suggested by one respondent that if specific roads were designated for testing, these should be signed. However another warned against providing the public with any specific information about test vehicle types and locations. One respondent suggested linking educational materials to warning signs and lights fitted to the vehicle. Another pointed out that materials should not only cover cars but also other automated vehicles including public service vehicles.

C.37 For the longer term, it was suggested that material should be incorporated into the new driver handbook package, *The Highway Code*, and the driving test.

C.38 It was considered that the media may perform a useful function in educating the public about the testing regime.

Q7. Do you have any observations on the possible reactions of other road users, or the risks of interaction with driverless cars, and possible mitigation measures?

C.39 Most respondents had some limited concerns about the possible reactions of other road users. These included the possibility of distraction or deliberately trying to 'test' the technology, for example pedestrians stepping in front of an automated vehicle to see if it stops, or 'crash for cash' type insurance fraud. However such incidents were felt likely to be rare. Requiring test drivers to always display 'normal' driver behaviour on the public road, for example not conducting other tasks while sitting in the driving seat, was highlighted as important to avoid distracting other drivers.

C.40 Various other potential risks were identified. For example criminals taking advantage of automatic emergency braking to stop a vehicle in order to commit a crime; vehicle to vehicle communications systems being misused to clear a route of traffic; jamming or interfering with GPS signals which might be necessary for the safe operation of an automated vehicle.

C.41 Concerns were expressed about automated vehicle's abilities to respond to poor driving from other road users, for example overtaking and cutting in. Equally a tailgating driver may be more likely to collide with the rear of an automated vehicle if it is able to respond and brake more quickly than a human driver. There was also concern about the ability of automated vehicles to detect other road users such as children, pedestrians and cyclists.

C.42 If automated vehicles were used in platoons with short headway distances, one stakeholder had evidence to suggest this could result in other road users reducing their distance to the vehicle in front.

C.43 It was suggested that those wishing to conduct tests should specify the actions taken to mitigate adverse behavioural effects of other road users and log any situations identified where automation may have triggered such an effect.

C.44 One respondent suggested the use of dashboard mounted cameras on test vehicles. While these might not prevent such incidents occurring (unless their use was widely publicised), they would help provide evidence in such circumstances.

Q8. Do you see any difficulties with the existing product liability regime, when operating driverless cars with high automation?

C.45 There were mixed opinions amongst stakeholders regarding product liability. While many felt the existing regime would be sufficient for testing to go ahead, almost equal numbers foresaw problems and the need for changes to be made.

C.46 There was general agreement that vehicle manufacturers should continue to be held strictly liable for mechanical and system failures as is already the case for emergency braking and cruise control systems.

C.47 Many respondents focused on the difficulty of establishing whether the driver or the automated system was in control of the vehicle at the time of a collision or other event. The use of a data recorder and camera systems showing both in-vehicle information and external views of the road were recommended to address this.

C.48 There was two suggestions about the operation of data recording devices. Firstly, that data recording devices for the purpose of liability should be independent, but access should be available to the owner, insurer and manufacture to help apportion blame in a collision.
By ensuring the data recording device is independent, the responder claims that it will help to enforce manufacture liability and increase end user confidence in automated vehicles. The second area for consideration was towards the possible legislation of what data is recorded, its retention time and the controlled release of the data. They go on to say how this would help ensure the required data was available to apportion liability.

C.49 Two stakeholders believed that whilst the driver remained in control of a highly automated vehicle, responsibility belongs to them.

C.50 One stakeholder highlighted that it should be possible to ascertain liability for the producers of information that aids vehicles in making decisions, they should also be able to identify when signals have been blocked or are false.

C.51 One response raised the point that if automated vehicles need to recognise road signs and lines to operate, then it is important to identify who is liable for the maintenance of them.

C.52 It was suggested that as with existing automated technologies, systems which self-check and self-calibrate, comply with the current liability regime. Therefore, they stated there would be no need for an extended liability regime, if the new technology checks and calibrates in the same manner.

