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Automated Vehicles

A joint preliminary consultation paper

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Consultation Paper 240

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THE LAW COMMISSIONS – HOW WE CONSULT

Topic of this consultation: The Centre for Connected and Automated Vehicles (CCAV) has asked the Law Commission of England and Wales and the Scottish Law Commission to examine options for regulating automated road vehicles. It is a three-year project, running from March 2018 to March 2021. This preliminary consultation paper focuses on the safety of passenger vehicles.

Driving automation refers to a broad range of vehicle technologies. Examples range from widely-used technologies that assist human drivers (such as cruise control) to vehicles that drive themselves with no human intervention. We concentrate on automated driving systems which do not need human drivers for at least part of the journey.

This paper looks at are three key themes. First, we consider how safety can be assured before and after automated driving systems are deployed. Secondly, we explore criminal and civil liability. Finally, we examine the need to adapt road rules for artificial intelligence.

Comments may be sent:

Using an online form at https://consult.justice.gov.uk/law-commission/automated-vehicles

However, we are happy to accept comments in other formats. If you would like to a response form in word format, do email us to request one. Please send your response:

By email to automatedvehicles@lawcommission.gov.uk

OR

By post to Automated Vehicles Team, Law Commission, 1st Floor, Tower, 52 Queen Anne's Gate, London, SW1H 9AG.

If you send your comments by post, it would be helpful if, whenever possible, you could also send them by email.

Availability of materials: The consultation paper is available on our websites at https://www.lawcom.gov.uk/project/automated-vehicles/ and https://www.scotlawcom.gov.uk/publications

We are committed to providing accessible publications. If you require this consultation paper to be made available in a different format please email automatedvehicles@lawcommission.gov.uk or call 020 3334 0200.

Duration of the consultation: We invite responses from 8 November 2018 to 8 February 2019.

After the consultation: The responses to this preliminary consultation will inform the next stages of this three-year project. The first review point will be in March 2019.

Geographical scope: This consultation paper applies to the laws of England, Wales and Scotland.

Consultation Principles: The Law Commission follows the Consultation Principles set out by the Cabinet Office, which provide guidance on type and scale of consultation, duration, timing, accessibility and transparency. The Principles are available on the Cabinet Office website at: https://www.gov.uk/government/publications/consultation-principles-guidance.

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About the Law Commissions: The Law Commission and the Scottish Law Commission were set up by the Law Commissions Act 1965 for the purpose of promoting the reform of the law.

The Law Commissioners are: The Hon Mr Justice Green, *Chair*, Professor Nick Hopkins, Stephen Lewis, Professor David Ormerod QC and Nicholas Paines QC. The Chief Executive is Phillip Golding.

The Scottish Law Commissioners are: The Honourable Lord Pentland, *Chairman*, Kate Dowdalls QC, Caroline S Drummond, David E L Johnston QC, Dr Andrew J M Steven. The Chief Executive is Malcolm McMillan.

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List of Abbreviations

ABI: Association of British Insurers.

ACSF: Automatically Commanded Steering Functions.

ADSE: Automated Driving System Entity.

AEV Act: Automated and Electric Vehicles Act 2018.

CCAV: Centre for Connected and Automated Vehicles.

DDT: Dynamic Driving Task.

LIDAR: Light detection and ranging.

MIB: Motor Insurance Bureau.

MaaS: Mobility as a Service.

ODD: Operational Design Domain.

OECD: Organisation for Economic Co-operation and Development.

SAE: Society of Automotive Engineers International.

UNECE: United Nations Economic Commission for Europe.

Glossary

Automated driving system entity: Our term for an entity responsible for vouching for the safety of an automated driving system for safety assurance purposes.

Automated driving system: A vehicle system that uses both hardware and software to exercise dynamic control of a vehicle on a sustained basis. Sometimes abbreviated to ADS.

Conditional automation: An automated driving system which can perform the dynamic driving task but which requires a user to be receptive to requests to intervene: SAE Level 3.

Driver assistance: Individual automation features such as adaptive cruise control or lane changing features which assist the driver. These can cover both SAE Level 1 features (which can perform either longitudinal or lateral vehicle motion control, but not both) and SAE Level 2 features (which can perform both longitudinal and lateral vehicle motion control).

Dynamic driving task: The tactical functions (object and event detection and response) and operational functions (longitudinal and lateral motion control) which comprise the task of driving a vehicle.

Everything somewhere: The path to automation which develops high levels of automation in a restricted domain. See also "something everywhere".

Full automation: An automated driving system which can perform the entire dynamic driving task, with an unlimited operational design domain: SAE Level 5.

Geneva Convention 1949: The Geneva Convention on Road Traffic. This has largely been superseded by the Vienna Convention 1968 (see below) but there are still some countries which are parties to this Convention and not to the Vienna Convention 1968 eg, Ireland, Japan, Spain and the USA.

Geofencing: The restriction of an operational design domain on the basis of geographical location, by technical means.

High automation: An automated driving system which can perform the dynamic driving task without requiring a user to be receptive to requests to intervene. Such a system could achieve a minimal risk condition: SAE Level 4.

Human Factors: The study of ergonomics in relation to human interaction with other parts of any overall system.

Intelligent transport system: An advanced application which provides services related to different transport modes and traffic management.

Licensed operator: We refer to "licensed operators" as the broad category of "mobility as a service" providers under existing licensing laws (including private hire services and public service vehicles) and potentially new licensing models. A licensed operator would provide journeys in an automated vehicle, like taxi or bus companies currently do. It would have responsibility for the operational readiness of the physical vehicle and the automated driving system.

Lateral control of a vehicle: Control of a vehicle's sideways movement.

Light detection and ranging: A remote sensing method that uses pulsed laser to measure distance to a target. Usually abbreviated to LIDAR.

Longitudinal control of a vehicle: Control of a vehicle's forward movement.

Minimal risk condition: A condition in which risk to road users is minimised when a given journey cannot or should not be completed. This may be achieved by a human user (at lower levels of automation) or by an automated driving system (at higher levels of automation).

Mobility as a Service (MaaS): This refers to a wide range of digital transport service platforms eg, taxi and private hire apps and online car sharing schemes.

National Police Chiefs Council (formerly ACPO): A body which brings together UK police forces to coordinate, reform and improve policing operations.

National Transport Commission of Australia: An independent advisory body that aids in the achievement of national transport policy objectives in Australia.

Operational design domain: The domain within which an automated driving system can drive itself. An operational design domain may be limited by geography, in time, by type of road or in some other way. Sometimes abbreviated to ODD.

Partial automation: The SAE use "partial automation" to describe an automated driving system which can perform both longitudinal and lateral control of a vehicle: SAE Level 2.

Society of Automotive Engineers International (SAE): The society which established the levels of automation of vehicles from 0 to 5 in their technical document J3016.

Society of Motor Manufacturers and Traders: A trade association representing more than 800 automotive companies in the UK.

Something everywhere: The shorthand term for the path to automation by increasing the automated capability of vehicles on the consumer market. See also "everything somewhere".

Thatcham Research Centre: A research centre established by the motor insurance industry in 1969.

UNECE Resolution on the deployment of highly and fully automated vehicles: The resolution of the Global Forum for Road Traffic Safety (WP.1) on the deployment of highly and fully automated vehicles in road traffic, adopted on 20 September 2018 at the seventy-seventh session (Geneva, 18-21 September 2018).

User-in-charge: Our proposed new category of user of a highly automated system. Their main role would be to operate the vehicle upon exiting the system's operational design domain. They would also have certain other positive obligations in respect of vehicle maintenance and insurance. The user-in-charge would not be a driver but must be qualified and remain fit to drive whilst the vehicle is driving itself.

Vehicle Certification Agency: An executive agency of the United Kingdom Department for Transport. The Vehicle Certification Agency is the United Kingdom's national approval authority for new road vehicles.

Vienna Convention 1968: The Convention on Road Traffic entered into at Vienna in 1968, also often referred to as the Vienna Convention on Road Traffic.

Chapter 1: Introduction

1.1 This paper is written jointly by the Law Commission of England and Wales and the Scottish Law Commission. The Centre for Connected and Autonomous Vehicles (CCAV)[1] has asked us to review the UK's regulatory framework to enable the safe and effective deployment of automated vehicles on Britain's roads.[2]

1.2 This is the first time that either Law Commission has been asked to recommend how the law should be adapted to circumstances that (in the main) do not yet exist, but are in prospect. This requires us to anticipate what might happen. The challenge is to regulate at the right time. Premature intervention could stifle innovation. Late intervention could jeopardise safety. We therefore intend to issue a series of consultations to test ideas and respond to developments over the next three years.

1.3 In this initial paper, our focus is on reforms that will enable automated vehicles to be used:

(1) lawfully, without falling foul of requirements designed for conventional vehicles which automated vehicles cannot meet;

(2) safely, through safety testing prior to their being placed on the market, and monitoring of their performance once deployed; and

(3) with appropriate legal mechanisms for attributing criminal and civil liability and for providing for compensation when things go wrong.

1.4 Our key objective is safety. Secondary objectives are to provide a clear allocation of responsibility and liability; and to reap the benefits of driving automation, through improvements in mobility and productivity. Driving automation technologies can enable new ways for those with visible and non-visible disabilities to get around.

1.5 We are keen to receive a wide range of responses, from all those who may be affected by automated vehicles. As Law Commissions, we are committed to open consultation and rely on responses to inform our conclusions. Open consultation is particularly important in this area, where fast-moving technology is raising issues that have no direct precedent.

1.6 In some areas, we ask open questions to seek views. In other areas, we make tentative proposals for reform. We then ask stakeholders if they agree with our conclusions, so that we can generate focused and critical feedback. Nowhere have we formed a definite

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1 In July 2015 the UK government established CCAV to develop policy and deliver a programme of research and deployment for connected and autonomous vehicles in the UK. It is a joint Department for Transport and Department for Business, Energy & Industrial Strategy unit. See https://www.gov.uk/government/collections/driverless-vehicles-connected-and-autonomous-technologies.

2 This review is part of the Law Commission's 13th Programme of Law Reform approved by the Lord Chancellor on 14 December 2017.

view and we intend to engage in further consultation before making final recommendations.

1.7 **We seek responses by 8 February 2019**. For details of how to respond, see pp i to ii above.

BACKGROUND

1.8 In 2017, the Government published an industrial strategy which outlined four "grand challenges" for the UK.[3] One challenge was for the UK to become a world leader in shaping the future of mobility, of which automated vehicles are a key part.

1.9 This review is part of a package of reforms to support the deployment of automated vehicles in the UK. It builds on CCAV's programme of work, which includes a Code of Practice for testing[4] and the insurance reforms in the Automated and Electric Vehicles Act 2018.[5] CCAV funds and supports many automated vehicles projects, through Innovate UK.[6]

OUR TERMS OF REFERENCE

1.10 The Law Commissions are independent law reform agencies. We work closely with government departments and other governmental bodies but conduct our work independently under terms of reference agreed in advance.

1.11 Our terms of reference are set out in full in Appendix 1 and described below. An extract is provided in paragraph 1.18.

Only road vehicles

1.12 This review is confined to road vehicles. It does not extend to airborne craft, such as drones. Vehicles that might travel on pavements, footways and footpaths are also outside the scope of this review.

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3 HM Government, *Building a Britain fit for the future* (2017) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf.

4 Department for Transport, *The Pathway to Driverless Cars: a Code of Practice for testing* (2015) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/446316/pathway-driverless-cars.pdf.

5 Discussed in detail in Ch 6.

6 CCAV are providing £250 million, matched by industry, for research and development projects. See https://www.gov.uk/government/organisations/centre-for-connected-and-autonomous-vehicles/about. Recent projects funded by CCAV include: automated vehicle test infrastructure; the development of automated vehicles; validation and safety assurance projects; and connectivity technology for use in vehicles. CCAV also aims to improve the mobility of older persons, those with assisted living needs and the differently-abled. See CCAV, *UK Connected and Autonomous Vehicle Research and Development Projects 2018* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/737778/ccav-research-and-development-projects.pdf.

What is an "automated vehicle"?

1.13 Driving automation refers to a broad range of vehicle technologies and uses. Examples range from widely used technologies that assist human drivers (such as cruise control) to vehicles that drive themselves with no human intervention.

1.14 Our terms of reference describe an automated vehicle as a road-based vehicle that is capable of "driving itself". In other words, it can operate in an automated mode, in which it is not being controlled and does not need to be monitored by an individual, for at least part of a journey.[7] Our focus is therefore on automated driving systems which do not need human drivers for at least part of a journey,[8] rather than on those which merely assist a human driver.

1.15 At the same time, driver assistance technology is already in use and is presenting challenges. Drivers who misunderstand or over-rely on the driving system can create significant safety risks. We agree with stakeholders who have highlighted that a clear boundary between assisted and automated driving systems is critical to reform, and requires consideration of technologies on each side of the boundary.[9]

A focus on passenger transport

1.16 We have been asked to focus on passenger transport,[10] as opposed to goods deliveries.[11] The freight industry has a distinct regulatory framework and specialised stakeholders. The Government is running trials for platooning, where two or more trucks operate in convoy, using connectivity and automated technology to maintain a set, close distance between each other.[12] This raises issues outside the scope of our review.

1.17 We nevertheless welcome input from the freight industry in those areas covered in this preliminary consultation paper which raise common concerns.

A regulatory framework which is fit for purpose

1.18 We have not been tasked with determining whether vehicle automation is a desirable policy. Instead, our focus is on the regulatory framework. Our terms of reference ask us

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7 This is the definition of "driving itself" in section 8(1)(a) of the Automated and Electric Vehicles Act 2018, discussed at paras 2.55 to 59.

8 UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), Report of the Global Forum for Road Traffic Safety on its seventy-seventh session ECE/TRANS/WP.1/165 Annex 1, paragraph 3(b) defines automated driving systems as "the combination of hardware and software that can exercise dynamic control of a vehicle on a sustained basis".

9 We note in particular Thatcham Research and Association of British Insurers, *Assisted and Automated Driving – Technical Assessment* (2018), https://news.thatcham.org/documents/thatcham-research-assisted-and-automated-driving-definitions-technical-assessment-79493.

10 This is a broad category, and where vehicles have more than eight passenger seats or weigh more than 3,500kg for example specific provisions may apply. We will consider the implications of these regulatory boundaries as part of our future work on mobility as a service.

11 Use cases can overlap and we are not seeking to draw artificial distinctions. For example, self-driving vehicles which may run empty between picking up passengers for different journeys raise similar questions about the use of automated vehicles to transport light goods, for example.

12 https://www.gov.uk/government/news/green-light-for-lorry-platooning and https://www.gov.uk/government/publications/truck-platooning-uk-road-trial-feasibility-study.

to consider where there may be gaps or uncertainty in the law, and what reforms may be necessary to ensure that the regulatory framework is fit for purpose. This includes but is not limited to the following issues:

(1) who is the 'driver' or responsible person, as appropriate;

(2) how to allocate civil and criminal responsibility where control is shared between the automated driving system and a human user;

(3) the role of automated vehicles within public transport networks and emerging platforms for on-demand passenger transport, car sharing and new business models providing mobility as a service;

(4) whether there is a need for new criminal offences to deal with possible interference with automated vehicles and other novel types of behaviour; and

(5) the impact on other road users and how they can be protected from risk.

Areas outside the scope of this review

1.19 Three areas are integral to delivering effective policy in this area, but are predominantly outside our terms of reference because they are being considered by others. These are:

(1) data protection and privacy;[13]

(2) theft, cyber security and hacking;[14] and

(3) land use policy.[15]

1.20 We will follow developments in these areas, which will inform our thinking. Other areas such as employment law and taxation lie beyond the remit of our work.

1.21 Cyber security is an area of major concern. In Chapter 8 we note widely reported fears that hackers might take over control of automated vehicles. It is necessary to design systems that will withstand attacks. The UK government has issued guidance for parties

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13 For discussion of this area, see Allen & Overy, *Autonomous and connected vehicles: navigating the legal issues* (2017) http://www.allenovery.com/SiteCollectionDocuments/Autonomous-and-connected-vehicles.pdf (last accessed 17 September 2018). See also the Alliance of Automobile Manufacturers and Association of Global Automakers, *Consumer Privacy Protection Principles: Privacy Principles for Vehicle Technologies and Services* (November 2014) https://autoalliance.org/wp-content/uploads/2017/01/Consumer_Privacy_Principlesfor_VehicleTechnologies_Services.pdf.

14 CCAV, Department for Transport, and the Centre for the Protection of National Infrastructure, *The key principles of cyber security for connected and automated vehicles* (August 2017) https://www.gov.uk/government/publications/principles-of-cyber-security-for-connected-and-automated-vehicles/the-key-principles-of-vehicle-cyber-security-for-connected-and-automated-vehicles.

15 Land use policy in England and Wales is primarily within the remit of the Department for Transport and is for the Scottish Government in Scotland. Local authorities also play a significant role in land use policy. Issues related to infrastructure and automated vehicles are being considered by organisations such as CCAV, Highways England, and also the Urban Land Institute UK. See http://uk.uli.org/wp-content/uploads/sites/73/2015/12/Driverless-Cars-and-the-City_Conference_InfoBurst_Urban-Land-Institute_UK_2015_FINAL.pdf.

in the manufacturing supply chain on cyber security for connected and automated vehicles.[16] Work on the issue is also being done at international level.[17] Our review is not intended to duplicate this work. However, we are keen to ensure that the law responds to public concerns. In Chapter 8 we review the existing computer misuse offences and provisionally conclude that they adequately criminalise hacking into autonomous vehicles.

INTRODUCING DRIVING AUTOMATION ONTO EXISTING ROADS

1.22 Our focus has been on a regulatory framework for automated vehicles which operate on Britain's existing road network. We have not assumed that new dedicated roads will be built for these vehicles. Nor have we proposed new investment in the road infrastructure to cater for such vehicles. A different legal regime might apply if automated vehicles were confined to dedicated roads.

1.23 Automated vehicle systems can operate independently or rely on connectivity with other vehicles, with the road infrastructure, or both.[18] Connectivity is key to many of the wider benefits driving automation may bring, both for reducing congestion and safety. At present, vehicle connectivity is hampered by variations in Britain's cellular network coverage. However, the possibility exists for "cooperative intelligent transport systems", in which (for example) vehicles can communicate their presence and issue warnings about the road ahead.[19] This has the potential to transform the driving experience.

1.24 The proposals in this paper do not rely on new forms of connectivity, either with other vehicles or with the road infrastructure. We will, however, monitor developments and take these into account as they occur.

MOBILITY AS A SERVICE

1.25 Passenger vehicles may be privately owned, or may offer a service to the public. There is a wide range of service models, from buses and coaches to taxis and private hire vehicles (sometime referred to, colloquially, as "mini-cabs"). Passenger services are subject to separate regulatory regimes (covering public service vehicles, taxis and private hire vehicles).

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[16] https://www.gov.uk/government/publications/principles-of-cyber-security-for-connected-and-automated-vehicles/the-key-principles-of-vehicle-cyber-security-for-connected-and-automated-vehicles.

[17] UN Task Force on Cyber Security and Over-the-Air Issues, *Draft Recommendation on Cyber Security of the Task Force on Cyber Security and Over-the-air issues of UNECE WP.29 GRVA*, 20 September 2018, available at https://www.unece.org/fileadmin/DAM/trans/doc/2018/wp29grva/GRVA-01-17.pdf.

[18] Connected vehicle systems refer to technologies achieving real time communication among vehicles (so-called "vehicle-to-vehicle" or V2V) and between vehicles and infrastructure (also referred to as "vehicle-to-infrastructure" or V2I). See OECD, *Automated and Autonomous Driving: Regulating Uncertainty* (2015) p 12, https://www.itf-oecd.org/sites/default/files/docs/15cpb_autonomousdriving.pdf. But see also B Walker Smith, "A legal perspective on three misconceptions in vehicle automation" in G Meyer and S Beiker, *Road Vehicle Automation* (2014) pp 85 to 91.

[19] Cooperative intelligent transport systems (also referred to as "C-ITS") are systems consisting of vehicles accompanied by a communication and sensor infrastructure, with which the vehicles – fitted with appropriate on-board devices – are capable of communicating between themselves and with the infrastructure. See European Parliament, *Briefing Note: Automated vehicles in the EU* (January 2016) p 2.

1.26 In 2014, the Law Commission of England and Wales reviewed the regulation of taxi and private hire services in a rapidly changing environment.[20] It considered the impact of online bookings and increasing shared and on-demand services, but did not depart from the assumption that the vehicle and its (human) driver are separate. As passenger services become automated, new models of provision are likely to emerge. The current regulatory structures around passenger transport systems will need to adapt.

1.27 In November 2017, the Government launched the Industrial Strategy's Future of Mobility Grand Challenge. As part of this challenge, the Government committed to developing a strategy for the future of urban mobility[21] and establishing a flexible regulatory framework to encourage new modes of transport and business models. In July 2018, the Department for Transport issued a call for evidence which considers current trends: an aging population leads to changing need, while young urban dwellers are driving less. Meanwhile, technological innovation allows for greater ride sharing, cleaner transport and more automation.[22] These strands of work will inform our review.

1.28 Our next consultation paper will focus on mobility as a service. In 2019 we intend to publish a paper on how the current regulation of taxis, private hire vehicles and public service vehicles should adapt to automated, on-demand passenger transport provision.[23]

A THREE-YEAR REVIEW

1.29 This is a three-year project, which started in March 2018. Our aim is to publish a final report with recommendations for legislation by March 2021. Our full programme of work leading up to our final report is not yet set. We shall use the evidence gathered during this initial consultation to influence what we should cover in our review and when we should do so.

1.30 We have agreed a review point with CCAV in March 2019. By that stage we will have considered the responses to this current consultation. Our aim is to publish a timetable and work programme for the rest of this review in April 2019.

DEVOLUTION

1.31 Our current assumption is that any new legislation would be enacted at Westminster. However, by virtue of the Sewel Convention, the UK Parliament will not normally legislate for devolved matters without the concurrence of the devolved legislatures. Thus devolved legislative competence in Scotland and Wales would need to be taken into account.

1.32 Following the Wales Act 2017, the Welsh Assembly is now able to pass legislation provided it does not relate to a matter reserved to the UK Parliament. Reserved matters relating to road transport include: regulation of the construction of motor vehicles;

[20] Taxi and Private Hire Services (2014) Law Com No 347.

[21] HM Government Industrial Strategy (November 2017) at p 51.

[22] As above, at p 51.

[23] Department for Transport, Future of Mobility, Call for Evidence (July 2018)

regulation of the use of vehicles; road traffic offences; driver licensing; and insurance of motor vehicles.[24]

1.33 Under the Scotland Act 1998, some transport matters are similarly reserved to Westminster, including the Road Traffic Act 1988[25] and the Road Traffic Offenders Act 1988.[26] Other matters are not reserved, and are within the competence of the Scottish Parliament. This includes the law of delict[27] and criminal offences other than those contained in road traffic legislation.[28]

1.34 Our remit does not extend to Northern Ireland: we can only make recommendations in respect of England, Wales and Scotland. It is, however, acknowledged that the issues relating to automated vehicles apply UK-wide.[29] We welcome feedback from stakeholders in Northern Ireland.

INTERNATIONAL AND EU LAW OBLIGATIONS

1.35 This review is being undertaken during a time of uncertainty regarding the UK's future relationship with the European Union (EU).

1.36 As we explain in Chapter 2, the UK is currently bound by international obligations regarding driving and vehicles standards which exist independently of EU law. These obligations will not be affected by any withdrawal agreement.

1.37 Several issues discussed in this paper are also covered by EU law. In these circumstances we have been guided by the principles set out in the Government's white paper of July 2018, on the future relationship between the UK and EU.[30] Future iterations of our proposals will take account of further developments.

KEY CONCEPTS

1.38 Three key concepts run throughout the paper. We provide a brief introduction here and discuss them in more detail in the substantive chapters.

A vehicle which "drives itself"

1.39 We draw a fundamental distinction between driver assistance features which help a human driver; and automated driving systems which conduct the entirety of the driving

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[24] Government of Wales Act 2006, sch 7A, s E1.

[25] Scotland Act 1998, sch 5, head E1(d). Exceptions include parking, the offence of failing to comply with road signs and road safety information.

[26] Scotland Act 1998, sch 5, head E1(d).

[27] Civil wrongs, usually compensated by damages, the equivalent of the law of tort in England and Wales.

[28] Including penalties and rules of procedure and evidence.

[29] See the UK government's industrial strategy, https://www.gov.uk/government/topical-events/the-uks-industrial-strategy. Some key statutes considered in this review do not apply in Northern Ireland, including Part 1 of the Automated and Electric Vehicles Act 2018, the Road Traffic Act 1988 and the Road Traffic Offenders Act 1988. Unlike the position in Scottish and Wales, matters relating to road vehicles are not excepted or reserved under the Northern Ireland Act 1998.

[30] The Future Relationship between the United Kingdom and the European Union (2018) Cm 1 – 9593.

task without the need for human intervention. We draw on section 1 of the Automated and Electric Vehicles Act 2018 to distinguish between vehicles which "drive themselves" and those which do not.[31]

1.40 Section 1 requires the Secretary of State to keep a list of all motor vehicles that are (in the Secretary of State's opinion) capable of safely driving themselves. Once a vehicle is on the list, it is said to be "driving itself" if it is operating in a mode in which it is not being controlled, and does not need to be monitored, by an individual.[32]

1.41 At present, the concept of a vehicle driving itself only applies to civil liability. We provisionally propose that it should apply more widely, including for purposes of criminal law.

A "user-in-charge"

1.42 Where a vehicle is listed as capable of safely driving itself, and the automated driving system is correctly engaged, the human user would not be a driver. In particular, the user would not generally be liable for criminal offences arising out of the driving task. However, a human may be required to take over driving in planned circumstances, or after a vehicle has reacted to a problem by coming to a stop. We therefore tentatively propose that an automated vehicle should have a person who is qualified and fit to drive, unless the vehicle is specifically authorised as able to operate without one. We refer to this person as the "user-in-charge".

The automated driving system entity

1.43 Safety is paramount. We provisionally propose that automated driving systems should only be allowed if they are authorised.

1.44 We refer to the organisation putting the system forward for authorisation as the "automated driving system entity" (ADSE). We provisionally propose that the ADSE should have legal responsibilities to ensure that the systems are safe. The ADSE should also be subject to a system of regulatory sanction if the vehicle acts in a way which would be considered a criminal offence if done by a human driver. Sanctions would include improvement notices, fines and (where necessary) withdrawal of approval.

STRUCTURE OF THIS PAPER

1.45 This consultation paper is divided into ten chapters.

(1) Chapter 1 is this introduction.

(2) Chapter 2 introduces the reader to key terms used in discussions of driving automation, starting with levels of automation. We also outline the role of the United Nations Economic Commission for Europe and the concept of a vehicle "driving itself".

(3) Chapter 3 (human factors) considers the relationship between human drivers and driving automation. It identifies the need for the new category of user-in-charge,

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[31] Discussed in Chapter 2 at paras 2.55 to 2.59.

[32] Automated and Electric Vehicles Act 2018, s 8(1)(a).

who is not a driver but who is ready to drive. It also asks whether driver distraction laws should be relaxed or changed for conditionally automated driving systems.

(4) The next two chapters look at safety assurance. Chapter 4 considers pre-placement regulation. It describes the international type approval system and the EU framework. The current system leaves gaps where vehicles are modified after being registered for use on the roads or produced in small series. We tentatively propose a new safety assurance scheme to authorise automated driving systems which fall within these gaps. We ask how far the safety assurance scheme should be based on third party testing, and how it can be made sensitive to local conditions.

(5) Chapter 5 considers the regulation of safety after vehicles are on the roads. Powers already exist to regulate advertising, market surveillance and roadworthiness tests, but responsibilities are spread between different organisations. We ask if the new safety assurance agency proposed in Chapter 4 should also have responsibilities in these areas. We then discuss driver training and accident investigation. Finally, we provisionally propose that the agency should monitor the accident rate of highly automated vehicles compared with human drivers. We ask for views on the technical challenges this poses.

(6) Chapter 6 considers civil liability under the Automated and Electrical Vehicles Act 2018. Now that the legislation has been enacted we do not see a pressing need for further legal change. However, we ask if further clarification is required in three areas: the meaning of causation; the operation of the contributory negligence provisions; and the need to retain data. Under the 2018 Act, once an insurer has settled a claim with the injured party it may then seek damages from other parties liable for the accident, such as the manufacturer. We look briefly at manufacturers' and retailers' liability. In general, we conclude that the current law is adequate. However, we ask if there is a need to review the way that product liability applies to defective software updates, which are not supplied alongside physical goods.

(7) Chapter 7 considers the current criminal liability of drivers. It is in five parts:

(a) We ask whether any offences are incompatible with automated vehicles.