Q9. Do you have any suggestions for standards to regulate the testing of prototype cars with high automation?

C.53 Many of the stakeholder responses included suggestions for standards to regulate the testing of highly automated prototype vehicles. Three stakeholders highlighted the importance of encouraging innovation without hindering development through the implementation of regulations. There is a danger that any regulations would be quickly outdated as prototype vehicles are developed.

C.54 Two stakeholders recommended that a visual or audio warning should indicate a fault, requesting the driver to take control of the vehicle. They suggested for a minimum reaction time for the driver to respond and take control.

C.55 Additional regulations were suggested to confirm high automation vehicles are safe before being allowed on public roads. These include:

- Tests to ensure automated features do not hamper the manual operation of the vehicle and vice versa.
- Standards for more vigorous computer software protection and the robustness of the computer algorithms for managing previously undefined scenarios that vehicles may face on the road.
- Two stakeholders suggested vehicles should comply with existing UN Regulations 10, 13H and 79 (EMC, Braking and Steering Equipment Regulations). Regulation 13H and 79 both refer to the "Special requirements to be applied to the safety aspects of complex electronic vehicle control systems."

C.56 It was recommended that testing of highly automated vehicles should initially be on closed test tracks, and that following this, public road testing should be away from built up areas to start with.

C.57 Stakeholders suggested that manufacturers prove that risks are as low as reasonably practicable. They identified ISO 26262 as having good principles to follow and highlighted that although the standard was intended for electrical systems on production vehicles, some practises could be transferred to prototype vehicles.

C.58 A regulation as to how the driver should ensure attention is not drawn to the vehicle and should be able to take control at any time was suggested. This agrees with responses found in questions one and three which ask about the experience and behaviour of the driver.

Q10. Are there current type approval or construction rules that prototype cars with high automation might not comply with?

C.59 Stakeholders provided a mixed response as to whether prototype highly automated cars comply with existing type approval or construction regulations. The general agreement amongst stakeholders is that some regulations may need to be modified as highly automated vehicles develop.

C.60 Four responses suggested that highly automated vehicles should comply with current approval and construction regulations. It is assumed that a driver will be present, and they will be able to take control in the event of a fault, complying in the same way as a regular vehicle. One of the respondents went on to say, that in particular these vehicles should meet requirements for steering effort, turning circle, brake performance and EMC before starting road trials.

C.61 Existing regulations were highlighted by a number of respondents where prototype high automation vehicles may not comply. These include:

- Article 8 Vienna Convention 1968 – It was also pointed out that the UK has not ratified the convention.
- Regulation 104 and 109 of the Road Vehicle (Construction and Use) 1986, which relate to ensuring the driver is in control of the vehicle and preventing the improper use of display screens within the view of the driver.
- UN Regulation 79 – Steering Equipment.
- UN Regulation 13H – Braking.

C.62 One stakeholder suggested there should be a move to self-certification, with liability shifting to the manufactures.

C.63 Awareness was raised of a system that is in development that allows the owner to control their car in slow manoeuvres, such as parking, from a mobile phone. Currently Road Traffic Act 1988 Section 41D prohibits driving or supervising of a motor vehicle whilst using a hand held mobile telephone or other hand held interactive device.

Q11. Are you able to suggest any specific areas (e.g. braking, steering) or any specific systems/technologies (e.g. ABS, ESC) where regulation needs to be amended or developed, as a priority?

C.64 Respondents raised some questions and points for consideration in areas where they believe further thought is needed. These include:

- Should there be a restriction on some manoeuvres during trial periods such as overtaking slow vehicles?
- Should lower speed limits be applied to automated vehicles during trials and potentially after trials?
- Should automated vehicles be able to tow?
- Will modifications to vehicles affect the safety of automated vehicles?
- Will systems such as front facing radars affect speed cameras?

C.65 New regulations recommended by stakeholders included:

- Clearly define how much stimulus on controls is required to regain command of the vehicle.
- Conduct trials in-field evaluation of sensors and control technology.

C.66 Two stakeholders had concerns about the regulation of the software, cybersecurity, networks and external communications of the vehicles. There was a suggestion that manufacturers should comply with the British Standards Institution (BSI) PAS 754 Software Trustworthiness, Governance and management. Specification to ensure use of trustworthy software.

C.67 It was highlighted that previous studies have identified driver's control over aspects such as steering deteriorates when features such as cruise control are in operation. This could be a safety concern as more features like this are used on highly automated vehicles.

C.68 Stakeholders requested that vehicle data should be collected and preserved in the event of a crash. It was suggested that this data should be independently reviewed, aiding the public's confidence that commercial interests did not influence allocation of liability.

C.69 It was suggested that Advanced Emergency Braking (AEB) should be mandatory on all highly automated vehicles. A minimum operating speed range of 10 km/h to 130 km/h was suggested. Stakeholders highlighted this system should recognise all road users including cyclists, pedestrians and horses. It was also raised that Automated Emergency Steering (AES) and other emerging automated safety systems should be considered in the future for regulation. They go on to say that, due to significant potential road safety and economic benefits there is justifiable requirements for compulsory fitment of this type of system.

C.70 Some believe it is too early to give an opinion on amending or developing regulation as it would be dependent on the direction the technology took during the testing.

Q12. Are any changes to the current roadworthiness regime required to permit the testing of driverless cars, or ensure their safety?

C.71 The overwhelming response from stakeholders regarding the roadworthiness regime for automated vehicles was that they should comply with the current MOT requirements. It was pointed out that due to the complexity of automated vehicle technologies, some special methods of testing automated features may need to be developed. It was felt this should not compromise safety or cost to the customer. It was also questioned as to whether the current test frequency of vehicles in the MOT scheme was suitable for more complex highly or fully automated vehicles.

C.72 Stakeholders suggested that with the new technology on these vehicles software updates would be constantly required to keep up to date with the ever-changing road network. It was raised that critical software updates may be more regular than the current annual MOT test and it would therefore be the owner's responsibility for updating the vehicle. There were some concerns regarding the security of the software and that updates should also contain continuous improvements to defend from cyber threats.

C.73 One response suggested that once highly and fully automated vehicles are commonplace on the road, new roadworthiness tests for these vehicles should be developed. The stakeholder suggested the possibility of using a self-test on start-up to check some systems and components. This would enable vehicles to check automated systems more regularly with items such as corrosion and mechanical components still requiring an annual test. One idea was that data collected during a self-test on start-up could support potential recalls.

C.74 The importance of the driver being able to take control of the vehicle in an emergency was highlighted. For this, a test was suggested to establish that manual control could be resumed within a set time, and ensure controls operated manually in an expected manner.

Q13. Have you any initial thoughts about any longer term risks and issues as driverless cars age, and possible requirements to address this?

C.75 There is concern amongst stakeholders that highly and fully automated vehicles will be more expensive to maintain and repair than a regular vehicle. This may lead to reduced levels of preventative maintenance and limit the vehicle's likely working life expectancy.

C.76 There was general agreement that software updates will be critical. It was felt that these updates should consist of:

- upgrades to work with the hardware on the vehicles; and
- continuous improvement to defend against potential cyber-attacks.

C.77 It is the opinion of three stakeholders that these updates should be automatic to all relevant vehicles and be both reliable and secure especially for critical safety components such as brakes and steering. There was concern that these updates would become a charged for service from the manufacturers and, at some point, the manufacturers may decide to stop supporting older vehicles completely. One stakeholder suggested that once the software and hardware is out of date with the UK's infrastructure the automated features should no longer work and the vehicle should only be driven manually.