(b) With driver assistance systems, the human driver will continue to be responsible for driving offences. However, as automation increases this will change. We tentatively propose legal clarification that when a vehicle is driving itself, the human user is not a driver. They are therefore not generally liable for the criminal offences which arise out of the driving task. Instead, where the fault lies with the automated driving system, the entity behind the system should be subject to a system of regulatory sanctions.

(c) We discuss that the obligations of the user-in-charge include being qualified and fit to drive.

(d) We then look at the many other responsibilities currently placed on drivers, ranging from insurance and roadworthiness to duties following an accident.

In the absence of a human driver, we consider where these responsibilities should fall.

(e) Finally, we consider aggravated offences where drivers cause death or serious injury to other road users. In the absence of a human driver, these will no longer apply. We look at other possible criminal offences where an automated vehicle caused a death or serious injury and ask if further offences are needed.

(8) Chapter 8 asks whether any new offences are needed to deter people from interfering with automated vehicles.

(9) Chapter 9 looks at how road rules might be adapted to govern decisions by artificial intelligence. At present, road rules are subject to many "common sense" exceptions in the interests of safety and traffic flow. The challenge is to render these exceptions into precise code. We initiate the debate by asking three sample questions: when may an automated vehicle mount the pavement; exceed the speed limit; or edge through pedestrians? We also look at public concerns about ethics, prejudice and transparency.

(10) Finally, Chapter 10 lists the questions we are asking in this paper.

1.46 Appendix 3 and background papers 1, 1a and 2 provide readers with further information. Appendix 3 explores human factors; background papers 1 and 1a relate to existing road traffic offences; and background paper 2 concerns aggravated offences involving death or personal injury.[33]

ACKNOWLEDGEMENTS AND THANKS

1.47 We have held more than sixty meetings with individuals and organisations contributing to this paper, and we are extremely grateful to them for giving us their time and expertise. We have also attended conferences which have enriched our understanding of the diverse and ever-changing connected and automated vehicle ecosystem in the UK and internationally. We include a list of stakeholders we have met and conferences attended in Appendix 2. We look forward to receiving responses from these stakeholders as well as from other stakeholders and the general public.

THE TEAM WORKING ON THE PROJECT

1.48 The following members of staff have contributed to this paper at various stages: Henni Ouahes (team manager); Jessica Uguccioni and Tamara Goriely (lawyers in the public law team at the Law Commission of England and Wales); Charles Garland (Project Manager, Scottish Law Commission) Alison Hetherington and Ross Grimley (research assistants, Scottish Law Commission); Ffion Bevan, Connor Champ, Anna Holmes, Fiona Petersen, Alexander Shattock and Eleanor Wilson (research assistants, Law Commission of England and Wales).

[33] Background papers 1, 1a and 2 are available at https://www.lawcom.gov.uk/project/automated-vehicles/

Chapter 2: Introducing key concepts

2.1 Most fields of human endeavour develop their own specialist terminology. Automated vehicles are no exception. In this chapter we introduce some terms used to discuss automated vehicles. This is intended as background to the questions asked in subsequent chapters. The lack of consistency in how terms are used and the absence of clear definitions pose a challenge for experts and the public alike.

2.2 As with many discussions of automated vehicles, we start with the "SAE levels". The Society of Automotive Engineers International (SAE) is a global association of engineers and technical experts in the aerospace and automotive industries. The SAE levels provide a common language to describe the respective roles of human drivers and automated driving systems at different levels of automation. This language includes many specialist terms such as "minimal risk condition" and "operational design domain", which we describe below.

2.3 The eventual goal of driving automation is to provide a fully automated vehicle that can drive itself anywhere that a human can drive. Commentators have identified two main "development paths" towards this goal. One is based on adding automated features to consumer vehicles; the other involves providing the end-consumer with a journey rather than a car. We describe these paths and their implications for this project.

2.4 Any legal developments within the UK must take place within a framework of international treaties. We introduce two treaties which are relevant to this project: the revised 1958 Agreement on vehicle standards[34] and the 1968 Vienna Convention on Road Traffic. Both are administered by the United Nations Economic Commission for Europe (UNECE). We provide a very brief introduction to the UNECE.

2.5 We then look at how these issues have been addressed in Great Britain. The crucial dividing line is between a vehicle that needs to be monitored by a human driver and one that effectively "drives itself", so that responsibility for driving lies with the automated driving system and not the human. The Automated and Electric Vehicles Act 2018 has recently provided a definition of "driving itself" for the purposes of civil liability. We discuss that definition in this chapter. In later chapters we consider whether it should also apply for other purposes, including criminal liability.

SAE LEVELS OF AUTOMATION

2.6 In 2014, the SAE issued a technical report with "the goal of providing common terminology for automated driving". The report builds on previous taxonomies of automation, primarily those adopted by the German Federal Highway Research

34 This is used as shorthand for the UNECE Agreement concerning the adoption of uniform technical prescriptions for wheeled vehicles and their parts.

Institute.[35] It has now been updated twice, once in 2016 and again in 2018.[36] It is widely used by industry and policymakers to provide a common international language for talking about automated driving.[37]

2.7 SAE levels are analytical tools to describe the respective roles of the human driver and the automated driving system. As we discuss below, they are merely guides to the discussion. Crucially, they do not define legal consequences.

Overview of the SAE levels

2.8 The SAE has adopted a six-level classification.[38] It ranges from "no automation" where the human driver performs all the driving functions (Level 0) to "full automation" (Level 5) where the vehicle can drive itself anywhere a human driver could, with no human input. A key transition happens when the task of monitoring the driving environment shifts from the human driver (at Level 2) to the automated driving system (from Level 3 upwards).

2.9 The six SAE levels can be summarised as follows:

(1) Level 0 – No automation. The human driver performs all aspects of all driving tasks, even when these are enhanced by warning or intervention systems.

(2) Level 1 – Driver assistance. The driver assistance feature can carry out *either* the steering or acceleration/deceleration.[39]

(3) Level 2 – Partial automation. The combination of driver assistance features can carry out both steering and acceleration/deceleration. The driver is responsible for monitoring the driving environment and must remain actively engaged in the driving task.

(4) Level 3 – Conditional automation. The driving automation features are generally capable of performing all of the driving tasks but the human driver is expected to respond appropriately to "a request to intervene". A human "fallback-ready user" is therefore essential. The fallback-ready user must be receptive to a handover request or to an evident system failure, but is not expected to monitor the driving environment.

(5) Level 4 – High automation. The driving automation features can perform all the driving tasks even if a human driver does not respond to a request to intervene.

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35 *Bundesanstalt fur Strassenwesen* (BASt) "Legal consequences of an increase in vehicle automation", (2013).

36 Society of Automotive Engineers, "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles" J3016 JUN2018 (SAE J3016 (2018)).

37 SAE levels are referred to in publications by (among others) the UK Government, the United Nations, the US Department of Transport in its Federal Automated Vehicles Policy, the European Commission, the OECD, ERTRAC, AdaptiVe and Euro NCAP.

38 SAE J3916 (2018).

39 Described as lateral motion control (steering) or longitudinal motion control (acceleration and deceleration). These features include a limited degree of "object and event recognition in the given axis of motion", in that they can detect the presence of other vehicles or keep within lane markings.

If the limits of the automated driving system are for some reason exceeded, the system will put the vehicle into a “minimal risk condition”. This may mean coming to a gradual stop, for example, or changing lane to come to rest on the hard shoulder.

(6) Level 5 – Full automation. The vehicle is capable of performing all driving functions in all situations and conditions that a human driver could.

2.10 Table 1 (overleaf) shows how the SAE describes the levels. The table uses a series of defined terms, discussed below. These include the “dynamic driving task” (DDT); “object and event detection and response” (OEDR); and “operational design domain” (ODD).

Level	Name	Narrative definition	DDT		DDT fallback	ODD
			Sustained lateral and longitudinal vehicle motion control	OEDR		
Driver performs part or all of the DDT						
0	**No Driving Automation**	The performance by the *driver* of the entire *DDT*, even when enhanced by *active safety systems*.	*Driver*	*Driver*	*Driver*	n/a
1	**Driver Assistance**	The *sustained* and *ODD*-specific execution by a *driving automation system* of either the *lateral* or the *longitudinal vehicle motion control* subtask of the DDT (but not both simultaneously) with the expectation that the *driver* performs the remainder of the *DDT*.	*Driver and System*	*Driver*	*Driver*	Limited
2	**Partial Driving Automation**	The sustained and *ODD*-specific execution by a *driving automation system* of both the *lateral* and *longitudinal vehicle motion control* subtasks of the *DDT* with the expectation that the driver completes the OEDR subtask and supervises the driving automation system.	***System***	*Driver*	*Driver*	Limited
ADS ("System") performs the entire DDT (while engaged)						
3	**Conditional Driving Automation**	The *sustained* and *ODD*-specific performance by an *ADS* of the entire DDT with the expectation that the *DDT fallback-ready user* is *receptive* to the *ADS*-issued requests to *intervene*, as well as to *DDT performance relevant system failures* in other vehicle systems, and will respond appropriately.	*System*	***System***	*Fallback-ready user (becomes the driver during fallback)*	Limited
4	**High Driving Automation**	The *sustained* and *ODD*-specific performance by an *ADS* of the entire *DDT* and *DDT fallback* without any expectation that a *user* will respond to a *request to intervene*.	*System*	*System*	***System***	Limited
5	**Full Driving Automation**	The *sustained* and unconditional (i.e., not *ODD*-specific) performance by an ADS of the entire *DDT* and *DDT fallback* without any expectation that a *user* will respond to a *request to intervene*.	*System*	*System*	*System*	**Unlimited**

Adapted from SAE, 'Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles' J3016 JUN2018

A focus on human-machine interactions

2.12 SAE levels focus on how machines interact with human users, with each SAE level involving a different interaction between human and machine. As we discuss in Chapter 3, different problems may arise at each level.

2.13 Although the SAE levels are essential to any discussion of human-machine interaction, it is important to understand what the SAE levels do not do. First and foremost, the expert committee responsible for the taxonomy emphasises that these levels are descriptive rather than normative, and technical rather than legal.[40] The SAE levels therefore do not purport to allocate legal responsibility, which requires a degree of specificity and sensitivity to context which the SAE levels alone do not provide. The Association of British Insurers notes that:

> Whilst these SAE Levels are a familiar method for broadly categorising vehicle automation, the international insurance industry believes consumers will need to see more specific design domain functionality descriptors for certainty of coverage. This will mean that, for a given vehicle, there will not necessarily be a direct correlation between the manufacturer-assigned SAE Level and classification as an assisted or automated vehicle.[41]

2.14 Key threshold concepts such as what can count as a minimal risk condition (discussed below) for the purpose of differentiating between Level 3 and Level 4 systems are not defined in the SAE levels. Substantive criteria would need to be developed before legal consequences could flow from the levels. In this paper we refer to SAE levels in order to discuss, rather than define, legal outcomes, in line with their stated purpose.

2.15 Additional points to note are that:

(1) SAE levels do not imply a sequence of introduction to the market.[42] Each level will not necessarily build on the preceding one: several stakeholders have suggested "skipping" SAE Level 3, for example. Furthermore, SAE levels do not necessarily reflect progressively more advanced technology. The sophistication of the system depends on both the level of automation and the conditions and limitations within which it is designed to be used.[43] For example, a Level 4 system which only works within a very narrow set of conditions may be less sophisticated than some Level 2 systems.

(2) SAE levels relate to the *automated features* that are engaged in any given instance of on-road operation, rather than to the *physical vehicle itself*. The same

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40 SAE J3016 (2018) pp 1 and 18.

41 Association of British Insurers and Thatcham, *Assisted and Automated Driving: Technical Assessment* (2018) p 5, https://news.thatcham.org/documents/thatcham-research-assisted-and-automated-driving-definitions-technical-assessment-79493.

42 See the comments by Emilio Frazzoli, Chief Technical Officer at nuTonomy, Guest Talk at Massachusetts Institute of Technology (MIT) 6.S094: Deep Learning for Self-Driving Cars, 2018 lecture series organised by Lex Fridman.

43 These are also referred to as the "operational design domain" of the system, which we discuss at paras 2.25 to 2.28 below.

vehicle may have features at different levels of automation, and these may or may not be activated at any particular time.[44]

(3) SAE levels do not apply to active safety systems such as lane departure warnings and automated emergency braking. The levels only cover technology supporting driving functions on a "sustained basis" and exclude systems that are only activated momentarily in a high-risk situation.[45]

The ability to achieve a "minimal risk condition"

2.16 The concept of a minimal risk condition is central to the distinction between Level 3 and Level 4 in the SAE classification. The SAE report defines the concept as a condition to which the user or system may bring the vehicle "in order to reduce the risk of a crash when a given trip cannot or should not be completed".[46] This may be performed either by the human user (in Level 3 systems) or by the automated driving system (in Level 4 systems and above).

2.17 The key difference between conditional automation and high automation is that conditional automation systems rely on the human user to be the "fail safe". By contrast, if a triggering event arises in a highly automated driving system, the system may give the human user the option to take over the dynamic driving task. If this does not occur, the system is then able to achieve a "minimal risk condition" on its own. Put simply, a request to intervene in a conditionally automated vehicle cannot safely be ignored. In a highly automated driving system, it can be (although of course that is not ideal).

2.18 The SAE explain that the characteristics of a minimal risk condition may vary:

> It may entail automatically bringing the vehicle to a stop in its current travel path or it may entail a more extensive manoeuvre designed to remove the vehicle from an active lane of traffic and/or to automatically return the vehicle to its dispatching facility.[47]

2.19 However, the SAE report does *not* specify what the minimal risk conditions must be. For example, it does not discuss whether it would be sufficient for a vehicle with a Level 4 system to come to a (gradual) stop, activating its hazard lights, even if it had no ability to change lane. This may be safe in some circumstances but extremely dangerous in others (if, for example, the vehicle stopped on a level crossing or in the outside lane of a motorway).

2.20 At the time of writing, there are no standards in respect of what may qualify as a minimal risk condition, though the issue is being discussed by the UNECE.[48]

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44 SAE J3016 (2018), para 1.

45 SAE J3016 (2018), para 1.

46 SAE J3016 (2018), para 3.17

47 SAE, J3016 (2018), para 3.12, note 3.

48 See paras 4.42 to 4.44.

The "dynamic driving task"

2.21 The SAE report uses the term dynamic driving task to refer to some (but not all) elements of driving. John Michon, an academic in the automotive field, identified a threefold division of the driving task:

(1) Strategic: choice of destination, route and trip planning.

(2) Tactical: manoeuvring the vehicle in traffic, deciding whether to overtake or change lanes, selecting an appropriate speed, checking mirrors.

(3) Operational: including split-second reactions and micro-corrections to steering, braking and acceleration.[49]

2.22 In SAE terminology, the dynamic driving task does not cover the strategic element. Instead, it encompasses the operational and tactical elements of driving on a sustained basis.[50] It refers to operating a vehicle in an active lane of traffic when the vehicle is either in motion or will imminently be so.[51]

2.23 Dynamic driving is typically divided into two aspects. The first relates to the control of the vehicle, described as lateral control (steering) and longitudinal control (acceleration and braking). The second relates to monitoring the driving environment (which includes detecting, recognising and classifying objects and events) and responding appropriately. The SAE refer to this as "object and event detection and response".

2.24 In Chapter 7 we distinguish between criminal offences which arise directly out of the driving function and those that relate to the wider responsibilities of a driver (such as taking out insurance, keeping a vehicle roadworthy and reporting accidents). We use the term dynamic driving task to distinguish between tasks which can be performed by an automated driving system and those which remain the responsibility of a human user.

The "operational design domain"

2.25 Until the emergence of a fully automated vehicle, able to drive anywhere that a human driver can drive, automated features will only be able to operate in defined conditions, The SAE refers to these as the "operational design domain" (or ODD). The ODD is determined by the manufacturer and sets out the conditions in which the system or feature is designed to function. Conditions may relate to a type of road (such as a

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49 JA Michon "A Critical View of Driver Behavior Models: What Do We Know, What Should We Do?" in L. Evans & R. C. Schwing (Eds.). *Human behavior and traffic safety* (pp. 485-520). New York: Plenum Press,1985, at p 489.

50 SAE J3016 (2018), para 3.13.

51 The UNECE refers to the concept as "dynamic control" in its Resolution on the deployment of highly and fully automated vehicles, using a similar definition. Para 3(b) states: "'dynamic control' refers to carrying out all the real-time operational and tactical functions required to move the vehicle. This includes controlling the vehicle's lateral and longitudinal motion, monitoring the road environment, responding to events in the road traffic environment, and planning and signalling manoeuvres." UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), Report of the Global Forum for Road Traffic Safety on its seventy-seventh session ECE/TRANS/WP.1/165 Annex 1.

motorway); a place (such as a city); a speed (such as under 12 km per hour); or weather (such as "not in snow"). The ODD sets the limits of what the automated vehicle can (and, crucially, cannot) do. The UNECE Resolution on the deployment of highly and fully automated vehicles adopts a similar approach:

> "operational design domain"… refers to the environmental, geographic, time-of-day, traffic, infrastructure, weather and other conditions under which an automated driving system is specifically designed to function.[52]

2.26 The technical descriptions of an ODD are, in principle, limitless, although the UNECE has considered how they might be standardised. So far, its work has concentrated on parking areas and road types, such as motorways, urban or inter-urban roads.

2.27 An alternative approach is to concentrate on specific places. Developers have told us that training for artificial intelligence could differ substantially from city to city. For example, Rome and London are both urban centres, but their driving behaviours differ. Stakeholders told us there are also significant differences between cities in the UK. We discuss this further in Chapter 4, on safety assurance.

2.28 Weather and light conditions may also limit the ODD. This may make it difficult to predict whether the domain will be exceeded on any given journey, as weather conditions can change rapidly. Automated vehicles are only as good as their sensors, which may be affected by a wide range of factors, including glare, mist or ice. At some stage, it may become necessary to provide a minimum list of weather and light conditions in which a feature must be able to operate before it is approved for sale.

Safety by design and user responsibility

2.29 Both the SAE and UNECE have suggested that automated driving systems should only be permitted to engage if they are within their ODDs.[53] Thus systems should be "geofenced" so that they cannot operate outside the geographical area for which they were designed, for example. It will be more difficult to do this for weather conditions, though vehicles might be linked to official data, such as the colour-coded severe weather warnings issued by the Meteorological Office.

2.30 At present it is unclear how far the technology will prevent automated vehicles from operating outside their ODDs, and how far responsibility for not exceeding the domain will rest with human users. There are clear advantages to a system which is safe by design and does not rely solely on the user's understanding. However, this may not always be possible. In some cases, a human user may need to take responsibility for not exceeding the domain. As we discuss in Chapters 6 and 7, the potential legal

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52 UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), Report of the Global Forum for Road Traffic Safety on its seventy-seventh session ECE/TRANS/WP.1/165 Annex 1, para 3(c).

53 SAE J3016 (2018), Table 2. UNECE Resolution on the deployment of highly and fully automated vehicles, para 4(e) provides that automated driving systems in highly and fully automated vehicles should "only operate within their ODD". UNECE Regulation 79 on Automatically Commanded Steering Functions (ACSF) includes a requirement that the ACSF must only work in circumstances where it can operate safely, within its operational design domain. Similarly, the provisions for virtual testing for software elements of systems under the UNECE's 1958 Revised Agreement also incorporate the concept that automated driving features should only function within their operational design domain (1958 Agreement, Sch 8).

consequences of exceeding the domain range from invalidating the insurance to being liable to criminal prosecution.

2.31 This suggests that, in respect of automated passenger cars operated by their individual users, the ODD should be very clearly delineated. Its limits should not be buried in the fine print of terms and conditions that consumers may fail to read or understand. In Chapter 5, we discuss ways in which users can be given better information and training on this issue. In the longer term, it may be advantageous to standardise domains, to avoid misunderstandings about the domain's extent.

FEATURES OR SYSTEMS?

2.32 Driving automation technology can be described in three different ways: in relation to the feature; the system; or the vehicle. Depending on context it may refer to:

(1) an individual feature (such as adaptive cruise control, automated parking or the ability to perform a lane change);[54]

(2) a package of features which collectively can perform the *entire* driving task. The SAE levels identify this as a distinct category, which only applies to SAE Level 3 and above. The SAE refers to this group of driving automation features as the "automated driving system" (ADS);[55] or

(3) a vehicle equipped with driving automation features.[56] In turn, vehicles can be classified by their design or by how they are being used at a particular time. Where a vehicle has automated driving capabilities which can be switched on and off, it may be treated as an automated vehicle for some purposes (such as type approval). However, for civil liability purposes, it would only be regarded as "driving itself" if the automated driving system was engaged.[57]

"Automatically Commanded Steering Functions"

2.33 At present, the main regulation of automated driving has concentrated on features. UNECE Regulation 79 describes a sliding scale of Automatically Commanded Steering Functions (ACSF) from Category A to E, described in detail in Chapter 4.[58]

2.34 Features currently on the market include remote control parking and lane keeping. Work is now taking place to allow lane change functions, either initiated by the driver or suggested by the automated driving system and confirmed by the driver.

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54 Each feature satisfies a usage specification, and is associated with a particular level of automation and operational design domain, see SAE J3016 (2018), para 3.9.

55 SAE J3016 (2018), para 3.2.

56 SAE J3016 (2018), para 7.2.

57 For discussion, see Ch 6. Under the Automated and Electric Vehicles Act 2018, s 1(1), listed systems need only be capable of driving themselves in "some circumstances or situations". This envisages that a vehicle may drive itself or only part of the journey. At other times a human driver will take over.

58 Discussed at paras 4.31 to 4.41.

2.35 Other than parking, the current ODD for use of these features is motorways. From a software design perspective, motorways are less complex than urban or rural roads, as they have a physical separation from oncoming traffic and do not accommodate pedestrians or cyclists.

2.36 The UNECE has envisaged a function (labelled Category E) which enables a vehicle effectively to drive itself on a motorway, changing lanes without further driver command. The driver would turn it on when entering the motorway, and receive a request to intervene in good time to take over driving before the motorway exit. However, there is no current timeline for identifying the criteria to regulate Category E.[59]

The challenges of "cumulative" automation features

2.37 A vehicle may contain several (limited) driving automation features which individually have a narrow use specification, but together may provide a driving experience very similar to an automated driving system. In addition, manufacturers may offer the possibility of updates to increase the automated capabilities of a vehicle, as well as adjusting existing functionalities.

2.38 These possibilities have the potential to make vehicles safer and perform better. However, a combination of automation features means that users may not fully understand the limits of the system they are using. As we explore in Chapter 3, a mixed situation carries significant risks of user confusion and over-reliance on automated driving systems.

TWO DEVELOPMENT PATHS TO AUTOMATION

2.39 In 2015, the Organisation for Economic Co-operation and Development identified two major development pathways towards "full automation", where a vehicle can drive itself under all circumstances for all parts of a journey.[60]

(1) Path 1 involves gradually improving the automation in conventional vehicles, sold to a mass consumer market.[61] These vehicles will continue to have identifiable human drivers, although, as the technology improves, human drivers will increasingly be able to cede control to the automated driving system.[62]

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59 See UNECE Regulation 79: UN ECE, *Addenda to the 1958 Agreement (Regulations 61 - 80)* https://www.unece.org/trans/areas-of-work/vehicle-regulations/agreements-and-regulations/un-regulations-1958-agreement/regulations-addenda-to-the-1958-agreement/old-version-of-regulations-pages/regs-61-80.html; UNECE, *Status Report of the Informal Working Group ACSF* (2016) https://www.unece.org/fileadmin/DAM/trans/doc/2016/wp29grrf/GRRF-81-32e.pdf.

60 OECD, *Automated and Autonomous Driving: Regulating Uncertainty* (2015) p 5, https://www.itf-oecd.org/sites/default/files/docs/15cpb_autonomousdriving.pdf.

61 Many driving features are already automated in existing conventional vehicles, and have been for some time. Examples of advanced driver assistance features include adaptive cruise control, lane keeping and lane changing technology, and self-parking. As these features become more advanced, more of the driving task will shift from the human driver to the automated driving systems.

62 Many automated driving features are already added to vehicles. Examples include adaptive cruise control, lane keeping and lane changing technology, and self-parking.

(2) Path 2 involves deploying vehicles without a human driver in limited local contexts and gradually expanding their range of use.[63] Here the role of the human occupant is that of a passenger rather than a driver.

2.40 These paths are likely to converge, as they eventually reach the same goal of fully automated driving. However, along the way they may differ in several respects.

2.41 Path 1 is being pioneered by motor manufacturers with a global business model based on selling cars for private ownership. They will continue to sell vehicles to consumers across international borders.

2.42 In Path 2 the emphasis is on selling journeys rather than vehicles. For example, a company may start by providing an automated shuttle bus, extend the service to other routes, and eventually offer on demand passenger transport services, such as private hire service without a driver.[64] The approach is more closely linked with the provision of Mobility as a Service, shared journeys, and integration with public transport.[65] It also has the potential to offer enhanced mobility to those who are currently unable to drive, such as disabled persons. Initially, Path 2 was pioneered by technology companies without a history in the automotive industry, though increasingly the trend has been towards partnerships between such technology companies and long-standing motor manufacturers.[66]

2.43 As automation develops, both paths are likely to operate at SAE Level 4. However, the vehicles will look and feel different to each other. Path 1 highly automated vehicles will move in and out of their operational design domains, passing performance of the driving task back and forth between humans and machines. By contrast, Path 2 vehicles will remain firmly within their geographical domains, with only limited possibilities for human intervention. They may, for example, be built without steering wheels or brake pedals.

2.44 Bryant Walker Smith, an academic in the field of vehicle automation, has labelled Path 1 as "something everywhere". This conveys the idea that the vehicle itself is not geographically limited. It can go everywhere, even though it will sometimes need a human driver. Meanwhile, Path 2 is labelled "everything somewhere", because the vehicle can perform the whole automated driving task without a human in the driving seat, but only in some places.[67]

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63 OECD, *Automated and Autonomous Driving: Regulating Uncertainty* (2015) p 5.

64 OECD, *Automated and Autonomous Driving: Regulating Uncertainty* (2015) p 20.

65 See House of Lords Transport Committee, *Mobility as a Service inquiry* (2017) https://www.parliament.uk/business/committees/committees-a-z/commons-select/transport-committee/inquiries/parliament-2017/mobility-as-a-service-17-19/. Automated vehicles may, for example, provide last mile transport from public transport hubs, sometimes called "personal rapid transit". For example, see Heathrow Airport's personal rapid transport pods at https://www.youtube.com/watch?v=Byk8LcPovOQ,

66 Example are the partnerships between General Motors and Lyft; Jaguar and Waymo; and Toyota and Uber. Some manufacturers are also developing their own car sharing schemes, such as BMW's DriveNow.

67 We do not wish to suggest that the "something everywhere" is limited to lower levels of automation. The UNECE is already exploring ways to approve steering systems with highly automated driving features, which

2.45 We have adopted these terms because they reflect trends which have been accepted in the existing literature,[68] noting that they graphically describe broad categories rather than providing precise definitions.[69]

2.46 As we discuss throughout this report, there are differences in how the existing system of regulation applies to each path, from the need for type approval to the responsibilities of users. In particular, the "everything somewhere" path may well be subject to the additional regulation which applies to those who sell Mobility as a Service, whether as taxis, private hire vehicles or public service vehicles. We do not discuss taxi, private hire or public service vehicle regulation in detail in this report. Instead, we will be addressing it in a later paper. However, we cannot simply ignore this additional regulation. It has implications for vehicle standards; for responsibilities for insurance and maintenance; and for the status of users.

2.47 In this paper we strive to treat both paths equally. The merits of the technology should determine its development path, not regulatory intervention. Our focus is on the underlying questions common to any deployment scenario for passenger vehicles: making sure the systems are safe, and ensuring compliance and accountability with legal rules, both criminal and civil. This requires striking a difficult balance between premature intervention (which risks stifling innovation) and excessive delay (which could insufficiently protect the public). We will continue to note the progress of development paths to ensure regulation can take these into account, without seeking to influence how business models develop.[70]

THE INTERNATIONAL FRAMEWORK

2.48 Vehicle design and driving are subject to systems of international regulation. For the purposes of this paper, the key organisation is the United Nations Economic Commission for Europe (UNECE). The UNECE was originally established in 1947 as a subsidiary body of the United Nations Economic and Social Council. Its goal was to promote pan-European economic integration.[71] To this end, in 1958 it sponsored an agreement to harmonise vehicle standards, which now extends far beyond Europe and includes (for example) Japan, South Korea and Australia.

2.49 In this report we refer to the UNECE's work in administering two important international agreements:

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may be described as doing all of the driving ("everything") within limited environments such as motorways ("somewhere"). For example, UNECE's ACSF proposed Category E steering functions.