C.78 Infrastructure security as opposed to vehicle security was also mentioned. It was stated that positioning, navigation and timing (PNT) systems will be crucial to highly automated vehicles and therefore an attack on these systems would cause serious issues.

C.79 It was recommended that if the owner chooses to ignore a warning indicator to correct a fault it would result in the automated features being inaccessible and only manual driving would be allowed. One stakeholder stated that it is the owner's responsibility to ensure automated components are maintained in safe working order, in the same way that they are responsible for tyre tread depth and correct functioning of lights currently.

C.80 Questions were raised over whether the original owner of a car could potentially control the vehicle even once it had been sold. Also questioned was if automated vehicles would understand the UK's road infrastructure and road laws if they were privately imported models.

C.81 It was highlighted that sensor failure was an important risk to consider, either due to a failure, damage or interference from the environment, such as rain, snow or leaves.

C.82 One stakeholder believed that it was too early to predict long term risks and implications of highly automated vehicles, and any risks will most likely change with development of the vehicles.

Q14. Cars with high automation would need to be registered. In due course, decisions would be required as to the level of taxation and whether the capability for autonomous operation would be recorded on the DVLA database, in order to provide data on uptake, but that seems to be outside the scope of this initial review. Do you have any comments on this approach?

C.83 A majority felt that highly and fully automated vehicles should be registered with DVLA. Some stakeholders mentioned there should be a marker on the Police National Computer to indicate which vehicles have the capability of driving themselves. It was suggested this would aid research and statistics which could be particularly helpful when developing the vehicles to see where improvements could be made. Responses also identified that the insurance industry could use this data to offer lower premiums to customers if the vehicles prove to have a better safety record.

C.84 There was a difference in opinion between stakeholders as to how highly automated vehicles should be taxed. Some argued that automated vehicles should be taxed in the same way as conventional vehicles are taxed currently, helping treat the vehicles with equality and increasing acceptance. Others suggested giving tax incentives to operators of automated vehicles to increase popularity. They stated this would result in more of these vehicles being on the road and therefore increasing road safety and reducing emissions.

C.85 Some emphasised there should be in-depth studies of all real world crashes involving automated vehicles. They indicated this would help speed up improvements in automated vehicle technology as sales of these vehicles increase.

Q15. Do you anticipate a need for special infrastructure to permit the testing of cars with high automation?

C.86 Some responses to this question highlight that special infrastructure may be needed depending on the technology fitted to the vehicles.

C.87 Several stakeholders felt that highly automated vehicles should be developed to work on the existing road network with no additional infrastructure required. They raised the point that the technology to recognise existing road signs already exists and the cost and time to implement additional infrastructure would be excessive, increasing the length of time it would take to get automated vehicles on the road. Once automated vehicles are on the road, they suggested additional infrastructure could be put in place to help the vehicles make more informed decisions. One respondent commented that specific infrastructure should not be relied upon, allowing vehicles to continue operating on roads where required infrastructure is not installed. They also raised the point that testing vehicles in areas with special infrastructure gives no information on how the cars will perform on roads with no infrastructure.

C.88 It was highlighted that if an automated vehicle needs to read road signs to operate correctly, then signs and markings will need to be better maintained and clear of blockages such as trees or snow.

C.89 Those stakeholders who anticipate automated cars needing special road infrastructure, identify benefits in safety and reduced congestion from additional information such as weather, communication with infrastructure and other vehicles to identify possible hazards. There is concern over potential jammers or spoof signals providing false information to automated vehicles, and an appropriate level of enforcement and legal action should be taken against this. One respondent claims cyber-attacks could potentially lead to disruption, damage or more serious consequences.

C.90 Due to the UK's ever changing road network, one response highlighted that automated vehicles will need constant updates of road layouts. They raise the point that an automated vehicle should be intelligent enough to work out changes to roads by itself, but should be up to date on speed limits, banned turns, closed roads etc.

C.91 Stakeholders suggested automated vehicle testing should be completed first on closed roads before mixing with other road users. Some responses suggested that during early testing on public roads automated vehicles should be segregated from regular vehicles.

Q16. What issues would need to be addressed, to enable insurers to offer suitable insurance products?

C.92 Insurance associations highlighted the importance of being able to identify who was in control of the vehicle at the time of a collision or criminal offence. Many suggested this could be done with an event data recorder and camera monitoring system which should always be recording, whether the driver or car is in control. Additionally, telematics should be able to recognise any involvement in an impact automatically, even when no contact has been made. It was mentioned, that it might be beneficial to record the data source that influenced the vehicle in its decision making, for example the road infrastructure could have provided the vehicle with false information. With increasing use of event data recorders, one stakeholder highlighted the importance of ensuring vehicle owners would still have free choice when selecting their insurance policy.

C.93 For insurers to offer competitive insurance products against other companies it was mentioned that manufacturers should provide information on the costs of automated vehicles and repairs. Stakeholders saw a benefit in insurance companies using safety related test data and an understanding of the technology to build a picture of risk. It was considered that premiums may be based on the risk of a particular model of vehicle as opposed to the driver.

C.94 It was noted that even with liability potentially falling with another party, owners should still require fire and theft insurance to protect against damage to their own car.

C.95 The opinion of stakeholders indicated that manufactures should consider their wider liabilities. For example, a fault in the design or failing to prevent someone hacking into the control systems of the automated vehicle, resulting in a collision.

C.96 Stakeholders raised concerns over the following scenarios:

- If an automated vehicle malfunctions and causes a criminal offence, where would liability fall?
- Who takes liability if the driver is partially in control? For example when the driver is in the process of regaining control to prevent an accident but it is too late?
- What would the impact be on “driving under the influence” if a fully automated vehicle was being used?
- How would highly or fully automated vehicles impact drivers who have medical records recorded with DVLA that currently prevent them from driving particular vehicles?

Q17. Are there other insurance-related issues which may affect the introduction and testing of driverless cars?

C.97 As with question 16, stakeholders are concerned about identifying liability if a vehicle is in an incident. They indicated that the time taken to investigate who is liable would be reduced by using an event data recorder, logging both the input from a driver and from the automated systems.

C.98 Responses highlighted that if an event data recorder was required by regulation then a minimum quantity of data should be collected and access controls should be in place to prevent fraud. It was suggested that the Police should consider if data from the event data recorder would be of use in the STATS19 dataset.

C.99 It was noted that all the time it is possible for a driver to take control of the vehicle, insurance products should provide the same level of cover as is currently available in a conventional vehicle. Stakeholders agreed, that there may become a time when there is no need for driver based insurance premiums. Initially, it is believed by respondents, that the cost of insurance premiums will be high, due to the lack of historical automated vehicle data.

C.100 There was no concern with regards to obtaining insurance for prototype automated vehicles. Stakeholders highlighted that insurance products for this purpose are already available and it was identified that some manufactures may choose to self-insure, as often they are the best at understanding the risks. One stakeholder suggested the Department for Transport may wish to consider necessary indemnification, in order for research to continue in the UK should manufacturers find it challenging to get the relevant protection.

C.101 Stakeholders identified the importance to counter cyber threats, preventing deliberate sabotage or fraudulent activity. One idea put forward was for insurance policies to become void in cases where the owner of the automated vehicle fails to update to the latest software.

Q18. Do you have any suggestions or concerns over data collection and privacy, when considering the testing of cars with high automation?

C.102 A majority of stakeholders agreed that an event data recorder fitted to an automated vehicle for development and aiding with identification of liability would be very useful. There was concerns from respondents about where this data was stored, who owned the data, who had access to it and what the data is used for.