68 See ERTRAC's 29/05/2017 report *Automated Driving Roadmap*, s 3. See also the OECD's urban mobility pathway: OECD, *Automated and Autonomous Driving: Regulating Uncertainty* (2015) p 21.

69 See paras 2.6 and 2.7 above.

70 This also reflects the longstanding technology-neutral approach adopted in the automotive industry through UNECE rules. See, for example, UNECE, *Mutual Resolution No. 2 (M.R.2) of the 1958 and the 1998 Agreements* (2015) ECE/TRANS/WP.29/1121.

71 The UNECE has 56 member States. It includes the countries of Europe, and extends to countries in North America and Asia, see https://www.unece.org/oes/nutshell/region.html

(1) The “revised 1958 Agreement” concerns vehicle standards.[72] It aims to reduce technical barriers to international trade in vehicles and vehicle parts. It has 53 contracting parties and we describe it in detail in Chapter 4.

(2) The Vienna Convention on Road Traffic 1968 (the Vienna Convention) aims to promote road safety and “facilitate international road traffic”.[73] The UK is in the process of ratifying the convention, which will come into force on 28 March 2019. The UK will then become the 76th contracting party.[74]

2.50 The UNECE has permanent working parties to oversee the operation of these agreements. The responsibilities of the Global Forum on Road Traffic Safety (Working Party 1) include the administration of the Vienna Convention. Meanwhile, the World Forum for Harmonisation of Vehicle Regulations (Working Party 29) is a group of experts that focusses on vehicle standards. Both working parties are extremely active in regulating the introduction of driving automation, and we refer to their work in the course of this paper.

Regulating driving under the Vienna Convention

2.51 The Vienna Convention has four requirements which are relevant to automated vehicles:

(1) every vehicle must have “a driver”;[75]

(2) every driver of a motor vehicle must hold a driving permit;[76]

(3) under Article 8.5, a driver must “at all times be able to control his vehicle”.[77] Article 13(1) then provides more detail about what this means. It states, for example, that the driver should pay constant regard to the circumstances “so as to be able to stop his vehicle within his range of forward vision and short of any foreseeable obstruction”;

(4) a driver of a vehicle shall “at all times minimize any activity other than driving”.[78]

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72 As we discuss at para 4.14, the full title is the UNECE Agreement concerning the adoption of uniform technical prescriptions for wheeled vehicles and their parts. We use “the revised 1958 Agreement” as shorthand.

73 Preamble to the Vienna Convention 1968.

74 The Vienna Convention supersedes obligations in the earlier Geneva Convention on Road Traffic 1949 for countries which have signed up to both conventions: art 48. However, many countries (including for example Ireland, Spain and the United States of America) are “Geneva only”, in that they have never signed the Vienna Convention. Our relationships with these countries will continue to be governed by the Geneva Convention.

75 Art 8.1.

76 Art 41.1(a).

77 Art 8.5.

78 Art 8.6. It goes on to state that domestic legislation should lay down rules on the use of phones and “shall prohibit the use by a driver of a motor vehicle… of a hand-held phone while the vehicle is in motion”.

2.52 Article 8.5 was amended in 2016 to take account of assisted driving features (described as "vehicle systems which influence the way vehicles are driven"). The amendment clarifies that such systems will be deemed to be in conformity with articles 8.5 and 13(1) through one of two routes.[79] The first is where the assisted driving system complies with international technical standards. The second is where the vehicle system can be "overridden or switched off by the driver".[80] This amendment to the Vienna Convention is a clarification, rather than a substantive change to the pre-existing position.[81]

2.53 The term "driver" is defined as "any person who drives a motor vehicle or other vehicle".[82] The discussions at Working Party 1 indicate that, until now, this has been interpreted to apply only to humans.[83] However, the obligations which that driver might have (including the ability to turn the vehicle system on or off) sets the threshold for being a driver quite low.

2.54 On 20 September 2018, Working Party 1 adopted the UNECE Resolution on the deployment of highly and fully automated vehicles. The resolution provides a flexible framework for interpreting the Vienna and Geneva Conventions' requirements as they can apply to automated driving systems in the absence of human drivers in the conventional sense.[84]

THE CONCEPT OF A VEHICLE "DRIVING ITSELF" IN THE LAW OF GREAT BRITAIN

2.55 As we discuss in Chapter 6, the UK Parliament has legislated for a new form of civil liability where vehicles are "driving themselves".[85] There is no simple definition of when a vehicle can be said to drive itself safely. Instead, decisions will be made on a case-by-case basis. Under section 1 of the Automated and Electric Vehicles Act 2018, the Secretary of State must prepare, and keep up to date, a list of all motor vehicles that:

(1) are in the Secretary of State's opinion designed or adapted to be capable, in at least some circumstances or situations, of safely driving themselves; and

(2) may lawfully be used when driving themselves, in at least some circumstances or situations, on roads or other public places in Great Britain.

2.56 Under section 8(1)(a) a vehicle is "driving itself" if it is operating in a mode in which it is not being controlled, and does not need to be monitored, by an individual. Although the

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79 Art 8.5 *bis* of the Vienna Convention.

80 See Art 8.5 *bis* of the Vienna Convention.

81 We note that the corresponding article in the Geneva Convention (Art 8.5 "Drivers shall at all times be able to control their vehicles…") has not been amended.

82 Art 1(v) of the Vienna Convention.

83 UNECE, Inland Transport Committee. Global Forum for Road Traffic safety, Special session, Geneva 3-4 May 2018. See https://www.unece.org/fileadmin/DAM/trans/doc/2018/wp1/ECE-TRANS-WP1-INF-May-2018-1e.pdf.

84 UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), Report of the Global Forum for Road Traffic Safety on its seventy-seventh session ECE/TRANS/WP.1/165 Annex 1, para 4.

85 This legislation does not apply to Northern Ireland.

issue is not addressed on the face of the legislation, the Government has indicated that only vehicles which can achieve a minimal risk condition will be listed as capable of safely driving themselves.[86]

2.57 The legislation provides a clear dividing line between driving automation systems which need to be monitored by a human driver ("driver assistance systems") and those which do not need to be monitored (which we refer to as "automated driving systems").

2.58 At present, the concept of a vehicle driving itself is only relevant for purposes of civil liability. However, in this consultation paper we tentatively propose that the dividing line should also apply for purposes of regulation and criminal liability.[87] Effectively, the line defines who is "driving" at any given time. With driver assistance systems, the human remains the driver. When a vehicle is driving itself, the dynamic driving task is performed by the system rather than a human.

2.59 Other jurisdictions have also recognised the need for this division. For example, the proposed SELF DRIVE Act in the United States defines a "highly automated vehicle" as a motor vehicle, other than a commercial motor vehicle, that is equipped with an automated driving system capable of performing the entire dynamic driving task on a sustained basis.[88]

THE CONCEPT OF DRIVING IN THE LAW OF GREAT BRITAIN

2.60 In England and Wales, the test for whether someone is driving depends on whether they are "in a substantial sense controlling the movement and direction of the car". In *R v MacDonagh,* Lord Widgery CJ gave the classic definition:

> The essence of driving is the use of the driver's controls in order to direct the movement, however that movement is produced.[89]

2.61 However, the courts have sometimes restricted this definition to prevent people from being convicted of serious offences that are not within the spirit of the legislation. For example, in *R v MacDonagh*, the appellant was disqualified from driving. His car was causing an obstruction on the road and a police officer told him to move it. He stood with both feet on the road, put his shoulder against the door pillar and pushed the car, putting one hand inside on the steering wheel to control the movement. The court held

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86 See the "will write" letters from ministers related to the Bill: https://services.parliament.uk/bills/2017-19/automatedandelectricvehicles/documents.html. In particular, the Letter dated 13 March 2018 from Baroness Sugg regarding whether the Automated and Electronic Vehicles Act 2018 covers Level 3 systems and the letter dated 15 November 2017 from John Hayes MP to Edward Leigh and Adrian Bailey MP regarding levels of automation.

87 Discussed at paras 3.24 to 3.57.

88 See the United States Congress H.R.3388 – SELF DRIVE Act (the "Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution Act") and the proposed amendments to section 30102 of title 49, United States Code, at https://www.congress.gov/bill/115th-congress/house-bill/3388/text.

89 [1974] RTR 372 at p 374 D–E. The definition of a driver in case law is supplemented (but not replaced) by section 192(1) of the Road Traffic Act 1988. This confirms that a vehicle may have more than one driver, where "a separate person acts as a steersman of a motor vehicle".

that this did not constitute driving, as it did not fall within the ordinary meaning of the word. Lord Widgery commented:[90]

> Giving the words their ordinary meaning there must be a distinction between driving a car and pushing it. The dividing line will not always be easy to draw, and the distinction will often turn on the extent and degree to which the defendant was relying on the use of the driver's controls.

2.62 Lord Widgery noted that the legislation applied to motor cycles, which must “be manhandled from time to time”. He commented that pushing a motor cycle while holding the handlebars did not constitute driving.

2.63 The Scottish courts have taken a different view. In *McArthur v Valentine*,[91] the accused was a drunk passenger in a car that failed to start. He tried to start the car by pushing it to the top of an incline. He released the steering lock and the handbrake and placed his hands on the wheel, while holding the driver's door open and both feet on the ground. A five judge bench of the High Court of Justiciary held that this was driving. It declined to follow the two-test approach in *R v MacDonagh*, reasoning that if a person used the drivers controls to direct the movement of the car, it was unnecessary to ask whether the act also amounted to “driving” within the ordinary meaning of the word. This leaves a difference between Scots law, on the one hand, and the law of England and Wales, on the other.

2.64 In practice, within England, subsequent cases have tended to approach the definition of driving pragmatically, as a matter of fact and degree. In *Jones v Pratt*,[92] the Divisional Court held that a front seat passenger was not driving, even though he momentarily grabbed the steering wheel, causing the car to leave the road. The courts have also held that there can be more than one driver at any given time.[93]

2.65 In *Burgoyne v Phillips* the defendant was drunk.[94] He sat behind the steering wheel, attempting to drive, and allowed the car to roll 30 feet before stopping. He failed to realise that the keys were not in the ignition and that the steering was locked. The court held this to be driving, even though the defendant conspicuously failed to direct the movement of the car. The case is interesting because, even though “the essence of driving” is said to be using the controls to direct the movement of the vehicle, a failure to direct the vehicle may also render a person liable for driving offences.

2.66 To conclude, under the current law, the “essence of driving” is said to be the use of the driver's controls to direct the movement of the vehicle. However, the courts have taken a pragmatic approach, looking at both the facts of the case and the policy behind the statutory provision. In some cases, a failure to direct the movement of the vehicle may

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90 *R v MacDonagh* [1974] QB 448, 452.

91 1990 JC 146.

92 [1983] RTR 54.

93 In *Tyler v Whatmore* [1976] RTR 83, both the person in the passenger seat (who had both hands on the wheel) and the person sitting in the driving seat were held to have been driving. Similarly, a learner driver in the driving seat and an instructor with simultaneous control can both be drivers at the same time (*Langman v Valentine* [1952] 2 All E.R. 803).

94 [1983] RTR. 49.

be sufficient to incur liability for a driving offence. The definition of driving is clearly a flexible one which, without statutory reform, may be difficult to apply to driving automation.

2.67 Although the human in the driving seat is considered a driver when using a driver assistance system, the position is less clear for automated driving systems. In Chapter 7 we propose legislative clarification.

Chapter 3: Human factors

3.1 At present, human drivers are subject to a wide range of legal obligations. As we explore below, they must be qualified, fit to drive and not distracted from the driving task. A driver whose actions fall below the required standard may be held liable in both civil and criminal law. As driving automation increases, this will change. Some journeys will be completely automated from departure to arrival. The occupants will just be passengers, who may be unqualified or otherwise unfit to drive, with no responsibility for the safety of the vehicle. In other journeys, however, there may still need to be a human "in the loop", to take over from the automated driving system in certain circumstances.

3.2 In this chapter we consider the role of the human driver at various levels of automation. Drivers using driver assistance features currently on the market continue to be subject to all their existing obligations. However, this will change as vehicles become capable of "driving themselves". When should humans in the driving seat be entitled to undertake some non-driving related tasks, such as reading emails or watching a video? When should they cease to be liable in civil law for any accident that occurs, or in criminal law for an infraction of traffic law? And when is there no need to have a human in the driving seat at all?

3.3 These questions need to be informed by a rich body of research into human-machine interactions, often referred to as "human factors" (or ergonomics).[95] We summarise the main findings and consider their implications before addressing two policy issues:

(1) In what circumstances should automated vehicles be required to have a human user who is qualified and fit to drive? We tentatively propose a new category of user, who is not a driver while an automated driving system is engaged but who is able to drive if called on to do so. We refer to this person as the "user-in-charge".

(2) When should humans in the driving seat be permitted to engage in non-driving activities? One approach is to restrict such activities unless the automated driving system can achieve a minimal risk condition without human intervention. The other approach would be to allow some activities in conditionally automated vehicles,[96] provided that the user's attention is appropriately managed.

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95 The International Ergonomics Association defines ergonomics as: "the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design to optimize human well-being and overall system performance". https://www.iea.cc/whats/index.html.

96 SAE Level 3.

A DRIVER'S LEGAL OBLIGATIONS

3.4 There are many ways to categorise a driver's obligations. For the purposes of the current discussion, we have distinguished six broad categories relating to:

(1) Qualifications: for example, every driver of a motor vehicle must hold a driving permit.[97]

(2) Fitness to drive: for example, a driver has obligations to avoid the consumption of drugs or alcohol in excess of the legal limit.[98]

(3) Distractions: drivers must drive with due care and attention,[99] and minimise activities other than driving ("secondary activities").[100] Secondary activities occupy a spectrum. Some are largely prohibited for drivers (such as using a handheld mobile phone whilst driving,[101] or watching a televisual screen[102]). Some are tolerated, provided they do not cause the driver to drive carelessly or dangerously (such as eating and drinking).

(4) Civil liability: drivers are liable to compensate others for any harm caused by a breach of the standard of care they owe to other road users. To ensure that victims receive compensation, drivers must carry compulsory insurance.[103]

(5) Criminal liability for failures which arise directly out of the dynamic driving task: these cover both failures to meet standards (such as driving inconsiderately or dangerously) and breaches of specific road rules (such as driving in a bus lane or speeding).[104]

(6) Criminal liability which does not relate to the dynamic driving task: these cover requirements relating to insurance and maintenance,[105] as well as reporting accidents and ensuring that children wear seatbelts.

3.5 As automation develops, there will no longer be a human driver subject to all six categories of obligation. In this chapter, we consider the first three questions: when a

97 Road Traffic Act 1988, s 87. See also Art 41.1(a) of the Vienna Convention 1968.

98 Road Traffic Act 1988, s 4 and s 5.

99 Road Traffic Act 1988, s 3.

100 Art 8.6 of the Vienna Convention 1968.

101 Road Traffic Act 1988, s 41(d); and Road Vehicles (Construction and Use) Regulations 1986 SI No 1078, reg 110. In June 2018, reg 110 was amended to allow remote control parking through a hand-held device (reg 110(5A)).

102 Road Vehicles (Construction and Use) Regulations 1986 SI No 1078, reg 109 provides that vehicles should not be driven whilst a televisual screen is visible to a driver, except where that screen is there to display information about the state of the vehicle or its equipment or to assist the driver in some way.

103 For further discussion, see Ch 6.

104 These are discussed in Ch 7 and 9 and background papers 1, 1a and 2.

105 For example, offences of using an unroadworthy vehicle are to be found in Road Traffic Act 1988, ss 40A, 41B and 42. These offences, together with offences relating to insurance, reporting accidents and wearing seatbelts are discussed in detail in background papers 1 and 1a.

human user needs to be qualified and fit to drive, and how far they may engage in secondary activities. Issues of civil liability are discussed in Chapter 6 and criminal liability in Chapter 7.

LESSONS FROM "HUMAN FACTORS" RESEARCH

3.6 Research into the effect of automation within the aviation industry shows that pilots may over-rely on automation and lose skills in the process. This has raised fears about the capacity of pilots to supervise automated systems or to take over in an emergency.[106]

3.7 As we discuss in Appendix 3, human factors research has produced the following robust findings:

(1) People often find passive monitoring of a task more difficult than active engagement in it.[107] The less people are called on to do, the more likely they are to lose concentration and become drowsy, inattentive or distracted.[108]

(2) Passive monitoring is particularly difficult if people do not know what they are looking out for. The effects of monitoring fatigue can be partially offset by training about the purpose of the monitoring task.[109]

(3) After using machines for a while without incident, people tend to become over-confident. They will then rely on automation even if they are told that it is not safe to do so.[110]

(4) Conversely, if a machine generates too many false alarms, people will lose confidence in it. They may then fail to use it at all.[111]

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106 M Ebbatson, D Harris, J Huddlestone and R Sears, "The relationship between manual handling performance and recent flying experience in air transport pilots" (2010) 53:2 *Ergonomics* 268 DOI:10.1080/00140130903342349.

107 V Banks, A Eriksson, J O'Donoghue and N Stanton, "Is partially automated driving a bad idea? Observations from an on-road study" (2018) 68 Applied Ergonomics 138 DOI: 10.1016/j.apergo.2017.11.010; V Banks and N Stanton, "Analysis of driver roles: modelling the changing role of the driver in automated driving systems using EAST", (2017) 18 *Theoretical Issues in Ergonomics Science* 1 DOI: 10.1080/1463922X.2017.1305465.

108 Gesamtverband der Deutschen Versicherungswirtschaft eV (German Insurance Association), "Tiredness and level 3 – automated driving" (2017) 70 *Compact Accident Research* 4.

109 W Payre, J Cestac, N Dang, F Vienne and P Delhomme, "Impact of training and in-vehicle task performance on manual control recovery in an automated car" (2017) 46 *Transportation Research Part F Traffic Psychology and Behaviour* 216 DOI: 10.1016/j.trf.2017.02.001.

110 R Parasuraman and D Manzey, "Complacency and Bias in Human Use of Automation: An Attentional Integration" (2010) 52 *Human Factors* 381 DOI: 10.1177/0018720810376055. See for example, the National Transportation Safety Board's finding that the car driver's inattention due to overreliance on vehicle automation was a contributing factor to the fatal Tesla crash on 7 May 2016 near Williston, Florida, https://www.ntsb.gov/news/press-releases/Pages/PR20170912.aspx.

111 R Parasuraman and V Riley, "Humans and Automation: Use, Misuse, Disuse, Abuse" (1997) 39(2) *Human Factors* 230 DOI: 10.1518/001872097778543886.

3.8 Experience from consumer research also suggests that warnings seen simply as "legal disclaimers" are often ignored.[112] Once a warning is viewed as irrelevant, repeating it will not necessarily make it more effective.

3.9 Below we consider the implications of this research for the interaction between human users and automated driving systems at increasing levels of automation. We look first at driver assistance systems; then at conditional automation; then at highly automated driving systems.

Driver assistance systems

3.10 Driver assistance systems (also sometimes referred to as "ADAS"[113]) are designed to help a human driver perform the dynamic driving task rather than take over the driving completely. Examples currently on the market are cruise control (which helps maintain the vehicle's speed); adaptive cruise control (which additionally helps to maintain a safe distance from other vehicles) and lane assist (which assists the driver to keep the vehicle in lane). Some vehicles also offer lane changing assistance.

3.11 With some forms of driver assistance, the system operates both the steering and speed controls (referred to as lateral and longitudinal control).[114] This might give drivers the false impression that the vehicle is "driving itself". In fact, as a matter of both design and law, the system requires a human to monitor the vehicle's behaviour and the external environment. The human driver remains responsible for performing the driving task, including, crucially, object and event detection and response.[115]

3.12 Experience in aviation indicates that pilots tend to over-rely on automated features which have been used without incident over a period of time.[116] Further, pilots tend to

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112 For a discussion of consumer over-optimism in relation to products, and disregard of "the small print", see S Huck and J Zhou, "Consumer Behavioural Biases in Competition: a survey" (May 2011) Office of Fair Trading; S Della Vigna and U Malmendier, "Paying not to go to the Gym" (2006) 96(3) *American Economic Review* 694 DOI: 10.1257/aer.96.3.694. For judicial recognition that disclaimers may not be effective, in law and in practice, see *DPP v Saddington* [2001] RTR 15. This case concerned whether a Go-ped (a motorised scooter) was intended for use on public roads. The Go-ped was supplied together with a disclaimer stating that it was not intended for road use. Nonetheless, it was held:

> the conclusion must be that general use on the roads is to be contemplated. The distributors' advice not to use the Go-ped on the roads will in practice be ignored to a considerable extent (paragraph 20, per Pill LJ).

113 An acronym for advanced driver assistance systems.

114 In SAE terms, this is what distinguishes Level 2 from Level 1. SAE Level 2 systems can perform both lateral and longitudinal control and are referred to as "partial driving automation"; Level 1 systems can only perform *either* lateral or longitudinal control, but not both.

115 See para 2.8 to 2.10 and glossary.

116 Unite note that in commercial aviation two trained pilots need to be on board to supervise, and they raise the challenge of ensuring that drivers are alert; Unite, 'Electric Vehicles, Autonomous Technology and Future Mobility' (February 2018), p 23. See further: R Parasuraman and D Manzey, "Complacency and Bias in Human Use of Automation: An Attentional Integration" (2010) 53(3) *Human Factors* 381 DOI: 10.1177/0018720810376055; J Lee and K See, "Trust in Automation: Designing for Appropriate Reliance" (2004) 46(1) *Human Factors* 50 DOI: 10.1518/hfes.46.1.50_30392.

overlook system limitations.[117] If these behaviours are seen in highly trained pilots, non-professional car drivers may be even more prone to error. A graphic illustration of this occurred recently when a driver on an English motorway moved into the passenger seat with his driver assistance system set to propel the car at 40 miles per hour.[118]

3.13 The challenge is how to ensure that drivers resist the over-confidence which results from the extended use of technology without mishap.[119] They also need to understand the limitations of the system, so as to know what they are looking for when monitoring.[120] It may be, for example, that a lane keeping function cannot steer around a parked emergency vehicle partially blocking a lane, or that adaptive cruise control cannot always gauge the speed of a motorcycle in front. If so, these crucial limitations need to be spelled out to drivers in a clear, accessible way.

3.14 One added complication is that several driver assistance features may be engaged at any one time: for example, adaptive cruise control may be used in combination with lane keeping assistance and lane changing assistance. Taken together, the three features may appear to be one self-driving system. However, as a recent research report emphasised, each feature may have a different operational design domain,[121] producing a "complex array of conditionality".[122]

3.15 At present, the main sources of information for drivers about system limitations are marketing, test drives and the user's manual. In Chapter 5 we consider whether more should be done to regulate marketing and consumer information to ensure that consumers understand the limitations of the systems they are using.[123] We also consider the possibility of additional training for drivers using driver assistance systems.[124] In Chapter 5 we conclude with proposals to monitor the safety of drivers operating with driver assistance systems to ensure that they are at least as safe as conventional drivers.

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117 R Parasuraman and V Riley, "Humans and Automation: Use, Misuse, Disuse, Abuse" (1997) 39(2) *Human Factors* 230 DOI: 10.1518/001872097778543886.

118 In April 2018, the driver pleaded guilty to dangerous driving, commenting that he was "the unlucky one who got caught". He was disqualified from driving for 18 months and sentenced to 100 hours community service: https://www.bbc.co.uk/news/uk-england-beds-bucks-herts-43934504.

119 R Parasuraman and D Manzey, "Complacency and Bias in Human Use of Automation: An Attentional Integration" (2010) 53(3) *Human Factors* 381 DOI: 10.1177/0018720810376055. See feedback loop diagram in Appendix 3.

120 Thatcham Research and Association of British Insurers, "Assisted and Automated Driving Definitions – Technical Assessment" (2018), p 12.

121 For a definition of "operational design domain", see glossary and discussion at paras 2.25 to 2.28.

122 B Seppelt, B Reimer, L Angell and S Seaman, "Considering the human across levels of automation: implications for reliance" (2017) *Proceedings of the 9th International Driving Symposium on Human Factors in Driving Assessment, Training and Vehicle Design* 228. This looks specifically at the features forming the combined Tesla Autopilot system.

123 See para 5.7 to 5.12.

124 Requirements for driving tests generally may also be reconsidered, to update them in light of new technologies changing vehicle functionalities. We discuss updating driver licensing requirements further below. See paras 5.39 to 5.55.

Conditional automation

3.16 In conditionally automated driving systems (SAE Level 3), technical responsibility for "monitoring" the driving environment is delegated to the automated driving system. However, responsibility for being "receptive" to a request to intervene rests upon a human, referred to as the "fallback-ready user".[125]

3.17 The SAE explain that receptivity refers to "a person's ability to reliably and appropriately focus his/her attention in response to a stimulus".[126] This contrasts with "monitoring", which involves sensing and processing information necessary for the safe operation of the vehicle. However, the distinction is a fine one. It is problematic for three reasons.

(1) Users are not simply expected to be "receptive" to a request to intervene issued by the automated driving system. They must also be "receptive" to other stimuli, even if there is no request to intervene. The SAE mention responding to an "evident" system failure, such as a broken suspension component, which would provide "ample kinaesthetic feedback".[127] It is not easy to define in advance the range of stimuli which users must be able to perceive.

(2) A fallback-ready user who has received a request to intervene must respond quickly, possibly within seconds and possibly in circumstances of imminent danger. They need to be sufficiently alert to gain an immediate awareness of environment. This will include the traffic ahead and behind, the nature of the road (for example, one way or two), its speed limit and any vulnerable road users in the vicinity. Even more problematically, they may also need to be aware of any hazards specified in road signs that have already been passed.

(3) The system requires a human fallback to intervene to ensure road safety. Unlike a highly automated driving system,[128] an SAE Level 3 system is not able to achieve a "minimal risk condition".[129] This means that any failure by a human user to resume the dynamic driving task may be dangerous. Similarly, severe consequences can flow from resuming the dynamic driving task but then not driving in an appropriate way.

3.18 The SAE requires that a request to intervene must be "timely",[130] to allow the fallback-ready user to "resume operation of the vehicle in an orderly manner".[131] As Bryan Reimer, a human factors expert at MIT, emphasised to us, this assumes that the conditionally automated driving system is good enough to recognize the need for intervention, alert the user, and continue driving for enough time for the user to be able to take over the controls. However, at the same time, it envisages that this system's

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125 See Society of Automotive Engineers, "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles" J3016 JUN2018 (SAE J3016 (June 2018)).

126 SAE J3016 (June 2018) para 3.23.

127 SAE J3016 (June 2018).

128 SAE Level 4.

129 As discussion at para 2.16 to 2.20, this is a term of art defined in SAE J3016 (2018).

130 SAE J3016 (June 2018) Table 2.

131 SAE J3016 (June 2018) para 3.18, example 2.

technology lacks the ability to achieve a minimal risk condition. In practice, this may be rare.

3.19 We note that conditional automation is not covered by the UNECE Resolution on the deployment of highly and fully automated vehicles. Any future deployment of conditionally automated vehicles is likely to be limited to more predictable environments and lower speeds, such as a system to handle traffic jams on motorways.[132] In other circumstances, it is difficult to see how a user could gain situational awareness sufficiently quickly to avert an accident, unless they were already monitoring the environment.[133]

Highly automated driving systems

3.20 The UNECE Resolution on the deployment of highly and fully automated vehicles defines a "highly automated vehicle" as:

> a vehicle equipped with an automated driving system. This automated driving system operates within a specific operational design domain for some or all of the journey, without the need for human intervention as a fall-back to ensure road safety.[134]

3.21 Highly automated vehicles[135] have two main distinguishing characteristics:

(1) unlike fully automated vehicles,[136] they have a restricted operational design domain; and

(2) unlike conditionally automated vehicles,[137] human intervention is not critical to safety. Instead the systems can achieve a minimal risk condition if they move out of their operational design domain or the system fails.

3.22 As discussed in Chapter 2, the SAE levels do not specify what the minimal risk condition must be. The report simply gives examples of possible minimal risk conditions, which might range from stopping in lane to limping home.[138] The UNECE Resolution on the deployment of highly and fully automated vehicles does not refer to a "minimal risk condition" as such. Instead it recommends that automated driving systems should "be

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132 As discussed in Ch 2, motorways are more predictable because they have a separation from oncoming traffic and no vulnerable road users, such as pedestrians or cyclists. A system limited to traffic jams can operate at lower speeds.

133 B Seppelt, S Seaman, J Lee, L Angell, B Mehler and B Reimer, "Glass Half-full: Use of On-road Glance Metrics to Differentiate Crashes from Near-crashes in the 100-car Data" (2017) 107 *Accident Analysis and Prevention* 48 DOI: 10.1016/j.aap.2017.07.021.

134 UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), *Report of the Global Forum for Road Traffic Safety on its seventy-seventh session* ECE/TRANS/WP.1/165 Annex 1, para 3(d).

135 SAE Level 4.

136 SAE Level 5.

137 SAE Level 3.

138 SAE J3016 (2018), Para 3.17, note 3.

capable of achieving a state that maximises road safety when a given trip cannot or should not be completed".[139]

3.23 At least at the initial stages of automation, minimal risk conditions may not be perfect. They may still involve heightened risk to other road users.[140] A tendency for vehicles to stop unexpectedly, or very quickly, in situations when the system fails or exits its operational design domain can increase the danger of rear-end collisions, particularly with conventional vehicles.[141] It may also disrupt traffic flow. Below we consider proposals to encourage a smooth handover to a human driver who is able to handle the situation.

A NEW ROLE IN DRIVING AUTOMATION: THE "USER-IN-CHARGE"

A vehicle that can "safely drive itself"

3.24 The concept of a user-in-charge would apply to a vehicle that can safely drive itself, but may require a handover if the vehicle leaves its operational design domain.

3.25 As we outlined in Chapter 2, the UK Government has legislated for a new form of civil liability where vehicles are "driving themselves". Under section 1 of the Automated and Electric Vehicles Act 2018, the Secretary of State must prepare a list of motor vehicles that are "in the Secretary of State's opinion" capable "of safely driving themselves". The text of this provision is set out at paragraph 2.55. Government policy is that only vehicles which can achieve a minimal risk condition will be listed.[142] Put simply, in the case of system failure, the vehicle must be capable of coming to a safe stop.

3.26 The legislation only requires listed systems to be capable of driving themselves in "some circumstances or situations". Thus the category does not require the vehicle to be capable of driving itself for the whole journey. Some vehicles may hand over responsibility for driving to the human and this may be planned or unplanned. Below we consider a possible legal framework for the respective roles of humans and automated driving systems before and after such a handover.

A "user-in-charge"

3.27 We tentatively propose a new category of user, who we have labelled the "user-in-charge". The user-in-charge would not be a driver whilst the automated driving system was in operation but must be qualified and fit to drive. Their main role would be to take over in planned circumstances or after the vehicle has achieved a minimal risk condition and has come to a stop. As we discuss in Chapter 7, the user-in-charge would also bear criminal liabilities for offences which do not arise from the dynamic driving task, such as

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139 UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), Report of the Global Forum for Road Traffic Safety on its seventy-seventh session ECE/TRANS/WP.1/165 Annex 1, para 4(f).

140 Too many stopped vehicles could also have adverse effects on emergency services or roadside assistance access to other drivers.

141 E Straub and K Schaefer, "It takes two to Tango: Automated vehicles and human beings do the dance of driving – Four social considerations for policy" (2018) *Transportation Research Part A* at p 5 DOI: 10.1016/j.tra.2018.03.005.

142 See para 2.56.

those relating to insurance and maintenance,[143] reporting accidents and ensuring that children wear seatbelts.

3.28 A "user-in-charge" differs from the SAE category of "fallback-ready user". To ensure safety, a fallback-ready user is required to take over driving a moving vehicle at short notice. By contrast, the concept of a user-in-charge would only apply where the vehicles is able to achieve a minimal risk condition on its own. Thus a user-in-charge would not be required to take over driving in urgent circumstances while the vehicle is moving, as recent research has shown how problematic that can be.[144]

3.29 We envisage that, at least initially, some highly automated driving systems will be confined to motorways.[145] In such cases, a human driver would need to drive the vehicle to the motorway. The human would then be required to remain ready to drive again when the planned exit is reached. While on the motorway, the human in the driving seat would not be driving, but we think that they should remain fit to drive while the system is engaged. For example, in Chapter 7 we propose that it should be a criminal offence for a user-in-charge to take alcohol or drugs so as to impair their fitness to drive.

3.30 However, the need for a user-in-charge is not confined to motorway-only systems. Even if the whole planned route could be completed without a human driver, there are still advantages to having a user who can drive in the vehicle. Planned routes can alter due to unforeseen events; weather can change; and systems can fail. It is true that in such circumstances, the vehicle would achieve a minimal risk condition - but this may be far from ideal. For example, on a trunk route, the vehicle may come to a halt on double red lines, causing traffic congestion. Users in the car may be tempted to take over driving, to avoid being stranded in an inconvenient place. The cautious approach would be to require that there is a person qualified and fit to complete the journey.

3.31 We tentatively propose that it should be a general requirement for automated vehicles to have a user-in-charge in a position to operate the controls, unless the vehicle is specifically authorised as able to function without one.

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143 For example, offences of using an unroadworthy vehicle are to be found in Road Traffic Act 1988, ss 40A, 41B and 42. These offences, together with offences relating to insurance, reporting accidents and wearing seatbelts are discussed in detail in background papers 1 and 1a.

144 V Banks, A Eriksson, J O'Donoghue and N Stanton, "Is partially automated driving a bad idea? Observations from an on-road study" (2018) 68 *Applied Ergonomics* 138 DOI: 10.1016/j.apergo.2017.11.010; V Banks and N Stanton, "Analysis of driver roles: modelling the changing role of the driver in automated driving systems using EAST" (2017) 18 *Theoretical Issues in Ergonomics Science* 1 DOI: 10.1080/1463922X.2017.1305465. The existing evidence shows that humans find taking over moving vehicles difficult, but we do not yet know whether it is so dangerous that it should be actively discouraged or even prevented. Our intention is that once the category of "user-in-charge" is established, the law on handovers could be adjusted in the light of further knowledge.

145 See, for example, the projected implementation of "highway" based driving features in ERTRAC's *Automated Driving Roadmap* (2015) https://www.ertrac.org/uploads/documentsearch/id38/ERTRAC_Automated-Driving-2015.pdf. There have also been proposals at UNECE level to limit some categories of automatically commanded steering functions (ACSF), to roads that have "physical separation that divides the traffic moving in opposite directions and have at least two lanes in the direction that the vehicles are driving". See proposed para 5.6.4.2.3 in the UNECE document ECE/TRANS/WP.29/2018/35.

3.32 In Chapter 7 we consider how the user-in-charge would be identified. Initially, being in position to operate the controls will be tantamount to being in the driving seat. However, as the design of vehicles changes, the concept of a "driving seat" will change, with a wider variety of controls, including those operated from outside the vehicle.[146] Remote parking features already allow a driver to park a car from outside the vehicle using a handheld device,[147] and the law has been modified to accommodate this.[148] Further developments are likely in the future. We intend to look at the particular challenges of remote operation in a later paper.

3.33 At paragraphs 3.59 to 3.77 below, we discuss circumstances where a user-in-charge may not be needed (such as where the journey is provided as a service by a fleet operator or the vehicle is specifically designed for those unable to drive).

The role of a "user-in-charge"

3.34 The central element of a user-in-charge is that they must be capable of taking over the driving task in planned circumstances or after the vehicle has achieved a minimal risk condition. They must therefore be qualified and fit to drive.[149] They must, for example, hold the appropriate licence, not be unfit to drive through drink or drugs or have a blood alcohol level over the prescribed limit. If they need glasses to drive, they must have their glasses to hand.[150]

3.35 However, crucially, the user-in-charge is not a driver. When the automated driving system is engaged, the user would be entitled to undertake secondary activities and would not be responsible for the dynamic driving task. Instead, this would be controlled by an automated driving system. It is interesting to compare this role with that of a supervisor of a learner driver. A user-in-charge is not a supervisor: they must be able to take over from the automated driving system, rather than to supervise it. However, in legal terms, there are some similarities. A supervisor must hold a relevant licence,[151] but is not considered to be driving unless they take control.[152]

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146 As we discuss below, it is likely that new forms of remote control will develop.

147 BMW, *Intelligent parking*, https://www.bmw.co.uk/bmw-ownership/connecteddrive/driver-assistance/intelligent-parking.

148 Changes have been made to the Highway Code and the Road Vehicles (Construction and Use) Regulations 1986 reg 110, and are planned to the Highway Code, to allow parking through a hand-held device, https://www.gov.uk/government/consultations/remote-control-parking-and-motorway-assist-proposals-for-amending-regulations-and-the-highway-code. However, the operator must still be within six metres of the vehicle when operating the car by such a function.

149 This reflects aspects of the policy in the UNECE Resolution on the deployment of highly and fully automated vehicles, para 5(d), which requires that if a vehicle user is required to exercise dynamic control, they should hold the necessary driving permit(s). UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), Report of the Global Forum for Road Traffic Safety on its seventy-seventh session ECE/TRANS/WP.1/165 Annex 1.

150 For a full discussion of offences relating to the condition of the driver, see background paper 1.

151 Motor Vehicles (Driving Licences) Regulations 1999 SI No 2864, reg 17.

152 In *Langman v Valentine* [1952] 2 All ER 803, the supervisor was considered a driver because he had control of the vehicle, with one hand on the steering wheel and one on the handbrake. He would not have been considered a driver simply from his status as supervisor in the absence of actual control.

Moving from human to system: new civil and criminal liabilities

3.36 When an automated driving system is engaged, civil and criminal liabilities on the driver would be replaced by new legal provisions. We discuss civil liability in Chapter 6. Under section 2(1) of the Automated and Electric Vehicles Act 2018, where an accident is caused while a listed automated vehicle is driving itself, the insurer is directly liable for any damage caused. The insurer may recover damages from another party at fault, such as the manufacturer.

3.37 We discuss criminal liability in Chapter 7. We ask how to deal with infringements of road rules and standards which take place while an automated vehicle is driving itself. We think that such infringements should be seen as early warnings of possible broader failures. Such infringements should be investigated. Where the automated driving system is found deficient, we tentatively propose that there should be a system of regulatory sanctions against the automated driving system entity.[153]

3.38 This leaves the question of how to allocate responsibility for maintaining and insuring vehicles which are "driving themselves". At present these responsibilities rest with the person who "uses the vehicle", though the courts have tended to interpret the term "user" to mean driver.[154] In Chapter 7 we tentatively propose that these responsibilities should rest with the user-in-charge.

The handover

3.39 Following a handover, the user-in-charge would become a driver, with all the responsibilities of a driver. From this point, the driver would be subject to the same distraction laws as any other driver, and would be liable in civil and criminal law for any infringements of road rules or standards.[155] Human factors research can inform ways of the type and timing of the handover, to effectively prepare the user to control the vehicle.

3.40 The Association of British Insurers (ABI) has suggested the need for transfer of driving control to comply with a clear "offer and confirm" requirement, whereby any request to hand over the driving task should only be effective upon confirmation by the human driver.[156] Subject to issues about "blame time" (discussed below), we think this would provide helpful clarity about who is driving at any given time. We seek views.

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153 For further explanation about the automated driving system entity, see paras 4.107 to 4.109.

154 For further discussion, see background paper 1.

155 This reflects aspects of the policy in the UNECE Resolution on the deployment of highly and fully automated vehicles, para 5(d), that a vehicle user who exercises dynamic control should comply with traffic rules. UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), Report of the Global Forum for Road Traffic Safety on its seventy-seventh session ECE/TRANS/WP.1/165 Annex 1.

156 The ABI argue strongly that only vehicles at SAE Level 4 which can achieve a minimal risk condition should be listed as able to drive themselves, so the handover must be seen in that context: See ABI, *Assisted and Automated Driving, Technical Assessment, Thatcham Research* (June 2018), http://www.mynewsdesk.com/uk/thatcham-research/documents/thatcham-research-assisted-and-automated-driving-definitions-technical-assessment-79493.

"Blame time"

3.41 One complication is that an accident might be caused by events preceding a handover, even though the accident takes place following a handover. This can be illustrated with an example:

> While in self-driving mode, an automated vehicle mistakenly turns into a one-way street in the wrong direction. A human takes over, but is unable to avoid a collision.

3.42 In such cases, it would seem fair for responsibility for the outcome to rest with the automated driving system. This extension of responsibility has been called "blame time".[157]

3.43 In the US, the draft Uniform State Laws deems that the automated driving system continues to perform the entire dynamic driving task "until a human driver or operator terminates the performance". However, if a human driver terminates the performance to mitigate a crash hazard caused by the automated driving system, "automated operation continues until the crash hazard is no longer present".[158] Below we ask if the UK should adopt a similar approach.

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157 S Shalev-Shwartz, S Shammah and A Shashua, Mobileye, "On a Formal Model of Safe and Scalable Self-Driving Cars" *arXiv* (2017), https://arxiv.org/abs/1708.06374.

158 See Uniform Law Commission, Drafting Committee on Highly Automated Vehicles Act, 2018 Annual meeting draft, section 2(4). http://www.uniformlaws.org/shared/docs/highly%20automated%20vehicles/2018oct_HAVA_Mtg%20Draft_ADA.pdf.

Consultation Question 1.

3.44 Do you agree that:

(1) All vehicles which "drive themselves" within the meaning of the Automated and Electric Vehicles Act 2018 should have a user-in-charge in a position to operate the controls, unless the vehicle is specifically authorised as able to function safely without one?

(2) The user-in-charge:

(a) must be qualified and fit to drive;

(b) would not be a driver for purposes of civil and criminal law while the automated driving system is engaged; but

(c) would assume the responsibilities of a driver after confirming that they are taking over the controls, subject to the exception in (3) below?

(3) If the user-in-charge takes control to mitigate a risk of accident caused by the automated driving system, the vehicle should still be considered to be driving itself if the user-in-charge fails to prevent the accident?

The term "user-in-charge"

3.45 The term "user-in-charge" is simply a label. It indicates that while an automated driving system is correctly engaged, the person in the driving seat is not a driver. However, the person would have the responsibilities which would apply to "users" and to those "in charge" of a motor vehicle under current road traffic legislation. It would have been possible to use other labels for the concept (such as "lead user", "responsible user" or "driving-able user"). We welcome views on whether the term adequately conveys the meaning we intend it to have.

Consultation Question 2.

3.46 We seek views on whether the label "user-in-charge" conveys its intended meaning.

Should the user-in-charge be under any responsibility to avoid an accident?

3.47 The starting point is that while a vehicle is driving itself, with the automated driving system appropriately engaged, the user-in-charge would not be in control of the vehicle. They would not be responsible for any problems arising from how the vehicle is driven.

3.48 We seek views on whether there should be an exception to this principle. The exception would place a residual responsibility on a user-in-charge to take reasonable steps to avert a risk of serious injury if they are actually aware of that risk. As discussed below, we see both advantages and disadvantages to such an exception.

Reasons for the exception

3.49 The rationale is that in some situations an effective intervention could prevent an accident. An example might be where a car edges forward through pedestrians, unaware that a casualty is lying on the ground under its path. If bystanders are shouting at the car to stop, and the user-in-charge is clearly aware of the problem, it would seem wrong for the user-in-charge to do nothing.

3.50 Imposing liability in these circumstances would appear compatible with broader principles of criminal law. Ashworth argues that it may be justifiable to impose criminal liability for an omission where life is endangered, the situation is urgent or the defendant has a special capacity to intervene.[159] In this example, all three requirements are met. First, the life of the casualty is endangered. Secondly, the situation is urgent because the car is about to run over the casualty. Thirdly, the user-in-charge has a special capacity to intervene because they are qualified and sober and near the controls.

3.51 Similar arguments might apply in other cases. For example, the user-in-charge may become aware that the automated driving system is malfunctioning (for example, that it is keeping dangerously close to the vehicle in front, veering between lanes or straddling white lines). Vehicles may conceivably be fitted with an alarm to alert the user-in-charge to a system malfunction or failure. It has been put to us that if safety is paramount. It would be wrong for a user-in-charge who is aware of a risk of serious injury to do nothing.

The limitation to subjective awareness

3.52 The proposed exception would only apply if the driver was subjectively aware of a risk of serious injury.[160] This does not mean that the defendant must admit awareness of the risk: the jury may infer awareness from all the circumstances**.**[161] In *G,* Lord Bingham stated:

> It is not to be supposed that the tribunal of fact will accept a defendant's assertion that he never thought of a certain risk when all the circumstances and probabilities and evidence of what he did and said at the time show that he did or must have done.[162]

3.53 However, there is a difference between deciding that the defendant *must* have been aware of a risk and that the defendant *should* have been aware of the risk. Crosby highlights that the subjective approach is a "narrow" form of liability, "based solely upon whether, as a question of fact, the accused foresaw the risk of harm".[163] If jurors accept

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159 A Ashworth, *Positive Obligations in Criminal Law* (1st ed 2013) p 79.

160 The difference between subjective and objective awareness is explored in *R v Cunningham* (1957) 41 Cr App Rep 155; *R v G* [2003] UKHL 50, [2004] 1 AC 1034; *R v Parker* [1977] 2 All ER 37*; R v Briggs* [1977] 1 All ER 475*;* and *R v Stephenson* [1979] QB 695 at 704.

161 D Ormerod and K Laird, *Smith, Hogan and Ormerod's Criminal Law* (15th ed 2018) p 102.

162 *R v G* [2003] UKHL 50, para 39.

163 C Crosby, "Recklessness – the continuing search for a definition" (2008) 72 *Journal of Criminal Law* 313, p 314.

that the defendant did not foresee the risk, they must acquit, even where they think that the defendant should have foreseen the risk.

Reasons against the exception

3.54 The issue is controversial. One concern is that discussion about what a user-in-charge *must* have known could slip into a discussion about what a user-in-charge *should* have known. This risks blurring lines of responsibility. For fully-automated vehicles, humans are not critical to safety. Instead, developers need to ensure that their automated driving systems are safe. Any suggestion that a human should intervene might reduce the importance of this principle and risks treating a self-driving SAE Level 4 system as if it were only conditionally automated, at SAE Level 3.

3.55 The role of user-in-charge only applies where vehicles are driving themselves at SAE Level 4. It is important to emphasise that at this level of automation, users are not required to monitor their environment. As we have seen, human factors research shows clearly that when people are not actively engaged in a task they find passive monitoring extremely difficult. We would not wish to introduce laws which encouraged developers or others to think that systems did not need to be fully safe because the user-in-charge would intervene in extreme cases.

3.56 A second concern is that, in many cases, users-in-charge will lack the situational awareness to intervene effectively in an emergency. Their attempts to do so may make the situation worse. We would not be wish encourage unnecessary and potentially dangerous interventions.

3.57 Overall, the issue is finely balanced. We invite views.

Consultation Question 3.

3.58 We seek views on whether it should be a criminal offence for a user-in-charge who is subjectively aware of a risk of serious injury to fail to take reasonable steps to avert that risk.

WHEN WOULD A USER-IN-CHARGE NOT BE NECESSARY?

3.59 Many of the benefits of driving automation only arise when vehicles are able to travel empty, or with occupants who are simply passengers. Passenger-only vehicles would bring the benefits of automation to many more people, including those unable to drive for reasons of age or disability. Further, many advantages flow from vehicles which are able to drive empty. This is obvious for delivery vehicles. Even in the passenger market, travelling empty would allow much greater use of vehicles, which could move seamlessly from one customer to another.

3.60 On the other hand, there are challenges to overcome before vehicles can operate smoothly without anyone able to assume control. To take an obvious example: operational design domains may be weather limited. This means that there needs to be a system for dealing with unexpected weather conditions, or to anticipate such conditions and prevent vehicles from being used. Diversions are also a challenge, such as where a police officer directs vehicles to cross a white line. Can the automated driving system recognise a police officer, understand their directions, and overcome its inbuilt prohibition on crossing such a line? Before a vehicle can be classified as capable of safely driving itself without a user-in-charge, the appropriate authority would need to be satisfied that these challenges can be met.

3.61 Below we consider some of the circumstances where it may not be necessary to have a user-in-charge of the vehicle. We tentatively propose new and flexible powers to approve automated vehicles as able to operate without users-in-charge, when new technologies become available.

Journeys supplied by licensed operators

3.62 In Chapter 2 we distinguished between two development paths: the "something everywhere" path, where vehicles are sold to private individuals, and "everything somewhere" path, where the emphasis is on supplying a journey rather than a vehicle.[164] This emphasis on providing a journey is often referred to as "Mobility as a Service".

3.63 At present, supplying journeys is a highly regulated activity. Operators must be licensed as providing either taxis, private hire vehicles or public service vehicles. Each of these licences includes requirements related to drivers, to vehicles and to the way that vehicles are maintained. In our next consultation paper, the Law Commissions will consider how these licensing arrangements should be adapted to the new challenges of automated vehicles.

3.64 Where automated vehicles are operated by a licensed entity, it may well be possible to take measures to deal with the problems which might arise in the absence of a user-in-charge. For example, the licence could impose requirements to maintain and update the vehicles and ensure that vehicles do not exceed their operational design domains. Licensing requirements could also operate flexibly to deal with teething problems as they arise. Take the following hypothetical example:

> All the automated vehicles of a particular type within a city break down on the same day, after a flurry of "the wrong sort of snow". This causes widespread traffic disruption.

3.65 It could be a condition of the licence that the operator takes measures to resolve any disruptions to traffic flow. For example, licensed operators could be required to rescue vehicles from the side of the road and to send other vehicles to enable passengers to reach their destinations. Licensed operators could also be required to stop the problem from happening again. In this case, having learnt from the experience, the operator might ensure that it obtains targeted weather warnings so that appropriate precautions are taken on predicted snow days.

3.66 Licensed operators could also make use of remote surveillance to deal with diversions. For example, Nissan is working on a system to allow an operator to oversee several vehicles at once. Nissan envisage that where an automated vehicle encounters a police

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164 See paras 2.39 to 2.47.

officer directing traffic following an accident, it would stop itself and request help from its command centre. A human in the command centre would receive livestreamed video footage from the car and could direct the vehicle's actions.[165]

3.67 These features address many of the concerns about vehicles operating without a user-in-charge. We envisage that if an operator was licenced to provide journeys in automated vehicles, it would not be required to have a user-in-charge of the vehicle.

Valet parking

3.68 The idea behind "valet parking" is that a vehicle would drop off its users at their destination and subsequently park itself, replicating the effect of a traditional valet parking service.

3.69 The term is used to describe a variety of different approaches. Some systems work on infrastructure installed at the parking garage. For example, Daimler and Bosch have developed a system in which the garage infrastructure can communicate with the car to "drive" it to an available parking space.[166] This approach means that cars may be able to use the systems even if they could not drive themselves in other circumstances.[167]

3.70 Other systems rely on the automated features within the vehicle rather than the garage. For example, Volkswagen is testing an autonomous parking feature at Hamburg Airport with the eventual goal of developing a vehicle which can park itself in any parking area.[168] Other companies are involved in projects to supply vehicles with information about parking spaces that might be available.[169]

3.71 These different systems raise distinct legal issues. Where the vehicle is driving itself using infrastructure installed within a private controlled space (to which the public does not have access), normal road rules would not apply. If an accident were to occur, neither the user nor the vehicle's insurer would be liable.[170] Instead, a claim would appear to lie against the garage under the Occupiers Liability Act 1984 in England and Wales or the Occupiers Liability (Scotland) Act 1960. However, road rules would apply

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165 A Davies, 'Nissan's Path to Self-Driving Cars? Humans in Call Centres' (May 2017), https://www.wired.com/2017/01/nissans-self-driving-teleoperation/.

166 The system has been tested at the Mercedes-Benz museum in Stuttgart since 17 August 2017. See https://www.bosch-mobility-solutions.com/media/global/highlights/automated-mobility/automated-valet-parking/avp_infografik-2.pdf.

167 Bosch state that all the vehicle needs is an automatic transmission, electronic stability control, an electric parking brake and steering, engine start/stop, and onboard connectivity See. https://www.bosch-mobility-solutions.com/media/global/highlights/automated-mobility/automated-valet-parking/avp_infografik-2.pdf.

168 According to Volkswagen, cars operating without a driver will have their own, separate traffic flow at first, using map data and visual cues to orient themselves and navigate. Data from sensors will be processed by the car via a central unit. Notably, Volkswagen does not use the term "valet parking" to describe this system. See https://www.volkswagenag.com/en/media/volkswagen-group-media-services/2018/04/autonomous-parking-ready-for-series-vehicles.html.

169 See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/725522/ccav-research-and-development-projects.pdf, p 55.

170 Note that section 2(1) of the Automated and Electric Vehicles Act 2018 only applies where an automated vehicle is driving itself "on a road or other public place in Great Britain".

if a vehicle drops its users off and then uses public roads to reach the relevant car park. Here the vehicle would need to be able to deal with all the challenges of a public road. In our view, the vehicle would need to be authorised to allow it to proceed without a user-in-charge.

"ADS-Dedicated vehicles"

3.72 Several companies have expressed an interest in developing vehicles which cannot be operated by a human driver.[171] The SAE refer to such vehicles as "ADS-dedicated vehicles".[172] Such a vehicle may lack the in-vehicle driving controls used by human drivers, such as steering wheels and brake pedals (although it may have other human-machine interfaces to allow for different forms of input). In such vehicles, the risk of a non-qualified person in the vehicle taking over the dynamic driving task is negligible, by design. Such vehicles might bring particular benefits to those unable to drive by reasons for disability.

Privately-owned vehicles

3.73 The benefits of full driving automation need not be confined to "Mobility as a Service". We appreciate the desire that these benefits should also be available to those who wish to own their vehicles.

3.74 Again, there may be new ways to accommodate the needs of those who wish to own vehicles that can travel without a user-in-charge. One possibility might be to require owners to contract with a service provider who would perform some of the same functions as licensed operators. For example, the service provider could ensure that vehicles are properly maintained and updated and could issue targeted weather warnings to ensure the operational design domain is not exceeded. A service provider could also supervise empty vehicles remotely and provide speedy break-down services to tow vehicles that have stopped.

3.75 We welcome other suggestions to address issues that might arise if consumer-owned vehicles which do not have a user-in-charge come to an unplanned stop by the side of the road.

Conclusion

3.76 It is not possible to specify hard and fast rules about when automated driving systems can operate safely and effectively in the absence of a user-in-charge. We have listed some possibilities. There are likely to be many more which have not been discussed.

3.77 At this stage, we would suggest new and flexible powers to authorise safe and effective systems as they become available. We discuss how such an authorisation system might operate in Chapter 4.

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171 See for example Waymo; D Welch and E Behrmann Bloomberg, "In self-driving car race, Waymo leads traditional automakers", (Automotive News Europe, 8 May 2018), http://europe.autonews.com/article/20180508/ANE/180509829/in-self-driving-car-race-waymo-leads-traditional-automakers.

172 Automated Driving System Dedicated Vehicles. The SAE refer to "a vehicle designed to be operated exclusively by a level 4 or level 5 [automated driving system] for all trips within its given [operational design domain] limitations (if any)" as a "dedicated" automated driving system vehicle: see SAE 2018, section 3.3.

Consultation Question 4.

3.78 We seek views on how automated driving systems can operate safely and effectively in the absence of a user-in-charge.

Consultation Question 5.

3.79 Do you agree that powers should be made available to approve automated vehicles as able to operate without a user-in-charge?

WHEN SHOULD SECONDARY ACTIVITIES BE PERMITTED?

3.80 Here we consider when a human user should be allowed to engage in secondary activities, such as looking at a screen, while the automated vehicle is driving itself.

3.81 It is tempting to see this question in terms of SAE Levels: should secondary activities be allowed at conditional automation (SAE Level 3) or only for high automation (SAE Level 4)? In practice, whether an automated driving system is safe enough to allow the human to carry out other activities will depend on many factors. These include the reliability of the system; how often and how predictably the operational design domain is exceeded; and the timing and nature of a request to intervene. However, a crucial question is whether the automated driving system can achieve a minimal risk condition without human intervention, or whether it needs human intervention to ensure safety.

International discussions

3.82 Article 8.6 of the Vienna Convention 1968 states that "a driver of a vehicle shall at all times minimise any activity other than driving". The question of how this should be interpreted has been considered by Working Party 1 of the UN's Global Forum for Road Traffic Safety (WP1). WP1 has endorsed the following interpretation:

> When the vehicle is driven by vehicle systems that do not require the driver to perform the driving task, the driver can engage in activities other than driving as long as:
>
> Principle 1: these activities do not prevent the driver from responding to demands from the vehicle systems for taking over the driving task, and
>
> Principle 2: these activities are consistent with the prescribed use of the vehicle systems and their defined functions.

3.83 WP1 and its expert sub-committee[173] are still discussing what sort of activities would deliver the outcomes sought by these principles. The international association for the

[173] The WP1 Informal Group of Experts on Automated Driving (IGEAD).

automotive industry, OICA,[174] has suggested that a driver may be able to use "infotainment" systems via a "vehicle integrated communication display". The display is controlled by the automated driving system so that, in the event of a take-over request, secondary activities terminate automatically. However, many contracting parties have expressed concerns that such systems are not necessarily safe.

Only if the system can achieve a minimal risk condition?