C.103 Four stakeholders believe that the Data Protection Act 1998 suitably covers this topic and abiding by it is paramount. Others went into more detail about the specific ways they believe the data should be handled:

- Data should be stored for a short period of time on the vehicle, with an extension to this if the vehicle is involved in a collision.
- Data is collected with permission of the driver or owner. Test drivers will be used to this as part of their role.
- Data could be stored on the vehicle or externally, although externally could present more risk from cyber threats. This data should be secure and available in a common format so it can be clearly understood and analysed.

C.104 It was suggested test data including collisions and near misses should be made available to the authorities to identify any particular areas of development or safety risks.

C.105 Both the driver and insurer should have access to the data to enable proper assessment and underwriting of risk.

C.106 Safeguards should be put in place to protect the location based information of where an individual may visit.

C.107 An event data recorder was likened to the flight recorders found on aeroplanes, and the important role they play in crash investigation was highlighted. They emphasised that it was one of the most important activities after a crash to obtain and download the data.

C.108 The point was raised that telematics is already being used for the education and further training of drivers, and that telematics from automated vehicles could be used in a similar way to help with development. Another stakeholder stated how the vehicles will have comprehensive systems monitoring the behaviour of the vehicle and the environment around it, therefore the ability to manage and interpret data efficiently is required.

C.109 One idea put forward for consideration was the ability for drivers to choose how much data they wish to make visible to insurers. They went on to say how this would most likely be reflected in the driver's insurance premium if minimal data was shared.

Q19. Do you (a) support amending diverse current regulations to cater for driverless cars alongside conventional ones, or (b) support creating a special regime via specific regulations to permit the testing of driverless cars under certain circumstances or constraints? (Or does it not matter as long as the regulations are appropriate and clear?)

C.110 There was mixed opinion on the best option for the implementation of regulations. However, most agreed that whatever regimes or regulations are decided on, they should be clear and appropriate.

C.111 It was felt by stakeholders, that it will require a huge amount of time and effort to accommodate automated vehicles into existing regulations. However, it was considered a good opportunity to update all road traffic laws to take account of modern technology which already exists on the road.

C.112 Two responses identified that existing regulations were never intended for modern technology and therefore a special regime would be better suited. Countering this, it was suggested it may get overcomplicated catering for different levels of automated vehicles with different versions of special regime.

C.113 Stakeholders believe further understanding is required on the rollout of automated vehicles in Europe and how it will affect the European Third Directive on driving licences. It was also noted that, if you need a driving licence to operate an automated vehicle, then it should be identifiable on the driving licence that a driver is qualified.

C.114 The use of special regimes which can be developed with the testing of automated vehicles was suggested. They go on to say, once automated vehicles are in production, regulations can be amended. Another stakeholder agreed with this method, stating it will give an opportunity for the behaviour of automated vehicles to be defined, agreed and tested.

C.115 It was suggested that different levels of automation would require different approaches to regulation. They commented that highly automated vehicles should use a combination of existing and new regulations, whereas fully automated will require a whole new set of regulations.

C.116 One stakeholder felt that the best outcome would be to support the UK's ambition to lead the field in automated vehicles technically, and that any changes should not be for the sole purpose of encouraging others to come to use the UK as a test track.

Q20. Do you have any other comments on the need for a special regime to cover the testing of driverless cars with high automation? Do you consider any other regulations or aspects of driving practice would pose a barrier, or do you consider that extra conditions would need to be imposed? Please give full details.

C.117 Stakeholder's opinion was for any new regulations to be carefully worded so they are suitable for future vehicles and will not need to be rewritten in the future to allow for new technologies.

C.118 One response suggested consideration should be paid to the role and expectations of the local authority or network operator and should be discussed and defined prior to testing.

C.119 One opinion was that human reactions to automated vehicles would prove to be a barrier. They felt that drivers would become non-compliant with 'distracted driving laws' once the highly automated mode was enabled. Contra to this, a different response suggested there would be little benefit to the mass market, if the regimes on what drivers could do was too strict.

C.120 A poll organised by an organisation identified that overcoming the technological and legal problems may be easier than convincing the public that automated vehicles are safer than conventional vehicles. It was pointed out, that by the time fully automated vehicles are mass produces and available to consumers, the public will be more conditioned to the idea.

C.121 It is the understanding of one stakeholder that current legislation allows for the testing of prototype vehicles on open roads, and the fact these vehicles will be automated will not cause legal problems, provided a driver is present. Other opinions for how these vehicles should be tested include:

- Giving consideration to what the implications of testing on different roads might be. For example motorways are very different to urban streets. They suggested in the early stages of testing, having special requirements, such as the use of lower speed limits on roads which have a high density of non-vehicle road users, such as transport hubs and schools.
- Licensing trials, ensuring that vehicles meet set minimum requirements off road before they are allowed on the road.
- Thought should be given to how the behaviour and potential risk of a trained test driver could be different to that of the public once automated vehicles go on sale.

C.122 It was suggested that with automated vehicles, a stance similar to the aircraft industry could be taken. That is, if one particular vehicle keeps crashing then all vehicles of the same type could be 'grounded' until the problem was identified and solved.

C.123 There was concern over the regulation of software and security. In particular over cyber security against unauthorised access, signal jammers and the regular updating process of vehicles. Some stakeholders feel regulation is necessary here to ensure sufficient protection is put in place. Cyber security was a theme throughout the call for evidence and it will be important to address this risk proportionally during the development of automated vehicles.

C.124 Also mentioned was the possible requirement of third parties such as highway authorities and navigation database companies to keep their systems fully up to date. This might include things like temporary speed limits, traffic regulations and maps. Responses suggest that it is essential full appreciation goes into how much vehicles will be dependent on the data and is catered for appropriately. The safety of road side workers was also raised for consideration should signs and road markings have to have more regular maintenance for automated vehicles to read them.

Annex D: Summary of actions for Government

Table D.1 Summary of actions for Government				
#	**Action**	**Date for completion**	**Paragraph number in summary report[121]**	**Paragraph number in detailed review**
1	Provide clarity on what should be considered 'safe vehicle use' in relation to the testing of automated vehicles.	Spring 2015	4.7	10.21
2	Require that testing is conducted with a suitably qualified test driver who is ready and able to take control.	Spring 2015	4.20	7.55
3	Require that test drivers are authorised by the organisation responsible for testing and should receive training on the safe use of the vehicle from that organisation.	Spring 2015	4.21	7.56
4	Make clear that the test driver (and the testing organisation for whom they are acting), will be considered responsible for the safe operation of the test vehicle whilst on public roads.	Spring 2015	4.27	5.18
5	Specify requirements for data recording. In the event of an incident or collision this data should be made available to the relevant authorities in a format which allows them to conduct analysis of the circumstances leading to the event.	Spring 2015	4.29	7.54

121 Note: The location of each action within the summary report and detailed review documents is provided as a paragraph number for the convenience of the reader.

Table D.1 Summary of actions for Government				
#	**Action**	**Date for completion**	**Paragraph number in summary report**[121]	**Paragraph number in detailed review**
6	Liaise with manufacturers and stakeholders to ensure an appropriate level of protection from unauthorised access, control or interference for automated vehicles engaged in testing.	Ongoing	4.37	15.17
7	Make clear that organisations planning to undertake automated vehicle testing should consult with the relevant highway authorities well before starting to test.	Ongoing	4.41	12.16
8	Recommend that those conducting testing provide information about their testing to the public, as part of their risk management process, taking into account the views of relevant stakeholders such as local highway authorities.	Spring 2015	4.43	6.19
9	Review existing legislation and provide clarity on how liability passes between the driver and the vehicle manufacturer according to mode of operation.	Summer 2017	N/A	13.12
10	Work with the insurance industry to develop requirements governing insurance of highly and fully automated vehicles and engage with the EU over their plans for automated vehicles.	Ongoing	N/A	13.21
11	Consider the existing licensing requirements for owners and users of highly and fully automated vehicles.	Summer 2017	N/A	4.20
12	Analyse existing regulations on vehicle use to ensure that automated vehicles are used and maintained in such a way as to preserve their compliance with road traffic law.	Summer 2017	N/A	5.30