3.84 One approach to this issue would be to restrict secondary activities unless the vehicle can achieve a minimal risk condition without human intervention. Effectively, this would require drivers to treat SAE Level 3 as a form of driver assistance. Unless an automated driving system can come to a safe stop without human intervention, the human driver would be responsible for monitoring the environment at all times.

3.85 This is the ABI-preferred approach, as discussed in Chapter 2.[175] It provides a clear, simple rule: unless self-driving technology operates at higher levels of automation, drivers would retain all their current duties, under both civil and criminal law. The advantage of this approach is its emphasis on clarity and safety.

3.86 However, this approach has potential problems. With sophisticated Level 3 systems, human drivers have very little to do - and the less humans do, the more their minds wander. The concern is that drivers will daydream or fall asleep, despite warnings to the contrary.[176] A growing body of research suggests that focus should shift from viewing secondary activities simply as distractions to a more active approach to drivers' attention management.[177] In other words, drivers should be encouraged to undertake tasks which are appropriately demanding on their attention – engaging enough to keep the driver alert, but not so engrossing as to make it difficult for a driver to resume the driving task if they are required to do so at short notice.

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174 Organisation International des Constructeurs d'Automobiles, http://www.oica.net/.

175 ABI/Thatcham Research, *Assisted and automated driving definitions - technical assessment* (June 2018). At p 11, the ABI define what they believe the criteria for an automated vehicle should be, including that it must be capable of initiating a minimum risk manoeuvre to avoid or minimise the effect of a collision.

176 For research showing that fatigue sets in faster for users of conditionally automated vehicles than for conventional drivers, see G Matthews, C Neubauer, D Saxby, R Wohleber and J Lin, "Dangerous Intersections? A review of studies of fatigue and distraction in the automated vehicle" (2018) *Accident Analysis and Prevention*, DOI: 10.1016/j.aap.2018.04.004; Gesamtverband der Deutschen Versicherungswirtschaft eV (German Insurance Association), "Tiredness and level 3 – automated driving" (2017) 70 *Compact Accident Research* 4.

177 B Seppelt, S Seaman, L Angell, B Mehler and B Reimer, "Differentiating Cognitive Load Using a Modified Version of AttenD (AHEAD)" (2017) *Proceedings of the 9th ACM International Conference on Automotive User Interfaces and Interactive Vehicular Applications* 114; J Coughlin, B Reimer and B Mehler, "Monitoring, Managing and Motivating Driver Safety and Well-Being" (2011) 10(3) *IEEE Pervasive Computing* 14 DOI: 10.1109/MPRV.2011.54; B Seppelt and others (2017). Glass Half-Full: Predicting Crashes From Near-Crashes in The 100-Car Data using On-Road Glance Metrics. Accident Analysis and Prevention; 2); B Seppelt and others (2018). Assessing the effect of in-vehicle task interactions on attention management in safety-critical events. Proceedings of The International Conference on Driver Distraction and Inattention.

An example: traffic jam assist

3.87 A typical example of a Level 3 system might be a traffic jam assist feature, which allows a vehicle to edge forwards at low speeds on a motorway, allowing the driver to check messages on an in-built screen. As soon as the speed of traffic rises, the system issues a request to intervene, and the screen shuts off.

3.88 As we discuss in Chapter 4, the question of whether such systems are to be allowed on UK roads will be decided at an international level. However, whether drivers would be allowed to use the in-vehicle screen during traffic jams is a matter for UK law. A cautious approach would be to forbid using such screens. On the other hand, if drivers are prevented from using the inbuilt screen, they may engage in other, more dangerous and unlawful activities. They may, for example, look at their own mobile phones, read a newspaper, day dream or fall asleep.

3.89 The issue is difficult, as even if secondary activities are restricted to inbuilt displays, safety issues remain. When drivers resume the dynamic driving task, they may lack the situational awareness needed to drive effectively.[178] While some people find it easy to switch between tasks, others will find this more difficult.[179] Variances also exist within a single type of task: for example, emails may range from banal to completely engrossing.

3.90 Finally, it may not be realistic to restrict users to using vehicle-integrated communication displays. Professor Bryan Reimer of MIT has pointed out that manufacturer systems may be inferior to the newer models of smart phones or laptop computers which drivers bring into the vehicle with them.

The German approach

3.91 Recent modifications to the German Road Traffic Act (Strassenverkehrsgesetz, "StVG") legalise the use of highly and fully automated vehicles.[180] The German category of "highly automated" cars, as defined by the StVG, includes SAE Level 3 "conditionally automated" cars.[181] The German approach is to allow limited distractions when such systems are engaged, provided that the automated driving system is used in the manner intended by the manufacturer. The driver can divert their attention when such a system is engaged, but must remain "wahrnehmungsbereit" or ready to perceive.[182] This means that the driver must be in position to take over the driving task when prompted by the automated driving system, or when they realise that they must do so because of

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178 K Zeeb, A Buchner and M Schrauf, "Is take-over time all matters? The impact of visual-cognitive load on driver take-over quality after conditionally automated driving" (2016) 92 *Accident Analysis and Prevention* 230 DOI: 10.1016/j.aap.2016.04.002.

179 DR Large, G Burnett, A Morris, A Muthumani and R Matthias, "A Longitudinal Simulator Study to Explore Drivers' Behaviour During Highly-Automated Driving." (2018) Stanton N. (eds) Advances in Human Aspects of Transportation. AHFE 2017. *Advances in Intelligent Systems and Computing,* vol 597. Springer, Cham.

180 As reported in the Federal Law Gazette of 20 June 2017, Part I No. 38, p 1648.

181 §1a of the StGV sets out a list of requirements for high automation: the vehicle must, for example, be able to identify the need to hand back control to the driver and provide a sufficient time buffer before doing so. However, the list does not include a requirement that the vehicle must achieve a minimal risk condition without human intervention.

182 §1b StGV.

"obvious circumstances". The issue of what amounts to "obvious circumstances" would need to be decided on a case by case basis.[183]

The United States: draft Uniform State Laws

3.92 In the United States, the Uniform Law Commission (ULC) [184] has formed a Committee on Highly Automated Vehicles. The ULC drafts laws with the aim of providing states with good quality legislation to clarify critical areas of state law and promote the enactment of uniform laws across the United States.[185] The Committee is currently drafting a uniform law for the deployment of automated driving systems, from SAE Level 3 through to Level 5.[186]

3.93 In their draft "Highly Automated Vehicles Act", the Committee has deliberately avoided using references to the SAE levels of automation.[187] However, by their own admission the draft Bill has implicitly included SAE Level 3 systems through its definitions for "Automated Driving System", "automated vehicle" and "automated operation".[188] SAE Level 3 has been included because, amongst other reasons, to leave it out would leave a "peculiar gap in state vehicle codes".[189] Notably the draft Act provides that when a vehicle is under automated operation the exclusive "driver" of the vehicle is the automated driving system.[190]

3.94 Section 7(h) of the draft Act provides that restrictions on the use of electronic devices do not apply during the automated operation of an automated vehicle. In the footnotes of the draft Act, the Committee explain that this provision has two purposes.[191] The first is to clarify that an occupant of an automated vehicle under automated operation can use these devices – though they also note that technically this would not be an issue, as the occupant would not be a driver and not subject to such restrictions. The second reason is to establish that should an automated driving system be designed to make use of such devices, it can do so as the driver of the vehicle.

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183 For further discussion on the German position see Appendix 3 at 3.34 to 3.42.

184 The ULC is also known as the National Conference of Commissioners on Uniform State laws.

185 ULC, *About the ULC* http://www.uniformlaws.org/Narrative.aspx?title=About%20the%20ULC.

186 ULC, *Committees – Highly Automated vehicles* http://www.uniformlaws.org/Committee.aspx?title=Highly Automated Vehicles.

187 The draft Bill released in December 2017 is accessible at http://www.uniformlaws.org/shared/docs/highly%20automated%20vehicles/2017dec_HAVA_Mtg%20draft_2017nov15.pdf.

188 See reporter's version release note from the February 2018 Committee discussion of the draft Bill. Accessible at http://www.uniformlaws.org/shared/docs/highly%20automated%20vehicles/2018feb_HAVA_Mtg%20Draft_(2).pdf.

189 The reporter's version release note from the February 2018 Committee discussion of the draft Bill, p 4.

190 As above, s 2.

191 As above, footnote 55 on p 14.

Conclusion

3.95 Some automated driving systems will not need a human to intervene to operate safely. When such a system reaches the limits of its operational design domain, it will be able to come to a safe stop (or in SAE terminology "achieve a minimal risk condition"). With these highly automated driving systems,[192] there is general agreement that the human in the driving seat should be permitted to engage in other activities.

3.96 There is more controversy over SAE Level 3 systems, which rely on a human to take over following a request to intervene to guarantee road safety. As discussed at paragraph 3.18, Level 3 systems may in practice be rare. They will probably be confined to low speed driving in restricted environments, such as traffic jams on motorways. Here the issue is more finely balanced. There are arguments for allowing users to be able to look at messages and emails, for example, on inbuilt screens, in accordance with the manufacturer's design. There are also contrary arguments in favour of a cautious approach, which preserves a clear line between driving and not driving. We have not reached a conclusion and welcome views.

Consultation Question 6.

3.97 Under what circumstances should a driver be permitted to undertake secondary activities when an automated driving system is engaged?

Consultation Question 7.

3.98 Conditionally automated driving systems require a human driver to act as a fallback when the automated driving system is engaged. If such systems are authorised at an international level:

(1) should the fallback be permitted to undertake other activities?

(2) if so, what should those activities be?

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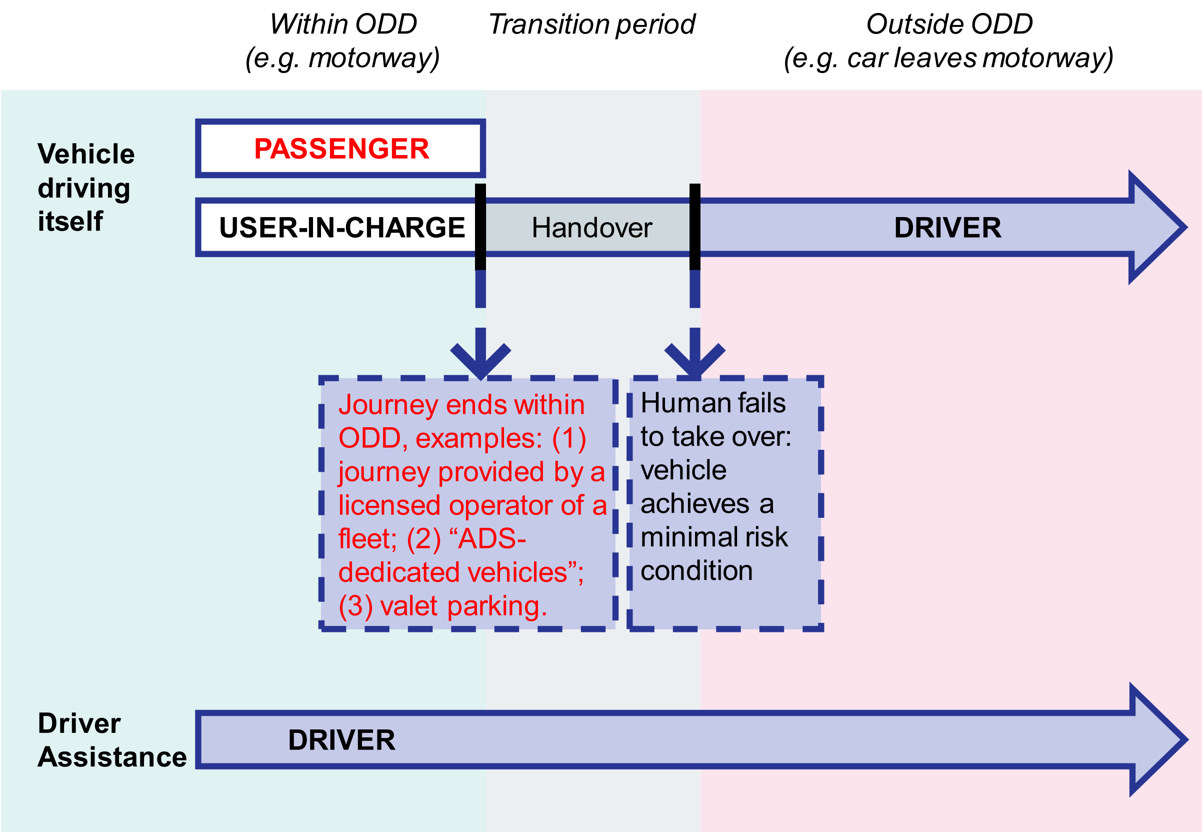
192 SAE Level 4.

A SUMMARY: HUMAN USERS AND THEIR ROLES

3.99 In Chapter 2 we explained that automated driving systems need to be understood both in terms of their level of automation and their design domains. In this chapter we emphasised the need for a clear regulatory boundary between driver assistance systems where human users retain all the responsibilities of being a driver; and vehicles that are capable of "driving themselves", where they do not. We noted that it is controversial to assert on which side of that regulatory boundary SAE Level 3 systems should lie for the purposes of civil and criminal liability.

3.100 The diagram below illustrates how the role of the human user can vary between being a driver at one end of the scale to being a passenger at the other. It includes the proposed new role of a "user-in-charge" and gives examples where these may not be needed.

Role of Human User



Chapter 4: Regulating vehicle standards pre-placement

4.1 At present, road vehicles are subject to regulatory approval *before* they are placed on the market. New vehicles for a mass market are subject to a sophisticated system of type approval, which relies on standards set at both United Nations and European Union level. In this chapter we outline the current system and consider the challenges posed by automated technology. Our aim is to explore how far the current system of type approval provides safety assurance for automated driving features and to identify any regulatory gaps.

4.2 In Chapter 2, we identified two main development paths to full automation. On Path 1, more and more automated features are added to cars with human drivers, sold to a mass consumer market (the "something everywhere" path).[193] On Path 2, the emphasis is on selling a journey rather than a vehicle. Highly automated vehicles are designed to provide end to end journeys without human drivers, though initially only in limited local contexts ("everything somewhere").

4.3 As we discuss below, the type approval system is aimed at motor manufacturers selling new vehicles across borders for a mass market. In other words, it is aimed at the "something everywhere" path. Where automated features are added to new consumer vehicles, an international system of checks, prior to vehicles being placed on the market, provides clear benefits to both manufacturers and consumers. That said, pre-placement checks can only go some way towards ensuring safety. In Chapter 5, we look at how far type approval may need to be supplemented by greater safety monitoring of automated driving features once they are on the road.

4.4 The system of type approval is less easy to apply to the "everything somewhere" path, where highly automated driving systems are developed to operate in local contexts. This may involve modifying existing vehicles, a process to which type approval does not apply. Alternatively, vehicles may be produced in small numbers, where nation states may set their own standards. We ask about a new system of safety assurance for automated driving systems in these circumstances.

4.5 We start with an outline of type approval generally. We then describe how it applies to automated driving, before turning to the policy implications.

AN OUTLINE OF TYPE APPROVAL

What is type approval?

4.6 Under the current law, the safety of motor vehicles is regulated through a system of type approval. Vehicles must obtain certification before they are placed on the market. Type approval relies on prior third-party testing. It differs from the approach taken in

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193 Organisation for Economic Cooperation and Development, *Automated and Autonomous Driving – Regulation under uncertainty* (2015).

other industries, which place more emphasis on self-certification by manufacturers to ensure compliance.

4.7 The system of type approval is complex. It has three main features. First, type approval involves testing components and systems against standards. Once the individual components and systems have been approved, a vehicle may be given a "whole vehicle approval certificate". Secondly, the system is international, drawing on standards set by both the United Nations Economic Commission for Europe (UNECE) and European Union (EU). Thirdly, as we shall see, the system is in flux, with recent or forthcoming changes at both UN and EU levels.

4.8 Within the EU, each member state must establish one or more type approval authority, giving manufacturers a choice of which authority to apply to. Certification by any one authority grants access to the market throughout the EU. In the UK, the relevant authority is the Vehicle Certification Agency (VCA), an executive agency of the Department for Transport.

Components, systems and whole vehicles

4.9 Type approval distinguishes between components, systems and whole vehicles. The testing is done on individual components (such as glazing or rear-view mirrors), and on systems, where many components work together (such as braking, steering and emissions).[194]

4.10 To gain approval for whole vehicles, around 70 components and systems must be approved individually. At the end of this process, the manufacturer submits a production sample of the whole vehicle to a type approval authority. The authority does not test the whole vehicle as such. Instead, it checks that each of its components and systems matches the specification contained in the individual component and system approvals.

4.11 The manufacturer must also satisfy the approval authority that there will be "conformity of production" – that is, that production models of the vehicle will be manufactured to the approved specifications. This requires manufacturers to document the way in which they follow quality assurance principles (such as certification to ISO 9001).

4.12 If all these requirements are met, the type approval authority provides what is known as a WVTA (Whole Vehicle Type Approval) certificate. The manufacturer then provides a "certificate of conformity" for each production vehicle to confirm that it meets the specification in the WVTA certificate. As we discuss below, this allows vehicles which conform to the type to be placed on the market throughout the EU. In the UK, before a vehicle is first registered, the certificate of conformity must be provided to the Driver and Vehicle Licensing Agency (DVLA).

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[194] For an overview, see Vehicle Certification Agency, *European Type Approval for Automotive Systems and Components*, Revision 13.

4.13 The Society of Motor Manufactures and Traders notes that whole vehicle approval for a passenger vehicle normally takes between six and 18 months, and costs between £350,000 and £500,000.[195]

UNECE: the revised 1958 Agreement

4.14 The "revised 1958 agreement" is the shorthand given to the United Nations Economic Commission for Europe (UNECE) Agreement concerning the adoption of uniform technical prescriptions for wheeled vehicles and their parts. The overarching aim of the agreement is to reduce technical barriers to international trade in vehicles.

4.15 The name "Economic Commission for Europe" reflects the fact that the original parties to the agreement were European. The UK has been a party to this UNECE agreement since 1963. However, participation now extends much more widely. As we have seen, it has 53 contracting parties, including Japan and Australia.[196]

4.16 States which are not members of the UNECE include the USA, Canada and China, which apply different standards. For example, the US Federal Motor Vehicle Safety Standards are incompatible with UNECE regulation, meaning that it is not currently possible to make one vehicle which can legally be sold in both the US and Europe. However, since 1998, progress has been made on reducing these differences by developing some global standards.[197]

4.17 UNECE Working Party 29 is tasked with creating a uniform system of regulations for vehicle design (referred to as UN Regulations). At the time of writing there are 145 UN Regulations annexed to the 1958 agreement, though some regulations apply only to some vehicle types.[198] Most regulations cover single components – such as headlights and head restraints. However, some regulations cover systems, such as steering. This includes Regulation 79, which we discuss below.

4.18 The revised 1958 Agreement is based on the principle of reciprocal type approval. Each contracting party designates an approval authority to decide whether a component or system meets the UN regulation and (if it does) approve it. Once one party has granted type approval to an item, every other party must accept that item for placement onto their market.[199] However, there are exceptions to this principle. Parties are not bound to accept all UN Regulations for each vehicle type.[200] And, if a party identifies a product

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195 Society of Motor Manufacturers and Traders (SMMT), *Type Approval: SMMT Issues Paper - November 2016*, https://www.smmt.co.uk/wp-content/uploads/sites/2/SMMT-Brexit-issue-paper-TYPE-APPROVAL.pdf.

196 The European Union is also a contracting party in its own right.

197 The US, Canada and China are signatories to the 1998 Agreement on UN Global Technical Regulations (GTRs) which promotes the harmonisation of existing technical regulations whilst recognising the right of Contracting Parties to adopt more stringent standards on grounds including health and safety.

198 See https://www.unece.org/trans/main/wp29/wp29regs.html (as of 10 September 2018).

199 1958 agreement (Revision 3, E/ECE/TRANS/505/Rev.3), art 3(2).

200 Contracting Parties may disagree (in which case the relevant regulation will not come into force for that Contracting Party unless and until it notifies its decision to adopt the relevant regulation); the Contracting Party may agree but delay applying the relevant regulation until the date it enters into force; or with one year's notice a Contracting Party may cease applying a UN Regulation it had previously adopted. See art 1(6) and art 12(5) of the revised 1958 Agreement (E/ECE/TRANS/505/Rev.3).

that does not conform, it may prohibit its sale and use within the territory until the non-conformity has been rectified.[201]

The EU framework

4.19 The EU is a party to the revised 1958 Agreement. This means that all EU member states must apply UNECE regulations by virtue of their status as member states, whether or not they are contracting parties in their own right.[202] Member states have also agreed to further harmonisation at EU level, under the Framework Directive 2007.[203] The Directive requires compliance with a wide range of separate regulations, most (but not all) of which reflect standards set at UNECE level.

4.20 While the 1958 Agreement aims to reduce barriers to international trade, the Framework Directive aims to create a single market. Member states must therefore accept all the standards adopted by the EU unless the vehicle will "present a serious risk to road safety, or seriously harm the environment or public health".[204] Furthermore, as we discuss below, member states have only a limited right to register for road use vehicles which do not conform to EU standards.

4.21 Traditionally, UN regulations have been confined to components and systems. In the EU, whole vehicle approval has been dealt with under the Framework Directive.

When may member states allow vehicles without type approval?

4.22 There are "small series" exceptions for vehicles which are produced in limited numbers.[205] Notably, under article 23 of Framework Directive, member states can also give "national type-approval" allowing them to waive "one or more" of the required technical specifications, as long as they "lay down relevant alternative requirements".[206]

4.23 Recital 7 of the Framework Directive states that "in order to prevent abuse, any simplified procedure for small series vehicles should be restricted to cases of very limited production". The Directive therefore sets out quantitative limits for small series

201 If the non-conformity is not fixed within a maximum time of six months, the original type approval will be withdrawn. See Arts 4.3 and 4.4 of the revised 1958 Agreement.

202 Letter from European Community to the Secretary General 29 July 1998, detailed in the footnotes attached to the treaty at https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XI-B-16&chapter=11&clang=_en#4. See also Annex III of Council Decision 97/836/EC which details the practical arrangements of the EU participation in the revised agreement.

203 Framework Directive 2007/46/EC, Official Journal L 263 of 9.10.2007 pp 1 to 160. This Directive will be repealed with effect from 1 September 2020 by Regulation 2018/858. We discuss this Regulation below at paras 4.28 to 4.30.

204 If so, member states may refuse registration for a maximum period of six months. The member state must immediately notify the Commission who will decide the issue: see Framework Directive 2007/46/EC, art 29(1). See also art 54 of Regulation 2018/858.

205 See Framework Directive 2007/46/EC, Arts 6(4), 22 and 23, for vehicles produced in a small series. In Regulation 2018/858, similar small series provisions are provided for in arts 37 and 41 to 43.

206 Above, art 23. Art 42 of Regulation 2018/858 also requires Member States to "lay down relevant alternative requirements" for national type-approval of vehicles produced in small series.

productions. For example, for "national-type approval" of passenger vehicles with no more than eight seats (M1 vehicles), this number is 100.[207]

Recent and forthcoming changes

4.24 The system of type approval is changing rapidly, at both UN and EU level.

4.25 The 1958 Agreement has been revised three times, in November 1967, in October 1995 and, most recently, in September 2017.[208] The current version is referred to as "Revision 3".[209] It responds to the rapid pace of change by introducing an exemption procedure for new technology and provision for virtual testing.[210]

4.26 Another key change is the move towards international whole vehicle type approval (IWVTA). A new UN Regulation, "UN R0",[211] which has come into force as an annex to the 1958 Agreement in July 2018, provides a "partial" IWVTA for cars (M1 vehicles).[212] Although the first version of UN R0 does not cover all components, it is an important first step towards achieving mutual recognition of whole vehicles at an international level.

4.27 At EU level, the system of type approval has come under pressure since September 2015, following concerns that vehicle testing underestimated emissions of diesel cars.[213] When the US Environmental Protection agency discovered illegal "defeat devices" in Volkswagen cars, the system of type approval risked losing public confidence.[214] The European Automobile Manufacturers Association has referred to "differences in interpretation and stringency in application of the requirements across Member States which became clear after several irregularities over the last years".[215]

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207 Framework Directive 2007/46/EC, annex XII A(2). See also SI 2018 No 673, The Road Vehicles (Defeat Devices, Fuel Economy and Type-Approval) (Amendment) Regulations 2018, Part 4 reg 8(3)(b). As discussed at para 4.29 below, these limits will be increased to 250 under Regulation 2018/858.

208 See UNECE document *Status of the Agreement, of the annexed Regulations and of the amendments thereto – Revision 26*, ECE/TRANS/WP.29/343/Rev.26.

209 E/ECE/TRANS/505/Rev.3.

210 See Sch 7 and 8 of the revised 1958 agreement, E/ECE/TRANS/505/Rev.3.

211 UN Regulation No 0 – Uniform provisions concerning the International Whole Vehicle Type Approval (IWVTA).

212 M1 vehicles are vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats, see as defined in the UNECE *Consolidated Resolution on the Construction of Vehicles (RE3)*, ECE/TRANS/WP.29/78/Rev.6, para 2.2.1.

213 The concern was a growing gap between "official" diesel emissions, as measured under laboratory conditions, and "real world" emissions occurring on the road. Reports suggested that this was partly due to outdated test procedures and "flexibilities" in test procedures, which allowed manufacturers to optimise performance in the tests (by for, example reducing, vehicle mass, adjusting brakes or overinflating tyres).

214 A "defeat device" is designed to cause a vehicle to perform differently in tests than in real life. For a legal definition, see Regulation (EC) No 715/2007, art 3(10).

215 ACAE Position Paper, *Approval and Market Surveillance of Motor Vehicles and their Trailers* (2016), p 1.

4.28 In January 2016, the European Commission published a proposal for a new regulation to replace the Framework Directive.[216] Following revisions from both the European Parliament and Council, this regulation has now been adopted and will come into force in September 2020.[217] The regulation addresses the following criticisms made of the current system. [218]

(1) *The independence of technical services, which carry out the tests*. Following complaints that manufacturers are too close to the technical services they choose and pay, technical services will no longer receive direct payments from manufacturers and will be subject to more stringent auditing.

(2) "*Forum shopping" between type approval authorities*. At present, EU manufacturers have a free choice between around 30 authorities, each of whom can give approval to vehicles. The new Regulation aims to introduce more rigorous audits for type approval authorities, to ensure that they apply standards consistently.

(3) *A lack of market surveillance*. Type approval looks at vehicles before they are placed on the market. It does not monitor how vehicles operate afterwards, in real world conditions. The new Regulation will place new duties on member states to monitor vehicles on the market.

4.29 Another significant change is that the small series limits are likely to increase, allowing member states to give "national type-approval" to vehicles produced in somewhat higher numbers. For M1 class vehicles, the limit is set to increase from 100 to 250 vehicles per year.[219]

4.30 The new Regulation will have effect before the end of the proposed transition period on 31 December 2020, during which the UK will continue to be bound by EU law. Thus, in the short term, the new Regulation is likely to become UK law. In the longer term, the UK Government has proposed to maintain a "common rulebook" with the EU, which would include the EU system of type approval for all categories of motor vehicles.[220] We have therefore written this consultation paper on the basis that EU law on type approval would continue to apply.

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216 European Commission, *Proposal for a Regulation of the European Parliament and of the Council on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles* (January 2016), COM(2016) 31 Final; 2016/0014 (COD).

217 Art 88, Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018. Official Journal L 151 of 14.6.2018 pp 1 to 218.

218 Press release 7 December 2017: agreement on Commission proposals to tighten rules for safer and cleaner cars. See http://europa.eu/rapid/press-release_IP-17-5131_en.htm and also "Technical harmonisation in the EU" at http://ec.europa.eu/growth/sectors/automotive/technical-harmonisation/eu_en.

219 Regulation 2018/858, annex V.

220 HM Government, *The Future Relationship between the United Kingdom and the European Union* (July 2018), para 29.

CURRENT STANDARDS FOR AUTOMATED DRIVING FEATURES

UN Regulation 79: Steering systems

4.31 At UNECE level, Working Party 29 has been under increasing pressure to provide standards for automated driving features, particularly those which affect steering. In March 2017,[221] Working Party 29 adopted a new version of UN Regulation 79 on steering systems to cover two categories of "automatically commanded steering functions"[222] (referred to as ACSF). These are:

(1) low speed manoeuvring or parking operations,[223] defined as involving speeds of less than 10 km per hour;[224] (referred to as "ACSF Category A"); and

(2) "corrective steering functions" to assist the driver in keeping the vehicle within the chosen lane by changing the steering angle "for a limited duration". [225] An example of such a function is "ACSF Category B1", described below.[226]

4.32 Both categories are subject to the requirement that "the driver remains at all times in primary control of the vehicle".[227] Furthermore, the Regulation requires that "the driver may, at any time and by deliberate action, override the function".[228] For the present, B1 functions have been discussed for use scenarios such as "roads exclusively for motor vehicles with physical separation from oncoming traffic", e.g. motorways.[229]

4.33 Thatcham Research and the ABI have described the regulatory control on these systems as "relatively light".[230] The main requirements for remote control parking under Category A is that it must operate on a "dead man's handle" basis[231] and only in close proximity to the vehicle.[232] B1 systems must monitor that the driver's hand is on the

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221 See UNECE document E/ECE/324/Rev.1/Add.78/Rev.3, this consolidated version reflects recent amendments to UN Regulation 79 on steering systems.