Table D.1 Summary of actions for Government				
#	**Action**	**Date for completion**	**Paragraph number in summary report[121]**	**Paragraph number in detailed review**
13	Review the allocation of criminal and civil liability between driver and manufacturer and amend the appropriate legislation, as necessary.	Summer 2017	N/A	5.22
14	Consider appropriate measures to ensure that automated vehicles are designed to respect road traffic law.	End of 2018	N/A	5.25
15	Consider the need for requirements governing decisions in vehicle control software and algorithms which may have safety implications for other road users.	End of 2018	N/A	5.27
16	Consider whether requiring a higher standard of driving than would be expected of a conventional driver is possible for vehicles operating in an automated mode.	Summer 2017	N/A	5.34
17	Review the applicability of existing restrictions on vehicle users in regard of fully automated vehicles prior to such vehicles becoming available on the market.	Summer 2017	N/A	5.36
18	Determine whether a section on automated vehicles should be developed and included in The Highway Code, to help guide how road users should interact with these vehicles.	Summer 2017	N/A	6.29
19	Engage the international community, through the European Union and the United Nations Economic Commission for Europe, to examine the vehicle type approval framework and its detailed technical standards to ensure suitability for automated vehicles.	End of 2018	N/A	8.14

Table D.1 Summary of actions for Government				
#	**Action**	**Date for completion**	**Paragraph number in summary report[121]**	**Paragraph number in detailed review**
20	Examine whether standardisation of the warning symbols and system for the driver to re-take control in an automated vehicle is required.	End of 2018	N/A	8.15
21	Examine the need to amend legislation to clarify when driving is allowed with the driver absent from the vehicle, and the need to include additional safeguards.	End of 2018	N/A	8.13
22	Review existing roadworthiness testing processes and legislation over time to ensure they remain appropriate for highly automated vehicles.	Ongoing	N/A	9.13
23	Ensure that malfunction of the automated technology is made clear to the driver and consider allowing use of the vehicle to continue in 'manual mode' only.	End of 2018	N/A	9.14
24	Keep the issues of ease of repair and an appropriate vehicle lifetime under review as this area of technology develops.	Ongoing	N/A	9.23
25	Review existing vehicle use requirements in the light of evidence and experience gained from automated vehicle testing. Consider how this should feed into European type approval requirements and domestic 'use' regulations.	Summer 2017	N/A	10.36
26	Consider the relative benefits and costs of whether to record the status of automation on the vehicle register.	Summer 2017	N/A	11.9

Table D.1 Summary of actions for Government				
#	**Action**	**Date for completion**	**Paragraph number in summary report**[121]	**Paragraph number in detailed review**
27	Keep under review the need for and provision of standards and requirements for additional roadside infrastructure to enable the sale and operation of automated vehicles on public roads.	Ongoing	N/A	12.23
28	Government to continue to engage at European and international level in the development and setting of regulations, standards and specifications in relation to the development and introduction of automated vehicles.	Ongoing	N/A	12.24
29	Government – in conjunction with road operators, vehicle manufacturers and other stakeholders – to keep road infrastructure design standards and long term roads policy under review in light of strategic and technological trends, including developments in automated vehicle technologies.	Ongoing	N/A	12.28
30	Participate in EU harmonisation activities to produce a standard for data recording for automated vehicles, and work with stakeholders on privacy issues.	End of 2018	N/A	14.20
31	Consider how the existing regulatory framework may be developed to ensure both automated and connected vehicle technologies are protected from possible cyber threats.	End of 2018	N/A	15.21

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