222 UN Regulation 79, para 2.3.4.1 ACSF "means a function within an electronic control system where actuation of the steering system can result from automatic evaluation of signals initiated on-board the vehicle, possibly in conjunction with passive infrastructure features, to generate control action in order to assist the driver."

223 UN Regulation 79, para 2.3.4.1.1.

224 UN Regulation 79, para 5.6.1.1.1 specifies that the speed should not exceed 10 km/h (+2km/h tolerance).

225 UN Regulation 79, para 2.3.4.2.

226 UN Regulation 79, para 2.3.4.1.2: "ACSF Category B1" means a function which assists the driver in keeping the vehicle within the chosen lane, by influencing the lateral movement of the vehicle.

227 UN Regulation 79, para 2.3.4.

228 UN Regulation 79, para 5.1.6.

229 See Working Party 29, 173rd session, Geneva 14-17 November 2017, Proposals for the Definitions of Automated Driving under WP.29 and the General Principles for developing a UN Regulation on automated vehicles, ECE/TRANS/WP.29/2017/145, at p. 10.

230 ABI /Thatcham Research, *Regulating Automated Driving – The UK insurer View* (August 2017), p 11.

231 That is to say, the vehicle will only move while the person operating the system actively manipulates the control device.

232 The specified maximum Remote-Control Parking operating range shall not exceed 6m, see UN Regulation 79, para 5.6.1.2.7.

wheel. If not, the system must provide a visual warning after 15 seconds, an audio-visual warning after 30 seconds and full deactivation after one minute.

Further revisions to UN Regulation 79

4.34 The limits of Regulation 79 have led to calls from car manufactures to allow more sophisticated automated driving features to receive type approval. An informal working group was set up to consider other forms of automatically commanded steering functions (ACSFs).[233] In March 2017, the informal group defined new categories to describe the following functions which may be "initiated/activated by the driver"[234]:

(1) "ACSF Category B2" keeps the vehicle within its lane by influencing the lateral movement of the vehicle for extended periods without further driver command/confirmation;

(2) "ACSF Category C" can perform a single lateral manoeuvre (eg lane change) when commanded by the driver;

(3) "ACSF Category D" can indicate the possibility of a single lateral manoeuvre (eg lane change) but only performs the manoeuvre following a confirmation by the driver;

(4) "ACSF Category E" can continuously both determine the possibility of a manoeuvre (eg lane change) and complete the manoeuvre for extended periods without further driver command/confirmation.

4.35 The informal working group completed work to regulate single manoeuvres under Category C at a special session in December 2017. It aims to regulate for Category B2 by February 2019.[235] It will also consider a possible new category (C2) which would require two interventions by the driver to change lane: using the indicator signal and applying a small turn to the steering wheel.[236]

4.36 Further developments are likely. An April 2018 paper raised the possibility of using these functions on urban and interurban roads.[237]

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233 The working group reports to a Working Party on Braking and Running Gear (known as GRRF), which in turn reports to Working Party 29, which is part of the UNECE.

234 These ACSF categories are now defined in Regulation 79, see paras 2.3.4.1.1 – 2.3.4.1.6. Special provisions are provided for category A and B1 systems at 5.6.1 and 5.6.2 of the Regulation, but are not implemented for other categories of ACSF.

235 For the timeline of changes, see https://www.unece.org/fileadmin/DAM/trans/doc/2018/wp29grrf/GRRF-86-20-r1e.pdf.

236 It is said that C2 might be appropriate for heavy commercial vehicles because it would leave more control to the driver over the timing of the lane change.

237 ECE/TRANS/WP.29/1140 at pp 10 and 11, with Category B1 features falling in the SAE Level 2 column. These recommendations are still subject to further consideration.

ACSF Categories and SAE levels

4.37 Much of the discussion over ACSF levels has focused on how the vehicle interacts with the driver (or, as it is referred to, the "human machine interface"). Category B1 features are considered as a form of driver assistance, reflecting SAE Level 2.[238] Hence the emphasis on warnings to the driver to keep their hands on the wheel and their eyes on the road. Discussions within Working Party 29 envisage that more sophisticated systems at Category B2, D and E will no longer be confined to operate at SAE Level 2. Instead they may be designed to operate at SAE Level 3 and higher levels of automation.

4.38 As we discussed in Chapter 3, one of the main dangers of automated functions is that consumers will over-rely on them: drivers will fail to understand the limitations of the system and will think that they are more sophisticated than they are. Therefore, Thatcham Research and the ABI argue that more needs to be done to regulate how automated functions are described to consumers. In particular, "terminology to describe system functionality should be accurate and descriptive" and "the use of words that suggest a higher level of automation than offered are unacceptable".[239]

4.39 However, at present, type approval agencies are not concerned with these issues. This can be illustrated by the debate following the decision by the Dutch type approval authority, RDW, to approve the Tesla autopilot system for use throughout the EU. Concern focused on the term "autopilot", which might suggest that drivers could use it without constantly monitoring their environment. A spokesman for RDW was quoted as saying:

> The RDW has no official opinion about the name Autopilot, as normally we only consider technical aspects and not names.[240]

4.40 This issue also illustrates the difficult dividing line between the role of the UNECE and contracting states. Our interpretation is that, even if a system were to be approved without automated requirements to keep hands on the wheel, states are not obliged to permit drivers to become distracted while operating the system. Although the UK would be required to allow the approved vehicle to be sold here, we think that the Government could still retain provisions to prevent the driver from (for example) using a mobile phone while using the function.[241]

4.41 Working Party 29's work on UNECE standards clearly needs to align with the work of Working Party 1, which leads the UN's work on driver requirements and compliance with the Vienna Convention. Both working parties are adopting increased joint working

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238 OICA and CLEPA, "ACSF B2 and C2 Industry expectations from ACSF IG Tokyo meeting", *Informal Document: ACSF-16-06.* See also definition of "Advanced Driver Assistance Steering System". "Advanced Driver Assistance Steering System" means a system, additional to the main steering system, that aids the driver in steering the vehicle but in which the driver remains at all times in primary control of the vehicle (para 2.3.4 of Reg 79).

239 Thatcham Research/ABI, *Regulating Automated Driving – The UK insurer View* (August 2017), p 13.

240 Reuters, 17 October 2016, "Dutch Regulator weighs Tesla's use of "Autopilot" name". See https://www.reuters.com/article/us-tesla-netherlands-idUSKBN12H1EK.

241 We discuss these issues in Chapter 3.

practices to promote speedier and more coherent progress on these issues at the international level.[242]

Defining a minimal risk condition

4.42 We noted in Chapter 2 that the ability of the automated driving system to achieve a minimal risk condition is a crucial regulatory boundary. It marks the difference between a system that can safely operate without the need for human intervention to guarantee road safety, and one that cannot.[243] To reach SAE Level 4, an automated driving system that cannot continue to control the vehicle on its journey must be able to manoeuvre the vehicle into a position that creates minimal risk of harm to its occupants and other road users.

4.43 UNECE Working Party 29 is currently considering the definition of a minimal risk condition, and what capability may be required of an automated driving system.[244] Pending the development of UNECE standards, some boundary of what can and cannot qualify as a minimal risk condition would need to be considered domestically.

4.44 “Minimal risk” differs from “minimum risk”. To be acceptable, a Level 4 system must be capable of placing the vehicle in a position that creates a very low (“minimal”) level of risk, not merely the lowest (“minimum”) level of risk that the system is capable of achieving. If stopping in the road and turning on the hazard warning lights is the best that the system can do, this is unlikely to be sufficiently safe in many circumstances. Some objective benchmark of safety appears necessary to avoid perverse incentives; otherwise, the less sophisticated the technology, the less would be required of it in a critical situation.

Testing new technologies

4.45 Automation poses challenges for the testing process. One consultee expressed the view that the current testing system is based on the concerns of the 1970s and often involves “throwing metal at walls”. The process of testing artificial intelligence requires a new expertise.

4.46 Revision 3 of the 1958 Agreement now contains provisions for “virtual testing”.[245] This requires manufacturers to supply the mathematical model, and necessary tools, for the product and to provide “appropriate support” to the approval authority or the technical service.

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242 The UNECE is establishing a joint programme committee to include experts from both Working Party 1 and Working Party 29 to support consistency between the Vienna Convention and the development of technical regulations: see https://www.unece.org/fileadmin/DAM/trans/doc/2018/wp29/ECE-TRANS-WP.29-1137e.pdf agenda item 8.2, at p.24 and https://www.unece.org/fileadmin/DAM/trans/doc/2018/itc/List_of_Decisions_80th_ITC_final.pdf.

243 SAE Levels 4 and 3, respectively.

244 The UN Regulation 0 (R0) sub-group of Working Party 29 seeks to establish an internationally recognised whole vehicle type approval (IWVTA) scheme within the framework of the revised 1958 Agreement, see https://www.unece.org/fileadmin/DAM/trans/doc/2015/wp29/WP29-165-15-rev.1.pdf.

245 See Schedule 3, paras 1.6 to 1.8; and Sch 8.

4.47 Work is taking place to develop more robust testing protocols, which are less dependent on information from manufacturers. The German Government has sponsored PEGASUS, a co-operative research project between industry and academics, to develop and refine safety tests for highly automated driving systems. Its aim is to fill "key gaps in the field of testing" by the middle of 2019.[246] To this end, the project has been capturing a library of driving behaviours and scenarios which can be replayed in simulation to test driving systems. The UK Government is also keen to encourage research into ways to test automated vehicle technology. In January 2018, it announced up to £15 million of funding for projects that use simulation and modelling in the development of approvals and standards for autonomous and connected vehicles.[247]

4.48 In the short term, however, type approval authorities and technical services may lack detailed knowledge of sophisticated electronic systems. As the European Automobile Manufacturers Association commented:

> Some aspects of type approval (eg safety of electronic control systems, OBD [On Board Diagnostics] etc) require a particular level of expertise of the technical service. And few experts have in-depth knowledge about how such solutions are implemented at the individual manufacturer level. Newly-assigned technical services would have to go through lengthy learning processes for these special cases.[248]

4.49 The speed of technical change places new pressures on a system which allows manufacturers a choice between a range of type approval authorities, some of which may be less well equipped.

Approvals for new technology outside current standards

4.50 One problem with a system of international standards is that it might fail to keep up with new developments. Manufacturers may wish to provide new features for which no standard is available. Special approval procedures exist to deal with this issue at both EU and UNECE level.

EU level

4.51 Article 20 of Framework Directive 2007 covers new technologies or concepts. It states that where a system, component or unit "incorporates technologies or concepts which are incompatible with one or more regulatory acts", member states may grant provisional approval which is valid only in their own territory. The approving state must pass information to the European Commission, and to other member states, without delay. Among other things, the information must include test results which demonstrate that the new technology provides "at least an equivalent level of safety and

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246 http://www.pegasus-projekt.info/en/about-PEGASUS.

247 A competition run by CCAV in association with Innovate UK was open from January to May 2018 see https://www.gov.uk/government/news/using-simulation-to-test-driverless-vehicles-apply-for-funding.

248 ACEA Position Paper, *Approval and Market Surveillance of Motor Vehicles and their Trailers* (April 2016).

environmental protection".[249] The Commission may then decide whether to accept or refuse approval.

4.52 We have been told that several manufacturers are considering making article 20 applications in respect of automated steering systems.[250] Difficult questions remain about how far article 20 will be used to go beyond what is permissible under Regulation 79, to allow additional ACSF categories.

UNECE level

4.53 A similar exemption procedure was added by Revision 3 of the 1958 Agreement. A new clause allows an approval authority to grant an "exemption approval" for a product "which is based on a new technology, when this new technology is not covered by the existing UN Regulation, and is incompatible with one or more requirements of this UN Regulation".[251]

4.54 The exemption is subject to authorisation by the Administrative Committee of the revised 1958 Agreement. Pending the decision of that committee, the contracting state may grant provisional approval *for its territory only.* Other states may or may not accept that provisional approval.

4.55 The Administrative Committee may authorise the approval if it is satisfied that there is evidence of "at least an equivalent level of safety and environmental protection" of the new technology compared to the requirements from which exemption is sought.[252] The Administrative Committee's exemption approval may contain restrictions, including a time limit. However, the time limit must be at least three years.[253] The exemption approval also triggers a process to update and modify the relevant UN Regulation.[254]

4.56 Once an approval has been authorised, there is a presumption that it will apply to all UNECE contracting parties. However, the 1958 Agreement differs from the EU article 20 procedure. While EU member states are obliged to accept the Commission's decision, UNECE states may notify their disagreement or intention not to accept the exemption approval. If so, the notifying state is not obliged to accept the new technology within its territory.

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249 Art 20(2)(c). Article 39 of Regulation 2018/858 will also allow for exemptions for new technologies or new concepts and uses similar wording to Article 20.

250 German manufacturers have been particularly active in this area: http://europe.autonews.com/article/20170906/ANE/170909879/audi-may-seek-type-approval-exemption-for-a8s-self-driving-system.

251 1958 Agreement, Article 12.6. Annex 5, Chapter IV of the 1968 Vienna Convention on Road Traffic also provides that contracting parties can grant exemptions, for domestic purposes, from its technical provisions in respect of vehicles used for experiments whose purpose is to keep up with technical progress.

252 Sch 7, para 3(3).

253 Sch 7, para 8.

254 Sch 7, para 9.

TYPE APPROVAL AND THE "SOMETHING EVERYWHERE" PATH

4.57 We have discussed the regulatory system which applies where manufacturers add automated functions to new vehicles designed for a mass consumer market with human drivers. As an OECD report points out, these features are likely to become ever more sophisticated, and provide an incremental path towards full automation.[255]

4.58 In these circumstances, strong reasons exist to regulate automated functions at an international level.

(1) Vehicle manufacturers are already familiar with the regulatory system. The automated function is treated as simply one more system within the vehicle, and does not require different regulation.

(2) Manufacturers are able to obtain a single approval to allow them to sell the same vehicle design in many separate states. This saves costs and promotes trade. Any system requiring multiple approvals in different states would add frictions to the process.

(3) Consumers are able to use their vehicles to cross national borders, without encountering additional regulatory requirements.

4.59 The emphasis has been on systems designed for restricted roads, without pedestrians or cyclists, such as motorways. Motorways have relatively similar layouts worldwide, and only limited adaptations of the systems would be required for them to operate in different countries.

4.60 The UNECE has been taking the lead in this field, and is developing new standards and testing protocols for automated functions. The UK Government has been an active participant in this process and we expect this to continue. We do not perceive a need to develop UK specific standards or tests for automated functions within new vehicles with human drivers.

4.61 Eventually, highly automated vehicles will be marketed across borders. The UNECE Resolution for the deployment of highly and fully automated vehicles aims to embed local standards within the international framework by requiring highly and fully automated vehicles to comply with local traffic laws.[256] These will vary significantly from place to place and may include, for example, following instructions from law enforcement authorities. It remains to be seen how compliance with local traffic laws will be tested and enforced.

4.62 Pre-placement testing can only go some way towards ensuring that vehicles are safe. The technology of automation is developing extremely fast - often faster than regulatory standards or testing protocols. With such sophisticated and untried technologies, it is

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[255] Organisation for Economic Co-operation and Development, *Automated and Autonomous Driving: Regulating Uncertainty* (2015) p 5, https://www.itf-oecd.org/sites/default/files/docs/15cpb_autonomousdriving.pdf.

[256] UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), Report of the Global Forum for Road Traffic Safety on its seventy-seventh session ECE/TRANS/WP.1/165 Annex 1, section IV.

not possible to know if the functions are safe enough until they have been used by (fallible) human drivers and met real world driving conditions. This puts considerable pressure on existing systems of "post-placement" monitoring, which we discuss in Chapter 5.[257]

REGULATING THE "EVERYTHING SOMEWHERE" PATH

4.63 New features in mass market vehicles are only one possible pathway to full automation. Another path is to provide a highly automated vehicle which operates without a human driver, but which is designed for a limited and specific domain. As the technology improves, the domain can be expanded to new places and conditions.

4.64 In 2015, the OECD noted that "vehicles that currently operate without any real-time input from human drivers are limited to highly specific contexts, including particular routes and low speeds".[258] However, it saw substantial potential for development. The OECD report provides a hypothetical example in which a developer might initiate a pilot project in which his vehicles operate in good weather at neighbourhood speeds along a carefully mapped, maintained, and monitored corridor within its corporate campus. It might then expand the pilot to select streets within the local community and later to a handful of other communities. As the developer improved its technologies and increased public confidence in them, it might deploy vehicles at higher speeds and on more road types.[259]

4.65 The OECD had noted it was not clear how authorities would seek to regulate such a development, and this remains the case today.[260]

4.66 In Chapter 2 we explain that the two "development paths" are paths to the same place. They will eventually converge to reach the same goal of fully automated driving.[261] However, in the short to medium term, there are likely to be multiple differences between those selling mass-market vehicles and those selling journeys. Those selling vehicles will focus on relatively homogeneous environments, such as motorways. Those selling journeys are more likely to focus on complex urban environments, notably major cities, which differ not only in rules and junction layouts, but also in signage and road user behaviour (including pedestrian behaviour). At least initially, those selling journeys are likely to develop automated driving systems to cope with a single place.

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257 We look at the regulation of consumer information and marketing, market surveillance, roadworthiness tests, driver training, accident investigation and statistical monitoring.

258 OECD, *Automated and Autonomous Driving: Regulating Uncertainty* (2015) p 16. It states: "examples include the CityMobil2 project supported by the European Union, the Navia shuttle marketed by Induct, and the buggies announced by Google. Such fully automated vehicles have also been deployed in restricted contexts for freight or industrial tasks, including tyre-based container repositioning vehicles in ports or fully automated ore trucks in some open-air mines." https://www.itf-oecd.org/sites/default/files/docs/15cpb_autonomousdriving.pdf.

259 OECD, *Automated and Autonomous Driving: Regulating Uncertainty* (2015) p 15, https://www.itf-oecd.org/sites/default/files/docs/15cpb_autonomousdriving.pdf.

260 OECD, *Automated and Autonomous Driving: Regulating Uncertainty* (2015) p 16, https://www.itf-oecd.org/sites/default/files/docs/15cpb_autonomousdriving.pdf.

261 For further discussion, see Ch 2 paras 2.39 to 2.47.

They will produce these systems in more limited numbers, possibly modifying existing vehicles or producing vehicles in small series.

4.67 Below we explain why these types of limited, specific vehicles may not fall within the scope of international vehicle standards. We then consider how they would be regulated under current UK law, and ask about possible reforms.

When type approval does not apply: modifications and small series

4.68 Under EU law, vehicles must have type approval to be registered for use on the roads. In the UK, before registering a vehicle for the first time, the DVLA would normally require a certificate of conformity to a type covered by a WVTA certificate.

4.69 However, there are two circumstances in which EU type approval is not necessary. The first is where a vehicle is modified *after* registration. Some software companies have outlined plans to buy standard vehicles, register them and then modify them to add the sensors and automated driving system. This would fall outside the scope of both the EU framework directive and the revised 1958 Agreement.

4.70 Secondly, even if the automated driving system was installed before registration, initially the vehicles may not be produced in great numbers.[262] They might therefore fall within the "small series" exemption. As we have seen, for M1 cars, where production does not exceed 100 vehicles (or 250 under Regulation 2018/858), member states may allow a manufacturer an exemption from one or more technical regulations.[263] For developers operating small numbers of vehicles in limited contexts, this may prove a more attractive route than full type approval.

4.71 For both these reasons, it is likely that the approval of the first highly automated vehicles operating in limited contexts in the UK would be subject to UK law rather than international vehicle standards. Below we consider how current UK law would regulate these vehicles.

Construction and Use Regulations

4.72 Under UK law, modifications to vehicles operating on the roads are only accepted if the vehicles continue to conform to the Road Vehicles (Construction and Use) Regulations 1986.[264] As the name implies, these Regulations cover both construction and use. As far as construction is concerned, the Regulations largely mirror international standards. All vehicles (including modified vehicles) must comply with a long list of requirements, from windscreen washers to tyres, brakes and steering. If the vehicle does not comply, using it on the road is a criminal offence.[265] In addition, the Regulations include

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262 That said, Waymo's partnership with Jaguar is planning for up to 20,000 vehicles in its first two years: https://media.jaguar.com/news/2018/03/waymo-and-jaguar-land-rover-announce-long-term-partnership-beginning-self-driving.

263 Article 23 of Directive 2007/46/EC and Art 42 of Regulation 2018/858 (see paras 4.28 to 4.30 for discussion of this Regulation).

264 In addition, modifications must comply with the Road Vehicles Lighting Regulations 1989 and the Road Vehicles Authorised Weight Regulations 1998.

265 These are set out in the Road Traffic Act 1988: s 40A covers using a vehicle in a condition which involves a danger of personal injury; s 41A of the Road Traffic Act 1988 covers brakes, steering-gear and tyres; s 41B

provisions about how the vehicle may be used, including prohibitions on (for example) the use of mobile phones while driving.

4.73 At present, however, there are no provisions regarding automated driving systems (other than to allow remote control parking[266]). But an absence of provision in the 1986 Regulations has a very different effect from an absence of provision at UNECE level. Under the UNECE approval system, a vehicle cannot be approved unless its systems and components positively comply with the requirements. By contrast, under the 1986 Regulations, anything is allowed that is not specifically forbidden. For purposes of the Road Vehicles (Construction and Use) Regulations 1986, the starting point is that an automated driving system is allowed, unless it contravenes a particular provision.

4.74 There is one general provision which stipulates that a motor vehicle should not be in a dangerous condition. Regulation 100(1) of the Construction and Use Regulations requires that:

> A motor vehicle… and all parts and accessories of such vehicle… shall at all times be in such condition… that no danger is caused or is likely to be caused to any person in or on the vehicle… or on a road.

4.75 A developer who put a dangerous vehicle on the road could be prosecuted under Regulation 100, but it does not establish any standard of safety.

4.76 The regulations also require that steering gear is "maintained in good and efficient working order and be properly adjusted".[267] Again, it might be possible to argue that allowing an unregulated automated steering function is failing to maintain steering in good working order, but the issue is far from certain.

4.77 Below we consider the practical effect of the current law, for road tests with a safety driver; for road tests without a safety driver; and for commercial deployment.

Road tests with a safety driver: the code of practice

4.78 In February 2015, the Government reviewed the law in this area and concluded that:

> 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.[268]

covers weight requirements; and s 42 covers any other construction or use requirement. For further details see background paper 1.

266 Changes have been made to the Road Vehicles (Construction and Use) Regulations 1986 reg 110, and are planned to the Highway Code, to allow parking using a hand-held device. However, the operator must still be within six metres of the vehicle when operating the car by such a function.

267 Road Vehicles (Construction and Use) Regulations 1986, reg 29.

268 Department for Transport, *The Pathway to Driverless Cars*, February 2015.

4.79 In other words, there is no clear prohibition on using an automated driving system on public roads in the UK, provided that enough is done to ensure safety and the vehicle is driven in a manner which complies with traffic laws.

4.80 In July 2015, the Government published a code of practice to provide guidance for testers. Compliance with the code is not compulsory, but "it details recommendations which the government believes should be followed to maintain safety and minimise potential risks".[269] Among other things, it sets out principles to ensure that drivers are qualified and alert (including provisions on training and hours worked) and recommends engagement with transport authorities and the public.

4.81 The code also stresses that the vehicles must meet construction and use requirements. This is not a problem where the vehicle retains all the features of a normal vehicle. It can become an issue, however, for unconventional designs, which (for example) deploy different configurations of steering wheels, brakes or mirrors. In these cases, testers may take advantage of two separate levels of exemption.

4.82 First, under the Road Vehicles (Authorisation of Special Types) (General) Order 2003, exemptions are available for "any new or improved type of motor vehicle or trailer which is constructed for tests or trials".[270] The exemptions apply to some (but by no means all) of the provisions that govern construction.

4.83 Secondly, developers who wish to make more radical changes may apply for a special vehicle order. This may be made under section 44 of the Road Traffic Act 1988 or section 11 of the Public Passenger Vehicles Act 1981.[271] Using the powers granted by these sections, the Secretary of State may authorise exceptions or modifications to the normal rules for certain categories of vehicles to be used on roads. Among other things, the power may be used in relation to:

> (a) special motor vehicles or trailers, or special types of motor vehicles or trailers, which are constructed either for special purposes or for tests or trials… [and]
>
> (c) new or improved types of motor vehicles or trailers… or of motor vehicles or trailers equipped with new or improved equipment or types of equipment.[272]

4.84 The decision lies with the Secretary of State, though in practice the application is made through the Vehicle Certification Agency.

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269 Department for Transport, *The Pathway to Driverless Cars*: A code of practice for testing, July 2015, para 2.1.

270 Art 36(1)(c).

271 Section 11 species the certification process for authorising the use of a vehicle adapted to carry more than eight passengers.

272 Road Traffic Act 1988, s 44(1). See also Road Vehicles (Authorisation of Special Types) (General) Order 2003 para 36.

Road tests without a safety driver

4.85 There is no legal provision in the UK which directly forbids automated driving systems from being used on the roads, even without a safety driver. As we discuss in Chapter 7 on road traffic offences, there is no direct requirement that vehicles must have drivers. The provision which comes closest to this is regulation 107 of the Road Vehicles (Construction and Use) Regulations 1986. This prevents a person from leaving on a road a motor vehicle:

> which is not attended by a person licensed to drive it unless the engine is stopped and any parking brake with which the vehicle is required to be equipped is effectively set.[273]

4.86 Thus a vehicle with an automated driving system should not be left unattended at any time throughout a trial. However, as we discuss in Chapter 7, the person attending it need not be driving. Nor need they be in the vehicle: attendance could be through a control centre.[274]

4.87 Clearly, without a safety driver, it is more difficult for the developer to show that the vehicle is not likely to cause a danger, contrary to Regulation 100. It may also be challenging for the developer to show compliance with other Construction and Use Regulations.[275]

The commercial deployment of automated driving systems

4.88 If there is no provision in UK law which absolutely forbids automated driving systems from being used on the roads, this raises the question of what would happen if a developer decided to move beyond trials, and to use the system commercially. Could an operator buy pre-registered normal vehicles, install an automated driving system and use the vehicles to provide a service to the general public?

Complying with Construction and Use Regulations

4.89 Generally, those who modify vehicles must notify DVLA. Under section 16(1) of the Road Vehicles (Registration and Licensing) Regulations 2002, the requirement to notify arises where "any alteration is made to a vehicle so as to make any of the particulars set out in the registration document incorrect".[276] Where a vehicle has been modified to such an extent that its identity has been lost, DVLA will require it to be re-registered. Such modifications must still comply with the Construction and Use Regulations.[277]

4.90 It would not be easy for an operator using an automated driving system commercially to show compliance. Particular issues might arise over compliance with Regulation 107 (not leaving the vehicle unattended), Regulation 100 (not likely to cause a danger) and, possibly, Regulation 104 (driver's control and full view of the road ahead). When moving

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273 Reg 107(1).

274 See para 7.8.

275 For a discussion of the effect of Reg 104 see para 7.10 to 7.11.

276 The registration document lists the type approval number and category, so it is arguable that modifying a vehicle so that it would no longer be eligible for type approval engages this provision.

277 See https://www.gov.uk/vehicle-registration/radically-altered-vehicles.

from testing to commercial deployment, the operator would no longer have the comfort of using compliance with a code of practice to show that the vehicle was "safe enough".

4.91 However, construction and use provisions do not present an absolute bar. They could be negotiated, with sufficient care.

Regulating the mobility service provider

4.92 The main regulatory barriers would depend on the type of service which the operator provided. The first distinction would be between services which moved goods and those which moved people.

4.93 If the provider was moving goods, regulation would depend on the weight of the vehicle. Businesses in England and Wales that use goods vehicles above a certain weight must obtain a goods vehicle operator's licence.[278] However, light delivery vehicles are not regulated, and the operator would not meet any further regulatory barriers.[279]

4.94 Passenger services are heavily regulated. The exact nature of the regulation depends on whether the vehicle comes within the definition of a taxi, private hire vehicle (PHV) or public service vehicle (PSV). Separate regulatory regimes apply to each. These regimes not only regulate operators and drivers, but also provide local licensing authorities, or traffic commissioners, with powers to set standards for the vehicle. [280]

4.95 This paper does not consider how the taxi, PHV or PSV regimes would apply to automated vehicles. This is a complex issue, which we intend to cover in a subsequent consultation paper. Here we simply note that, under the law as it currently stands, responsibility for setting regulatory standards for taxis and PHVs using automated driving systems would appear to fall on local authorities or, in London, Transport for London (TFL). This has the potential to place a heavy burden on those who would not necessarily have the resources or expertise for the task, and gives rise to the danger of inconsistencies.

4.96 There are already difficulties in placing safety standards for taxis and PHVs on local authorities or TFL for conventional vehicles. In 2014, the Law Commission reviewed law of taxis and private hire vehicles in England and Wales (without, at that stage, considering automated vehicles). Even without the complications of automation, the Law Commission saw a greater role for national standards, commenting:

> Currently all standard-setting for taxi and private hire services is left to local licensing authorities. There are over 300 different sets of standards across England and Wales. This means that passengers in some areas may be put at

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278 See Goods Vehicles (Licensing Operators) Act 1995, as modified by the Goods Vehicles (Licensing of Operators) (Amendment) Regulations 2017, SI 2017 No 874. These provisions apply if the maximum weight that the vehicle can have at any one time is over 3,500kg, or the unladen weight is over 1,525 kg.

279 Goods Vehicles (Licensing Operators) Act 1995. This Act applies to England, Wales and Scotland.

280 See Local Government (Miscellaneous Provisions) Act 1976, s 68; Metropolitan Public Carriage Act 1869, s 9; London Cab Order 1934 (SI 1934/1346); Private Hire Vehicles (London) (Operators' Licences) Regulations 2000 (SI 2000/3146); Public Passenger Vehicles Act 1981, s 6; Public Service Vehicles (Operators' Licences) Regulations 1995 (SI 1995/2908); Road Transport Operator Regulations 2011 and Civic Government (Scotland) Act 1982, ss 10 to 23.

unnecessary risk because standards are too low, whilst licence-holders in other areas may be subjected to unduly burdensome requirements. It can also have a restrictive effect on business; for example, a provider seeking to expand into a neighbouring area will have to apply for separate additional licences; and drivers, vehicles and private hire operators may well have to meet different standards. Introducing certain common standards also provides the foundations for better enforcement of the licensing system across borders, also promoting passenger safety.[281]

4.97 The Law Commission recommended national standards for all taxis and private hire vehicles, set by the Secretary of State. Local licensing authorities would have power to set additional standards for taxi services only. Local authorities and TFL would, however, remain responsible for issuing licences and enforcement in relation to both taxis and private hire vehicles.

Provisional conclusion: a gap in safety regulation

4.98 This short review highlights two potential gaps in the regulation of automated driving systems. The first is where a vehicle is modified after it has been registered, to install an automated driving system. Installing an automated driving system could be legal, provided that the operator is careful to comply with the provisions of the Road Vehicles (Construction and Use) Regulations 1986. This would include, for example, not leaving the vehicle "unattended"; and not causing a danger.[282] In theory, it might be possible for a suitably audacious operator to press ahead on that basis, though more cautious operators would wish for greater certainty about how safe the system needed to be to be safe enough. The law in this area is uncertain. If operators were to install unauthorised systems, enforcement authorities may ask the courts to take a wide view of existing restrictions.

4.99 There would be no further restrictions on using an automated driving system in a light delivery vehicle, though further regulations do apply to heavy goods vehicles and passenger services. If the operator wished to offer a taxi or PHV service, the burden of regulating safety standards for automated vehicles would fall on around 300 separate licensing authorities in England and Wales, leaving aside Scotland.

4.100 The second gap is where the automated driving system is installed before the vehicle is registered, but vehicles are manufactured in limited numbers - soon to be increased from 100 to 250.[283] For these small series, the Secretary of State may issue a special vehicle order, under section 44 of the Road Traffic Act 1988, authorising "new or improved" types of vehicle for use on the roads. At present, this is entirely a matter for the Minister, without a system of safety assurance to guide the process.

4.101 The legislation on road vehicles was not drafted with automated vehicles in mind. The way that it currently deals with automated driving systems fails to meet the needs of the public or developers. The public could be exposed to unregulated dangers from

281 Law Commission, Taxi and Private Hire Services, Law Com No 347 (May 2014) pp 78 to 79.

282 We consider the role of the General Product Safety Regulations, which apply to guarantee the safety of products supplied or made available to consumers, not covered by specific sectoral requirements, in Chapter 5.

283 Increased by Regulation 2018/858, discussed at 4.28 to 4.30.

modified vehicles, while responsible developers would wish for greater guidance on how safe is safe enough. They could risk unfair competition from less scrupulous providers. Furthermore, manufacturers of small series vehicles may well ask the UK Government for exemptions to enable them to provide automated services in local conditions without incurring the expense and delay of international type approval. If so, the UK Government would need a more formalised system which applied “relevant alternative requirements”.

A NEW SAFETY ASSURANCE SCHEME

4.102 We tentatively propose that the UK should set up a new safety assurance scheme for automated driving. The scheme should have powers to authorise automated driving systems which are installed either as modifications to registered vehicles or in vehicles manufactured in limited numbers (a "small series"). It could be a new agency or part of an existing agency (such as the Vehicle Certification Agency or the Driver and Vehicle Standards Agency).

4.103 The safety assurance scheme would also take over the current powers of the Secretary of State under section 44 of the Road Traffic Act 1988 to make special vehicle orders in respect of highly automated vehicles. This would allow a highly automated vehicle to include other design changes (for example, to mirrors or steering wheels) which would otherwise breach construction and use regulations.

4.104 It is not our intention to replicate the work done at the international or EU level. If, for example, UNECE Regulations were to be developed for highly automated vehicles operating in urban environments, it may no longer be necessary for the UK to have its own system of authorisation. However, UNECE standards for this type of vehicle appear to be many years away, and even if such standards are developed, they may well provide only a minimum floor of requirements. They may, for example, allow contracting parties to require that the vehicles meet their own traffic laws and can recognise the many types of vulnerable road users who use that environment. If so, additional national standards would still be needed.

Prohibiting unauthorised automated driving systems

4.105 We tentatively propose that, following a new system to authorise automated driving systems, unauthorised systems should be prohibited. In other words, the Road Vehicles (Construction and Use) Regulations 1986 should be amended to require that every automated driving system is authorised either at international or national level. Under section 42 of the Road Traffic Act 1988 it would then be a criminal offence if a person “uses on a road a motor vehicle… which does not comply with such a requirement, or causes or permits a motor vehicle… to be so used”.

4.106 This would address a possible loophole in the current law, under which it might be legal to install an automated driving system, even if it does not meet national requirements.

The role of the automated driving system entity (ADSE)

4.107 The National Transport Commission (NTC) of Australia has recommended that each automated driving system should be backed by a specified organisation, known as the "automated driving system entity" or ADSE. The ADSE would be required to demonstrate that it had identified and managed safety risks to a legal standard of care.[284]

4.108 The concept of an automated driving system entity is also reflected in the US draft Uniform State Laws, which provide for a new automated driving provider registration system. Bryant Walker Smith, reporter of the draft "Highly Automated Vehicles Act", has highlighted:

> The diversity of automated driving requires flexibility with this concept. Automated driving systems may be installed on vehicles by the developer of the system, the manufacturer of the vehicle, or another entity altogether. The vehicles may be owned by sophisticated technology companies, by fleet operators with some familiarity with automation, or by individuals (or their lenders) with no technical knowledge whatsoever. But regardless of ownership, the continued safety of automated operation is likely to require the ongoing involvement of a technically competent entity that facilitates data transfers, software updates, and technical support.[285]

4.109 We think it is important to have clarity about the entity behind the automated driving system. We have therefore borrowed the concept of the ADSE, to refer to the organisation which makes the application for authorisation. In most cases this will be the manufacturer. However, it might be a software developer; or a partnership between developer and manufacturer; or an importer. The ADSE would be required to demonstrate that it has undertaken safety tests, that it carries insurance, and that it has adequate resources to assume an ongoing responsibility for the system.

Other functions of the safety assurance scheme

4.110 We envisage that the powers to authorise automated driving systems would be exercised alongside the other functions discussed in this report. In Chapter 5 we ask whether the organisation that authorises systems before they are allowed on the road should also regulate automated vehicles once they are on the road. In particular, we ask whether the organisation should have responsibilities for consumer information, market surveillance and roadworthiness tests.[286]

4.111 In Chapter 7 we ask what should happen where an automated driving system (ADS) has acted in a way which would be a criminal offence if done by a human driver. We tentatively propose that a regulatory agency should be able to apply a range of regulatory sanctions to the entity behind the ADS. The sanction would include

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284 See para 7.26 to 7.28.

285 Uniform Law Commission, *Draft Highly Automated Vehicles Act* (June 2018). This version of the Act was a produced for the 20 to 26 July meeting of the Highly Automated Vehicles Committee.

286 See paras 5.30 to 5.32.

improvement notices, fines and (where necessary) withdrawal of ADS approval.[287] This would be another important function to be exercised by the new organisational structure.

Accreditation or third-party tests?

4.112 We welcome views on how far any new safety assurance system should be based on self-certification by the entity behind the automated driving system. Alternatively, should it involve an element of third party testing?

4.113 In June 2017, the NTC of Australia consulted on regulatory options to assure safety in automated vehicles. The main choice was between two options. The first was an accreditation system, in which the ADSE was required to demonstrate that it had carried out adequate safety testing. The second option involved an element of pre-market approval, in which a government agency tested the system to see if it met minimum standards. Following consultation, the NTC decided against pre-market approval, which "is resource-intensive and time-consuming". It thought that it could also limit or obstruct safety-related innovations. However, in the long term it might be an option, once regulators have a better understanding of the technologies and risks.[288]

4.114 The NTC developed its proposals in a 2018 Regulation Impact Statement. The document puts forward a preferred option under which the ADSE would provide self-certification against fixed criteria. This would be combined with oversight by a government agency, specific offences and enforcement measures. In addition, a "primary safety duty" would be imposed on the entity responsible for the driving system. The duty is described as an:

> overarching and positive general safety duty… to ensure the safety of the automated driving system so far as reasonably practicable.[289]

4.115 In April 2018, California established rules which would not only allow automated technology to be tested without a safety driver, but would allow it to be used by the public. The system is based on self-certification by "the manufacturer". The manufacturer must certify that it has "conducted test and validation methods, and is satisfied the vehicle is safe for deployment on public roads".[290] If deployed for public use, a person authorised by the manufacturer must sign and certify "under penalty of perjury" that, among other things, autonomous vehicles:

(1) meet all applicable Federal Motor Vehicle Safety Standards;

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287 See para 7.27.

288 NTC Australia, *Regulatory options to assure safety in automated vehicles* Discussion Paper (June 2017) p 69.

289 NTC Australia, *Safety Assurance for Automated Driving Systems: Consultation Regulation Impact Statement* (May 2018) p 31.

290 See press release at https://www.dmv.ca.gov/portal/dmv/detail/pubs/newsrel/2018/2018_17. See also the Draft Highly Automated Vehicles Act produced by the Uniform Law Commission, which provides in Section 5(2) that an automated driving provider must submit to the United States National Highway Traffic Safety Administration a safety self-assessment or equivalent report for the automated driving system.

(2) are designed to be incapable of operating in autonomous mode outside their disclosed operational design domain;

(3) are equipped with data recorders; and

(4) meet current industry standards to defend against cyber-attacks.

If the vehicle does not have a driver, there must be a communication link between the vehicle and a remote operator.[291]

4.116 The RAND Corporation has proposed a graduated approach, in which limited initial deployment is used to gather more data.[292] At first, manufacturers would provide regulators with evidence from their own trials, gained from track-based tests, virtual testing and road-trials with safety drivers. On this basis, the regulator would allow a small number of vehicles to be deployed commercially, on the condition that the deployment was used to gather data.[293] Once safety had been demonstrated, the number of vehicles would be increased. This approach is analogous to that taken in pharmaceutical trials, which gradually gather more data and use this to help determine safety.[294]

4.117 In conclusion, there are a variety of possible approaches to safety assurance. The choice between third party testing and self-certification is not necessarily binary. Some self-certification requirements are more specific than others. Furthermore, a system that relies primarily on self-certification may involve some element of testing. Expert panels and committees might evaluate the scientific and technical issues raised by the technologies seeking approval, similar to the approach used for approving new drugs, for example.[295] At this stage we welcome an initial steer on how to achieve the appropriate balance between the two systems.

291 The regulations are to be found at https://www.dmv.ca.gov/portal/wcm/connect/aa08dc20-5980-4021-a2b2-c8dec326216b/AV_Second15Day_Notice_Express_Terms.pdf?MOD=AJPERES.

292 See RAND Corporation 2017, *Challenges and approaches to realizing autonomous vehicle safety* (2017). This document was created from recorded testimony presented by Nidhi Kalra (of the RAND Corporation) to the (US) House Energy and Commerce Committee, Subcommittee on Digital Commerce and Consumer Protection on 14 February 2017.

293 We discuss the challenges of monitoring the safety of automated vehicles following commercial deployment in Ch 5 paras 5.69 to 5.71.

294 New drugs go through a multi-stage “discovery and screening phase”, followed by clinical trials increasing the number of participants at each stage before safety and labelling are reviewed for final (unrestricted) approval. For an overview of the process in the Europe Union see http://www.ema.europa.eu/ema/index.jsp?curl=pages/regulation/general/general_content_001772.jsp&mid=WC0b01ac0580b18a39.

295 See http://www.ema.europa.eu/ema/index.jsp?curl=pages/regulation/general/general_content_001595.jsp&mid=WC0b01ac0580b18a3d and https://www.fda.gov/drugs/developmentapprovalprocess/default.htm.

Ensuring local input

4.118 The new safety assurance system would be aimed at the “everything somewhere” path where, at least initially, vehicles would be confined to limited operational design domains. These could be as small as a campus or a bus route; could be as large as city; or could be limited by weather conditions or type of road.

4.119 As the NTC of Australia pointed out, the crucial safety issue is whether the vehicle can cope with demands of the operational design domain, which include (for example) the demands of dealing with its traffic controls, road conditions and environmental conditions.[296] A driving system designed to avoid kangaroos on an unsealed Australian road in a dust storm will be different from one designed exclusively for central London. Even within UK cities we have been told that driving environments in London may differ substantially from those in Manchester or Edinburgh. A system designed for one city would need to be retrained even for other city markets within the UK.[297]

4.120 The challenge is to ensure that a safety assurance scheme is sufficiently expert to understand the technology while still sufficiently sensitive to local conditions to be aware of the challenges they pose. The difficulty in reaching an acceptable balance between local and national powers is illustrated by the heated debates in the USA over the proposed SELF DRIVE Act.[298] The Bill provides for federal pre-emption in respect of automated vehicle policy, which would prevent States from imposing their own standards.

4.121 In the UK, local highway authorities have a significant role to play in creating a safe environment for automated technology. Under the Road Traffic Regulation Act 1984, local highway authorities have wide powers to prohibit, restrict or regulate the use of a given road by traffic or class of traffic. In practice these powers are commonly used to implement parking restrictions, restrict the movement of heavy goods vehicles in residential areas and restrict traffic for the purposes of special events.[299] However, these powers could be used in new and experimental ways. They could, for example, be used to restrict automated vehicles on a given road; or by contrast, to restrict all vehicles other than automated vehicles to dedicated lanes.

4.122 There is a need for an appropriate balance. Any national agency responsible for the safety of automated vehicles will need to work closely with local agencies to ensure a co-ordinated approach. We seek views on how this can best be achieved.

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296 NTC Australia, *Regulatory Reforms for Automated Road Vehicles* (November 2016) p 38.

297 Particular local challenges relate to the presence of trams and level crossings, or to the presence of vulnerable road users, such as horse riders or horse drawn carriages.

298 The Bill, numbered H.R. 3388, was introduced on 25 July 2017 by Rep. Robert Latta (R-OH5), chairman of the House Subcommittee on Digital Commerce and Consumer Protection. The acronym is short for the Safely Ensuring Lives Future Deployment and Research in Vehicle Evolution Act. See https://www.congress.gov/bill/115th-congress/house-bill/3388. The Bill was passed by the House of Representatives but, at the time of writing (October 2018), has stalled at the Senate.

299 House of Commons Library, *Roads: Traffic Regulation Orders (TROs)* SN6013 (2014).

Consultation Question 8.

4.123 Do you agree that:

(1) a new safety assurance scheme should be established to authorise automated driving systems which are installed:

(a) as modifications to registered vehicles; or

(b) in vehicles manufactured in limited numbers (a "small series");

(2) unauthorised automated driving systems should be prohibited;

(3) the safety assurance agency should also have powers to make special vehicle orders for highly automated vehicles, so as to authorise design changes which would otherwise breach construction and use regulations?

Consultation Question 9.

4.124 Do you agree that every automated driving system (ADS) should be backed by an entity (ADSE) which takes responsibility for the safety of the system?

Consultation Question 10.

4.125 We seek views on how far should a new safety assurance system be based on accrediting the developers' own systems, and how far should it involve third party testing.

Consultation Question 11.

4.126 We seek view on how the safety assurance scheme could best work with local agencies to ensure that it is sensitive to local conditions.

Chapter 5: Regulating safety on the roads

5.1 In Chapter 4 we argue that pre-placement testing can only go some way towards ensuring that automated vehicles are safe. The technology of automation is developing extremely fast - often faster than regulatory standards or testing protocols. With such sophisticated and untried technologies, it is not possible to know if automated systems are safe enough until they have been used in real world driving conditions.

5.2 This is true for all levels of automation. Where advanced driver assistance systems are installed in consumer vehicles, the main challenges arise out of human-machine interactions. In Chapter 3 we discuss the problem of "automation complacency". How do we ensure that human drivers are aware of the limitations of the system, and how do we prevent drivers from over-relying on automation? With highly automated systems, it is even more difficult to know how automated driving systems will interact with other road users until they operate in practice.

5.3 In this chapter we provide a short round-up of the many ways in which road safety is monitored and regulated in the UK. We look at:

(1) consumer information and marketing;

(2) market surveillance and recalls;

(3) roadworthiness tests;

(4) driver training; and

(5) accident investigation.

5.4 The first responsibility, for consumer information and marketing, lies with trading standards and the Advertising Standards Authority (ASA).[300] The Driver and Vehicle Standards Agency (DVSA) sets standards for driver training and roadworthiness. It also monitors recalls of vehicles and parts, and carries out tests on commercial vehicles and their drivers.[301] Meanwhile, the police have responsibility for investigating accidents and for enforcing traffic law through the criminal justice system.[302]

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300 The Advertising Standards Agency is the UK's independent regulator of advertising. It ensures that advertisements in the UK comply with the Advertising Codes. For more information, see https://www.asa.org.uk/.

301 The Driver & Vehicle Standards Agency Business Plan 2017 to 2018 lists nine specific tasks, including approving instructors and MOT testers; testing lorries, buses and coaches and trailers; carrying out checks on commercial drivers; and supporting Traffic Commissioners to license and monitor companies who operate lorries, buses and coaches.

302 In 2016, around 4,900 dedicated police officers were employed to enforce traffic law (a fall from 5,237 in 2015) see https://www.racfoundation.org/media-centre/another-fall-in-traffic-police-numbers. This compares with 4,338 full-time equivalent staff employed by the Driver & Vehicle Standards Agency in 2016-17: see The Driver & Vehicle Standards Agency Annual Report and Accounts 2016/17, p 35.

5.5 We are interested in whether this division of responsibilities works for an automated driving environment. Alternatively, do we need a new organisational structure to oversee the safe deployment of automated vehicles, which brings together these disparate responsibilities?

5.6 We also ask whether there needs to be a standard of “safe enough” which includes the overall casualty levels caused by automated driving systems, compared with human drivers. If so, how would that standard be measured?

REGULATING CONSUMER INFORMATION AND MARKETING

5.7 In Chapter 3, we discussed the insights of human factors research for advanced driver assistance systems. The challenge is to ensure that drivers are not beguiled into thinking that these new technologies are more capable than they really are. There is a need to ensure that drivers understand when and where the technology can be used and how to stay alert for possible dangers.

5.8 Consumers receive information about advanced driver assistance systems from many sources, including marketing, the “sales pitch” during a test drive and the owner’s manual. The message given at each stage needs to reinforce an accurate understanding of what the function can (and more importantly, cannot) do. If a vehicle is hyped during marketing, subsequent warnings to “keep your hands on the wheel” are likely to be less effective. As discussed in Chapter 4, Thatcham Research has argued that more should be done to ensure that that the terminology used to describe system functionality is accurate.[303] Similarly, there needs to be clear and memorable information about the limits of the vehicle’s operational design domain.

5.9 At present, marketing terms are not considered as part of the type approval process discussed in Chapter 4. Instead, they are regulated through separate laws.

5.10 EU member states have powers to regulate marketing. Under the Unfair Commercial Practices Directive 2005, traders are forbidden from making misleading statements or misleading omissions.[304] If they do, in the UK, action can be brought against them by trading standards officers employed by local authorities. Where advertisements are misleading or encourage irresponsible driving behaviour, it is also possible to complain to the ASA. The ASA does not have formal statutory powers. However, it can publicise its rulings, require that an advertisement is withdrawn or amended and refer issues to Trading Standards for further action.[305]

5.11 Although the powers to regulate marketing exist, the institutional structure for doing so is less than ideal. Trading Standards may lack a detailed understanding of the limits of

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303 Association of British Insurers and Thatcham Research, *Assisted and Automated Driving Technical Assessment* (June 2018).

304 2005/29/EC, implemented in the UK by the Consumer Protection from Unfair Trading Regulations 2008.

305 In March 2017, the Advertising Standards Authority found that an advert by Jaguar Land Rover Ltd was irresponsible and encouraged unsafe driving. The advert claimed that the in-built technology in the car meant the driver could use their car as an extension of the workplace. The Advertising Standards Authority required Jaguar Land Rover Ltd not to show the advert again. See https://www.asa.org.uk/rulings/jaguar-land-rover-ltd-a16-357750.html.

an automated driving system. They may also assume, wrongly, that if a named function has received type approval at EU or international level, the name given to the function has also been approved. Furthermore, Trading Standards departments are under considerable financial pressure,[306] which means that local authorities may be reluctant to take on complex litigation with vehicle manufacturers.

5.12 Below we ask about a new organisational structure to regulate the safety of automated vehicles. If so, should it have responsibilities to ensure clear consumer information and marketing about the limits of advanced driver assistance systems?

MARKET SURVEILLANCE AND RECALLS

Market surveillance

5.13 One criticism of type approval following the Volkswagen emissions scandal was that it failed to do enough to test vehicles in real world conditions after they had been placed on the market. Post-placement monitoring of this type is referred to as "market surveillance". There are currently no market surveillance requirements in the Framework Directive on type approval.[307] Instead, motor vehicles are subject to general market surveillance requirements which apply to all consumer products.

5.14 The relevant provision is EU Regulation 765/2008 on Accreditation and Market Surveillance. This is written in broad, general terms. Member states must appoint appropriate surveillance authorities to carry out checks and, if problems are found, to work with the industry to find a solution. In serious cases, authorities are under a duty to ensure that the product is taken off the market. Under Article 20 of the 2008 Regulation, where member states find products which "present a serious risk requiring rapid intervention", they must ensure that the products are "recalled, withdrawn or that their being made available is prohibited".

5.15 Within the UK, surveillance of automotive products is the responsibility of the DVSA. The UK's National Market Surveillance programme for 2017 describes the DVSA's work in the following terms:

> DVSA's Market Surveillance Unit ensures that products in free circulation comply with relevant safety and environmental legislative requirements.
>
> The Unit manages a programme of in-service market testing assessments checking that vehicles meet (in service) type approval requirements and aftermarket components are manufactured to the correct standards….

306 In 2015, research commissioned by the Department for Business, Innovation and Skills and Trading Standards Institute reported that "almost all trading standards departments have experienced sharp cuts in their budgets and most now operate with about half the number of staff that they employed five years ago": J Raine, C Mangan and P Watt, *The Impact of Trading Standards in Challenging Times* (March 2015).

307 Following concerns about emissions, the EU Commission proposed that there should be much more specific requirements for member states to monitor vehicles on the market, to deal with both environment and safety risks: see European Commission 27.1.2016; COM (2016) 31 Final. This is addressed in the new draft Regulation. Member states will be under new duties to carry out regular spot checks on vehicles on the market and make the results publicly available.

> Enforcement activity is carried out through reacting to complaints, testing of products at approved test facilities, monitoring of information and products at point of sale, and monitoring of advertisements.[308]

5.16 In 2017, the focus of the Unit's work was on exhaust emissions. Following a programme of work in 2016 to test diesel cars, it expanded its work to include petrol cars, light vans, trucks and buses.

Powers to recall or withdraw unsafe products

5.17 The Market Surveillance Regulation 765/2008 imposes a duty to remove unsafe products from the market, but does not provide the power to do so. In the UK, powers to remove unsafe products are to be found in the General Product Safety Regulations 2005,[309] which implement the EU Directive on General Product Safety.[310] Regulation 15 provides for "a recall notice":

> where an enforcement authority has reasonable grounds for believing that a product is a dangerous product and that it has already been supplied or made available to consumers, the authority may serve a notice ("a recall notice") requiring the person on whom it is served to use his reasonable endeavours to organise the return of the product from consumers to that person or to such other person as is specified in the notice.[311]

5.18 Under regulation 14, there is a power to issue withdrawal notices, preventing dangerous products from being placed on the market. Injunction-type powers can be powerful deterrents to putting products on the market that have not been proven to be safe. A high-profile example in the United States saw the National Highway Transport Safety Administration threaten a company which proposed to sell an "add on" which professed to make otherwise conventional cars self-driving with a fine of up to $21,000 per day unless it proved the safety of the self-driving feature.[312]

Recalls in practice

5.19 Product recalls in the automotive sector are common. In 2016, DVSA issued 764 such recalls; in 2017 it issued 914.[313]

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308 Department of Business, Energy and Industrial Strategy, *UK National Market Surveillance Programme 2017* (October 2017).

309 SI 2005 No 1803.

310 2001/95/EC, together with 2004/95/EC. The Internal Market and Consumer Protection Committee has submitted a proposal to replace the directive with a regulation of the European Parliament and the Council laying down rules and procedures for compliance with and enforcement of Union harmonisation legislation on products, http://www.europarl.europa.eu/RegData/etudes/BRIE/2018/614696/EPRS_BRI%282018%29614696_EN.pdf.

311 General Product Safety Regulations, SI 2005 No 1803, s 15(1).

312 http://uk.businessinsider.com/george-hotz-comma-ai-shuts-down-driverless-car-project-2016-10.

313 Figures are taken from the Driver and Vehicle Standards Agency recalls database. Note that some recalls have the same reference number but relate to different models/variants of the same manufacturer/vehicle. Database accessible at http://www.dft.gov.uk/vosa/apps/recalls/default.asp.

5.20 DVSA has worked with motor manufacturers and industry groups to develop a code of practice to govern recalls.[314] The onus is on manufacturers to organise the process under DVSA supervision. The Vehicle Safety Branch within DVSA acts as the main contact for all safety defect and recall matters.

5.21 Where a producer or supplier becomes aware of a safety defect affecting vehicles, they should notify the Vehicle Safety Branch. Where appropriate, the Vehicle Safety Branch authorises the Driver and Vehicle Licensing Agency to release information about the relevant vehicle keepers. The manufacturer then writes to registered keepers, and where necessary, contacts the press. The Vehicle Safety Branch comments on drafts of letters to customers, and receives reports about response rates every three months.[315] Usually, the process of repairing or refitting vehicles is carried out by the manufacturers' dealership network.[316] However, manufacturers may need to give information to independent outlets to discharge their responsibilities.

5.22 All consumer product recalls in the EU must be reported to RAPEX (Rapid Exchange of Information System). This is an EU initiative under the Directive 2001/95/EC, to share information about serious product defects between member states. The Government has indicated that it wishes to remain part of RAPEX.[317]

Implications

5.23 DVSA is required to monitor the safety of vehicles, to see if they present a serious risk requiring rapid intervention. If so, powers exist to require that the product is withdrawn and recalled. The Vehicle Safety Branch within DVSA already works closely with vehicle manufacturers to oversee recalls in practice.

5.24 These powers appear sufficient to ensure that if automated vehicles generate safety concerns, they can be recalled or withdrawn from the market. However, safety concerns about automated vehicles may emerge in different ways from concerns about conventional vehicles. Where vehicles drive themselves, concerns may arise from breach of traffic laws, following police reports that automated vehicles were (for example) speeding, failing to stop for red traffic lights or driving in a dangerous way. Others may arise from accidents. At the end of this chapter, we consider the need for statistical monitoring, so that action could be taken if the accident rate of automated vehicles exceeds that of equivalent human drivers.

5.25 We ask whether the organisation which authorises automated driving systems before they are allowed onto the roads should also be responsible for market surveillance.

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314 DVSA, *Vehicle Safety Defects and Recalls: Code of Practice* (2013). Available at https://www.gov.uk/government/publications/code-of-practice-on-vehicle-safety-defects-and-recalls/vehicle-safety-defects-and-recalls-code-of-practice. There is a separate code for the vehicle aftermarket.

315 DVSA, *Vehicle Safety Defects and Recalls: Code of Practice* (2013), section 10.

316 DVSA, *A Manufacturer's Guide to Recalls in the UK Automotive Sector* (April 2014), https://www.gov.uk/government/publications/manufacturers-guide-to-recalls-in-the-uk-automotive-sector.

317 HM Government, *The Future Relationship between the United Kingdom and the European Union* (July 2018) para 46.

ROADWORTHINESS TESTS

5.26 Most vehicles over three years old are required to undergo an annual roadworthiness test. When the tests were introduced in 1960, they were administered by the then Ministry of Transport (MOT). The term "MOT" is still used to refer to the test and the certificate, in both common parlance and official documentation.[318] However, the scheme is currently administered by the DVSA, operating subject to the provisions of EU Directives.

5.27 In 2014, the EU adopted a new package of rules to strengthen roadworthiness testing.[319] For the present purposes, the most important provision is Directive 2014/45/EU on periodic roadworthiness tests, which came into force in May 2018. Among other things, this introduces new standards for training inspectors and requires the testing of electronic safety components such as anti-lock braking systems, electronic power steering and airbags. It sets minimum standards and allows member states to set higher standards if they wish.[320]

5.28 At present, there is no testing of automated driving features. Instead cars with advanced driver assistance features may need to disable the function before the vehicle can be tested.[321]

5.29 In the future, new tests for automated features need to be developed. We seek views on whether, if a new organisation is established to promote the safety of automated vehicles, it should have responsibility for setting standards and testing procedures for the roadworthiness of automated vehicles.

A NEW ORGANISATIONAL STRUCTURE?

5.30 This discussion has shown that powers already exist to regulate marketing material, to recall vehicles and to expand roadworthiness testing. However, the current institutional structure does not necessarily bring together specific expertise about automated vehicles.

5.31 In Chapter 4 we tentatively proposed a new safety assurance scheme to authorise automated driving systems before they are allowed onto the roads. We ask if the same organisation that authorises automated driving systems before they are deployed should also regulate the safety of driving automation on the road. At this stage, we are particularly interested in whether the organisation should have responsibilities for consumer information, for market surveillance and for roadworthiness tests.

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318 UK Government, https://www.gov.uk/topic/mot.

319 S Pillath, European Parliamentary Research Service, *Briefing: Automated vehicles in the EU* (2016) p 8.

320 Directive 2014/45/EU recital 4 and art 2(3) states that "Member States may introduce national requirements concerning roadworthiness tests for vehicles registered in their territory which are not covered by the scope of this directive".

321 For example, Tesla provides guidance to its customers as to how to configure their cars for standard MOT tests: https://www.tesla.com/en_GB/support/mot-testing.

5.32 Many of these current concerns in this area are not confined to highly automated systems which drive themselves. There are also concerns about how consumers receive information about advanced driver assistance systems, and the lack of roadworthiness tests for such systems. We therefore ask if the safety assurance agency should have responsibilities for monitoring the safety of driver assistance systems (at SAE Level 2) as well as highly automated vehicles which drive themselves.[322]

Consultation Question 12.

5.33 If there is to be a new safety assurance scheme to authorise automated driving systems before they are allowed onto the roads, should the agency also have responsibilities for safety of these systems following deployment?

5.34 If so, should the organisation have responsibilities for:

(1) regulating consumer and marketing materials?

(2) market surveillance?

(3) roadworthiness tests?

5.35 We seek views on whether the agency's responsibilities in these three areas should extend to advanced driver assistance systems.

BREACHES OF TRAFFIC LAW

5.36 In Chapter 7 we look at the way in which human drivers incur criminal liability if their driving breaches rules and standards. We envisage that for lower levels of automation, where a human driver is responsible for monitoring the driving environment, this system will continue. Human drivers will continue to be prosecuted if the vehicle speeds, or runs a red light or drives dangerously. However, for higher levels of automation, where human monitoring is not required, there comes a point at which it may no longer be appropriate to hold a human driver responsible for faults within the automated driving system. This raises questions about how driving infractions of traffic by highly automated driving systems will be dealt with.

5.37 In Chapter 7 we tentatively propose that where an automated driving system has acted in a way which would be a criminal offence if done by a human driver, the regulatory authority should be able to apply a range of regulatory sanctions to the entity behind the automated driving system.

5.38 A full discussion of this issue is to be found at paragraphs 7.23 to 7.35. At this stage we simply note that breaches of traffic law may be an additional responsibility for the new organisation.

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322 Our proposals for a safety assurance agency can be found at paras 4.102 to 4.122 above.

DRIVER TRAINING

5.39 Consumer information can only go so far to communicate what an automated system can (or more importantly, cannot) do. Not all drivers read the manual, so regulating written information may not be sufficient. Would the UK be able to go further, and require that human drivers using advanced driver assistance systems receive training about the limits of the system and how to monitor it effectively?

5.40 We start by considering whether some form of additional or alternative driving test for driver assistance systems would be compatible with the Vienna Convention on Road Traffic and EU law. We look briefly at each before considering whether new driver training would be desirable.

5.41 In the longer term, humans in highly automated systems may require a different skill set compared to drivers in conventional cars. This could have positive impacts for disabled persons for example, and others currently unable to fulfil current driving licence requirements. As the Royal Society for the Prevention of Accidents noted in its submission to the Select Committee on Science and Technology in 2016:

> As highly and fully autonomous vehicles are developed it will be necessary to decide whether they can be driven on a normal car licence, or whether a new licence category for highly autonomous vehicles will be needed.[323]

5.42 In Chapter 3, we raised the possibility of "remote driving" from a control centre, where several vehicles are supervised at once. This too may involve new and different skills.

The Vienna Convention on Road Traffic 1968

5.43 As we discuss in Chapter 2, this is an international treaty to establish common traffic rules that facilitate international commerce and better road safety. The Convention has 78 countries which are parties to it. The UK signed the Treaty in 1968, and began ratification on 28 March 2018.[324]

5.44 Under Article 41(1)(a) of the Convention, every driver of a motor vehicle must hold a driving permit.[325] The Convention aims to bring some standardisation to categories of driving permits. Annex 6 sets out seven categories of permit and six sub-categories,

[323] The Royal Society for the Prevention of Accidents, Submission to the House of Lords Select Committee on Science and Technology Autonomous vehicles inquiry (October 2016). Available at https://www.rospa.com/rospaweb/docs/advice-services/road-safety/consultations/2016/autonomous-vehicles-inquiry.pdf.

[324] Information on Treaty participants and their status is available at - https://treaties.un.org/pages/ViewDetailsIII.aspx?src=IND&mtdsg_no=XI-B-19&chapter=11&Temp=mtdsg3&clang=_en; see also https://www.gov.uk/government/publications/road-haulage-and-driving-in-the-eu-post-brexit/ratifying-the-1968-vienna-convention.

[325] Parties to the Convention undertake to ensure that "driving permits are issued only after verification by the competent authorities that the driver possesses the required knowledge and skill": art 41(1)(b). One advantage of ratification is that the UK can now issue International Driving Permits, which must be recognised by every other party to the convention: art 41(2)(a)(ii).

each relating to a type of vehicle. For example, motorcycles are category A and light motorcycles are sub-category A1.

5.45 Importantly, however, the Convention allows contracting parties to add new categories of driving licence if they wish. As Annex 6 states, "domestic legislation may introduce categories and subcategories of vehicle other than those listed".[326] Therefore, the Convention does not preclude the UK from setting up new forms of licence categories for automated vehicles if this were thought desirable.

EU law: Third Driving Licence Directive 2006

5.46 This EU Directive[327] builds on previous directives to harmonise driving licence rules across the EU. Under the Directive:

(1) all driving licences issued in EU Member States must follow the same format and contain the same information;[328]

(2) driving licences in EU Member States must be mutually recognised.[329]

(3) set categories of vehicles for which licences can be issued are fixed, with minimum age requirements for each;[330] and

(4) theory and skill tests for licences issued in EU Member States are subject to common standards;[331]

5.47 Under Article 4(5), member states have a limited right to exclude certain specific types of vehicles (such as special vehicles for disabled persons) from these requirements. However, this requires agreement from the European Commission.

5.48 The European Commission reviewed the Directive in November 2017. The Commission noted the "current climate of new technologies" and the need in the longer term to remove obstacles to "the deployment of electric vehicles, vehicles with alternative propulsions and vehicles with advanced driver assistance systems".[332] It also

326 Annex 6, para 10.

327 Third Driving Licence Directive, 2006/126/EC.

328 Art 1.

329 Art 2.

330 Art 4. Broadly the categories are mopeds (Categories AM, P and Q), motorcycles (categories A1, A2 and A), Light vehicles including cars and quad bikes (Categories B, B auto, BE), medium sized vehicles (Categories C1 and C1E), large vehicles (Categories C and CE), minibuses (Categories D1 and D1E), and buses (D and DE).

331 Art 7. For example, to drive a large motorcycle (category A or A2), a driver must have a minimum of 2 years' experience on a small motorcycle (category A1). This particular change was introduced by the Third Directive.

332 European Commission, *Final Report: The implementation of Directive 2006/126/EC on driving licences* (February 2018) p 9; https://publications.europa.eu/en/publication-detail/-/publication/bbd8141d-e603-11e7-9749-01aa75ed71a1/language-en.

commented that "automated driving raises the question of whether the Third Driving Licence Directive provides a suitable basis for current and future technologies".[333]

5.49 The Commission concluded, however, that there should be no additional categories for now. It thought that that while technological developments such as automated driving mean that "new provisions may be needed and several legal problems must be solved", it was important that the existing category system be kept as simple as possible. Accordingly, "the introduction of new categories should be avoided unless strong benefits are found".[334]

5.50 It appears that, at present, introducing a new category of driving licence for a human driver to use an automated vehicle is not compatible with EU law, but this may change in the future.

Adding elements to the main driving test

5.51 Even if it is not currently possible to require a separate licence category to drive a highly automated vehicle, the UK could require some familiarity with automated driving systems in the main driving test, if this were thought desirable.

5.52 The Directive states that all driving tests must consist of a theory test and a test of skills and behaviour.[335] The theory test must consist of questions on topics such as road traffic regulations, alertness, driving risk factors and vulnerable road users.[336] This might, for example, include questions on maintaining alertness while using driver assistance features and understanding the risk factors for vulnerable road users.

5.53 Furthermore, the requirements under the Directive are described as "minimum requirements for driving tests." This suggests that, despite the inflexibility regarding permissible categories of driving licence, there is flexibility as to what a member state can require of a driver for each category of licence.

Is additional driver training desirable?

5.54 For the present, most drivers do not use the more advanced driver assistance systems. It therefore appears premature to consider changes to the main driving test. Furthermore, each manufacturer has a different system, so it would be difficult to offer training which covered all the variables. However, if driver assistance systems become common and standardised, the issue may need to be revisited.

5.55 In initial discussions stakeholders suggested that, rather than change the law, the issue could be dealt with by voluntary training. It was suggested that insurers could provide incentives for voluntary training by offering discounts on insurance premiums. For

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333 As above. Of the twelve EU Member States that commented on the issue of automated driving, six stated it had at least some influence and six stated it had none. Several Member States expressed the view that the Directive was not relevant to automated driving at all.

334 European Commission, *Final Report: The implementation of Directive 2006/126/EC on driving licences*, as above.

335 The requirements of the UK driving test are found in the Third Directive on driving licences, Directive 2006/126/EC, Annex II and are implemented in the The Motor Vehicles (Driving Licence) Regulations 1999, SI 1999 No 2864, schedules 7 and 8.

336 The Motor Vehicles (Driving Licence) Regulations 1999, SI 1999 No 2864, schedule 7.

example, insurers could work with manufacturers to offer short courses on using advanced driver assistance systems: the insurer would benefit from safer drivers and the driver would benefit from cheaper insurance. We seek views.

Consultation Question 13.

5.56 Is there a need to provide drivers with additional training on advanced driver assistance systems?

5.57 If so, can this be met on a voluntary basis, through incentives offered by insurers?

ACCIDENT INVESTIGATION

5.58 The UK currently has specialist units to investigate the causes of aviation, maritime and rail accidents. These are the Air Accident Investigation Branch, the Marine Accident Investigation Branch and the Rail Accident Investigation Branch.[337] Their main purpose is to investigate the causes of accidents and provide recommendations to prevent similar incidents in the future. Rather than attempting to allocate blame, they exist to improve overall safety. They enjoy high reputations for their independence and technical expertise.[338]

5.59 There is no similar organisation to investigate accidents on the road. Instead, road traffic accidents are investigated by coroners' departments[339] or the police. Coroners investigate road deaths to find the cause of death and can make recommendations to improve safety.[340] Before writing their reports, they may take advice from technical experts or ask for a response from the highway authorities. However, their recommendations are non-binding.

5.60 Police investigations are mainly centred on establishing whether an offence has been committed so that, where appropriate, criminal proceedings can be brought. This is fundamentally different from an accident investigation board that attempts to look at the causes of an accident.[341] The police may make recommendations for future changes which, like coroner's reports, are non-binding.

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337 These agencies are part of the Department for Transport (DfT) with chiefs that report to a departmental director general, who is on the DfT board. Despite this, because they conduct their investigations free from interference, they are considered largely independent.

338 S Gooding, RAC Foundation, 'Towards an Accident Investigation Branch for Roads?' (December 2017). https://www.racfoundation.org/research/safety/towards-an-accident-investigation-branch-for-roads.

339 Or in Scotland, by the Procurator Fiscal, who holds a Fatal Accident Inquiry. In both jurisdictions, the Health & Safety Executive may be involved where someone was driving in the course of their employment.

340 Courts and Tribunals Judiciary, https://www.judiciary.gov.uk/publication-jurisdiction/coroner/.

341 Transport Safety Commission, *UK Transport Safety: Who is responsible?* (2015) p 30. http://www.pacts.org.uk/wp-content/uploads/sites/2/TSCResponsibility_LowRes%20COMPLETE%20FINAL.pdf.

The debate over an accident investigation branch for road traffic

5.61 Air and rail casualties attract more public concern than road casualties, partly because more people tend to be affected by a single incident. However, in terms of overall numbers, far more deaths occur on the roads than in other forms of transport.[342] In the year ending September 2017 there were 1,720 road deaths in Great Britain.[343] By comparison, for large commercial passenger aircraft, there have been no fatalities in the UK or involving UK-registered airlines since 1999. There have been no passenger deaths in a train collision since 2007.[344] In light of the high number of road deaths, there have been calls for a dedicated accident investigation board to analyse the root causes of road accidents.

The arguments for

5.62 The arguments for a road accident investigation branch are that it could develop high levels of technical expertise and pool data over many individual incidents. Unlike a police investigation, an AIB investigation would aim to understand the causes of an accident, rather than ascribe blame. This, it is argued, encourages a more open climate and allows stakeholders such as manufacturers and highways authorities to contribute information and suggestions without fear of exposing themselves to litigation. This is cited by Hodges and Steinholtz as one of the prime benefits of the accident investigation boards in other industries.[345]

International experience

5.63 There are international precedents for organisations which investigate road accidents, though they tend to allocate resources only to those accidents which raise significant safety concerns. For example, the Swedish Accident Investigations Authority will generally only investigate accidents if several persons have been killed, or there has been serious damage to property, or there are important lessons to be learned.[346]

5.64 In the United States, the National Transportation Safety Board (NTSB) has a remit which includes aviation, marine, rail and significant types of highway accidents. Investigators from the agency examine highway accidents involving issues with wide-ranging safety significance. They also conduct studies and research to identify the common risks or underlying causes of crashes.[347] On 19 March 2018, the NTSB opened

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[342] UK government, https://www.gov.uk/government/statistical-data-sets/ras53-modal-comparisons#history.

[343] UK government, https://www.gov.uk/government/statistics/reported-road-casualties-great-britain-provisional-estimates-july-to-september-2017.

[344] Passenger deaths have occurred on the train-platform interface, where passengers have fallen between the platform and train and have been struck by moving trains when standing too close to the edge: Transport Safety Commission, *UK Transport Safety: Who is responsible?* (2015) p 1 http://www.pacts.org.uk/wp-content/uploads/sites/2/TSCResponsibility_LowRes%20COMPLETE%20FINAL.pdf.

[345] C Hodges and R Steinholtz, *Ethical Business Practice and regulation: A Behavioural and Values-based Approach to Compliance and Enforcement* (1st ed 2017) p 84.

[346] SHK, Swedish Accident Investigation Authority. https://www.havkom.se/en/om-shk/vaegtrafik-och-oevriga-olyckor.

[347] National Transportation Safety Board, https://www.ntsb.gov/about/organization/HS/Pages/office_hs.aspx.

an investigation into a fatal collision between an automated Uber test vehicle and a pedestrian in Tempe, Arizona. On 24 May 2018 it released its provisional findings.[348]

The arguments against

5.65 Successive UK governments have resisted calls for a dedicated road AIB. It is argued that many police and coroner units have built up considerable experience investigating road traffic incidents and their reports effectively address the root causes of individual accidents.[349] Secondly, without substantial investment, the volume and geographical spread of collisions may be beyond the capabilities of a non-police organisation. Thirdly, the police have powers to close motorways and use blue lights and high speeds to attend the site of the collision. Thus, it is said, setting up an AIB would be expensive but provide little benefit.[350]

Trials of a new investigatory approach

5.66 In December 2017, the RAC Foundation published a report looking at the how the first steps could be taken towards a more investigatory approach to accidents. It acknowledged that a case-by-case investigation of every injury accident, "would be a huge - probably impractical - undertaking". Instead what was needed was data analysis to identify patterns and systemic weaknesses, coupled with "a deep-dive analysis of a sample of incidents" and research to establish the prevalence of identified risk factors.[351] The Director, Steve Gooding, argued that:

> If DfT provided some modest seed corn funding it would be possible to envisage a local or regional pilot involving one or more highway authorities and their associated police constabularies acting together on a voluntary basis.[352]

5.67 On 11 June 2018, the Government announced that it will provide the RAC Foundation with £480,000 of government funding to trial "an innovative new approach to road casualty investigation alongside police forces".[353] The RAC foundation report that the money will be spent:

> helping selected police forces to recruit additional staff to collect and collate collision data which will then be analysed to identify and understand common themes and patterns that result in death and injury on the public highway. The insight could then help shape future policy making.[354]

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348 https://www.ntsb.gov/news/press-releases/Pages/NR20180524.aspx.

349 In Scotland, the creation of Police Scotland as a single force also allows the development of specialist expertise.

350 Hansard (HC), 30 March 2017, vol 624, col 391, Debate on a Road Collision Investigation Unit.

351 S Gooding, RAC Foundation, *Towards an Accident Investigation Branch for the Roads?* (December 2017).

352 https://www.racfoundation.org/research/safety/towards-an-accident-investigation-branch-for-roads.

353 https://www.gov.uk/government/news/drink-drivers-face-swifter-justice-with-new-roadside-breathalysers.

354 https://www.racfoundation.org/media-centre/crash-investigation-stepped-up-a-gear.

5.68 As part of this project we have been told that the Government is exploring options to enhance its road traffic data collection programme to support investigations into incidents involving advanced and automated driving systems.[355]

Investigating accidents involving automated vehicles

5.69 The introduction of driving automation raises new challenges for the current system of investigating road accidents. If these systems malfunction, they are likely to do so in ways which are unfamiliar to coroners or police officers. Understanding the causes of such failure will involve new types of expertise.

5.70 We seek views on how these challenges could be met. One possibility might be to consider an Accident Investigation Branch, similar to the NTSB in the United States, to investigate high profile road accidents which raise general safety issues. Such a branch might be able to develop particular expertise in driving automation.

5.71 An alternative approach would be to maintain the current system of police and coroners' investigations, but to provide investigators with new resources to draw on. These new resources could provide specialist expertise in driving automation and allow in-depth "deep dive" investigations into high profile accidents, as well as analysing trends and data.

Consultation Question 14.

5.72 We seek views on how accidents involving driving automation should be investigated.

5.73 We seek views on whether an Accident Investigation Branch should investigate high profile accidents involving automated vehicles. Alternatively, should specialist expertise be provided to police forces.

SETTING AND MONITORING A SAFETY STANDARD

5.74 The UK Government has drawn attention to the safety benefits of automated vehicle technologies, stressing "the potential to improve road safety and reduce casualties".[356] This leads to the question of how safe an automated driving system needs to be in order to be allowed on UK roads. How will the standard be set, and how will it be monitored in practice?

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355 One possibility would be to enhance the RAIDS database described at para 5.96. The database is run by an independent research institute, TRL. TRL explains that their experts "quickly and accurately reconstruct collisions and analyse the data, to inform road and vehicle safety research policy and to develop standards to prevent future collisions or mitigate injuries": see https://trl.co.uk/projects/road-accident-depth-study-raids.

356 Department for Transport, *The Pathway to Driverless Cars: a Code of Practice for Testing* (July 2015) para 1.1.

How safe is "safe enough"?

5.75 In the US context, Nidhi Kalra and David Groves of the RAND Corporation have explored this issue in depth. They set out the dilemma as follows:

> From a utilitarian standpoint, it seems sensible that HAVs [highly automated vehicles] should be allowed on US roads once they are judged safer than the average human driver so that the number of lives lost to road fatalities can begin to be reduced as soon as possible. Yet, under such a policy, HAVs would still cause many crashes, injuries, and fatalities — albeit fewer than their human counterparts. This may not be acceptable to society, and some argue that the technology should be significantly safer or even nearly perfect before HAVs are allowed on the road. Yet waiting for HAVs that are many times safer than human drivers misses opportunities to save lives. It is the very definition of allowing perfect to be the enemy of good.[357]

5.76 The authors of the RAND study modelled the effects of allowing highly automated vehicles for consumer use when safety performance is just 10% better than that of the average human driver, compared with policies under which safety performance had to be 75% or 90% better. They found that over 15 years, many more lives were saved by introducing highly automated vehicles early (when they were just 10% better).[358]

5.77 Kalra and Groves conclude that "society — including the public, policymakers, the judicial system, and the transportation industry — must balance the incidence of crashes from highly automated vehicles and conventional cars with the social acceptability of each".[359] However, this should be done with an understanding of the trade-offs involved.

The need for a performance-based safety standard

5.78 In Chapter 4 we noted that, under the framework directive, new technologies should only be approved if they show an "equivalent" level of safety.[360] This suggests that automated driving systems should at least meet the standard of a reasonably competent human driver in their overall safety record. There is an argument that automated driving systems should be held to a higher standard than human drivers, as (unlike humans) they do not become drowsy or distracted. On the other hand, machines are subject to failures to which humans are not. As the RAND Corporation point out, setting too high

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357 Kalra and Groves, RAND Corporation, *The Enemy of Good: Estimating the Cost of Waiting for Nearly Perfect Automated Vehicles* (2017) p ix, https://www.rand.org/content/dam/rand/pubs/research_reports/RR2100/RR2150/RAND_RR2150.pdf.

358 Kalra and Groves comment that and "those savings can be significant — tens of thousands to hundreds of thousands of lives": see Kalra and Groves, RAND Corporation, *The Enemy of Good: Estimating the Cost of Waiting for Nearly Perfect Automated Vehicles* (2017) p 25.

359 Kalra and Groves, RAND Corporation, *The Enemy of Good: Estimating the Cost of Waiting for Nearly Perfect Automated Vehicles* (2017) p 31.

360 For new technologies, the process for obtaining an exemption from certain regulations is set out in the Framework Directive 2007/46/EC, art 20(2)(c) and UNECE 1958 Agreement (Revision 3, E/ECE/TRANS/505/Rev.3) schedules 1 and 7. For a full discussion, see paras 4.50 to 4.56.

a standard could delay the introduction of driving automation, which might lead to more deaths overall.[361]

5.79 The most difficult trade-offs are found where an automated system is safer overall, but is subject to new and surprising failures in specific circumstances. Transport Systems Catapult note that the shift to automated driving potentially changes the way that risks are distributed between the different groups affected by road accidents:

> The redistribution of risk from one group of would-be manual drivers who may have been inattentive/incapacitated/incapable when faced with a high-risk situation, to a new group who are selected by fate to suffer a collision, is an ethical issue which requires further thought and research.[362]

5.80 The Health and Safety at Work Act 1974 refers to the standard of "as low as reasonably practicable". Section 2 requires:

> provision and maintenance of plant and systems of work that are, *so far as is reasonably practicable,* safe and without risks to health.[363] (emphasis added)

5.81 This has been put forward as an alternative possible benchmark. Transport Systems Catapult notes, however, that this does little to identify an acceptable level of risk.[364] It could also a involve cost benefit analysis, by which some safety features were considered too expensive.

5.82 The RAND Corporation concludes that "whether AVs should be merely better than the average driver, or much better — or even worse — is a policy question still to be determined".[365] It is not the role of the Law Commissions to decide where the standard should be set. The issue of how safe automated vehicles need to be compared with human drivers will be a matter for the Government, after detailed consultation. Once Government has set the standard, it will need to be monitored, as discussed below.

The need to monitor safety standards in practice

5.83 The RAND Corporation has shown how difficult it would be to measure whether automated vehicles are safer than human drivers *before* they are deployed commercially. This is partly because it would take billions of miles of test driving to provide a sufficient statistical sample to show any safety difference.[366] It is also because

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361 Kalra and Groves, RAND Corporation, *The Enemy of Good: Estimating the Cost of Waiting for Nearly Perfect Automated Vehicles* (2017) p 26.

362 Transport Systems Catapult, *Taxonomy of scenarios for automated driving - Technical Report* (2017) p 31.

364 Transport Systems Catapult, *Taxonomy of scenarios for automated driving - Technical Report* (2017) p 29.

365 RAND Corporation, *Autonomous Vehicles and Federal Safety Standards: An Exemption to the Rule?* (2017) p 6, https://www.rand.org/content/dam/rand/pubs/perspectives/PE200/PE258/RAND_PE258.pdf.

366 Mathematic modelling demonstrates, for example, that based on fatalities alone, it would take 8.8 billion miles of driving to show with 95% confidence that automated driving had 20% fewer fatalities than the average US rate: see N Kaira and M Paddock, RAND Corporation, *Driving to Safety: How many miles of driving would it take to demonstrate autonomous vehicle reliability?* (2016).

we will never fully understand how automated systems will interact with human drivers and other road users until they are deployed in real world conditions.

5.84 Safety will therefore need to be monitored after deployment. We envisage that once Government has set a safety standard, a Government agency would need to be responsible for monitoring the standard in practice. This would involve collecting data on the level of accidents caused by automated vehicles,[367] and comparing the data with equivalent rates for human drivers. Initially, the agency would work with developers to make improvements. However, if the level of casualties proved unacceptable, regulatory tools to issue recalls are available under the General Product Safety Regulations 2005. The UK Government could use the data to trigger procedures under the UNECE agreement and EU law to refuse registration of vehicles which present a serious risk to road safety.[368]

5.85 In our view, this monitoring will be essential for highly automated vehicles which drive themselves. We tentatively propose that the new safety assurance agency should compare the accident rate of highly automated vehicles with human drivers. We seek views on whether there is also a need to monitor the accident rates of advanced driver assistance systems (operating at SAE Level 2). Although any individual accident for driver assistance systems will be seen as the fault of the individual driver, statistical monitoring may reveal more systemic issues about human-machine interactions.

Consultation Question 15.

(1) Do you agree that the new safety agency should monitor the accident rate of highly automated vehicles which drive themselves, compared with human drivers?

(2) We seek views on whether there is also a need to monitor the accident rates of advanced driver assistance systems.

THE TECHNICAL CHALLENGES OF MONITORING ACCIDENT RATES

5.86 Collecting and comparing accident data presents numerous technical challenges, which are explored below.

Figures for deaths on the roads: variations

5.87 Discussions over accident rates typically start with fatality rates. This is because deaths are easy to measure, and the figures are generally reliable across time and place.[369] As

367 For a discussion of the meaning of whether an accident is "caused" by an automated vehicle, see paras 6.40 to 6.51.

368 Art 29 of the EU Framework Directive 2007/46/EC allows member states to prevent registration of vehicles which "present a serious risk to road safety" for six months, and refer the matter to the European Commission. See also Art 4.3 and 4.4 of the UNECE Agreement, discussed at para 4.18.

369 As the 2015 Annual Report for reported road casualties points out, comparison between road accident reports with death registrations show that very few, if any, road accident fatalities are not reported to the

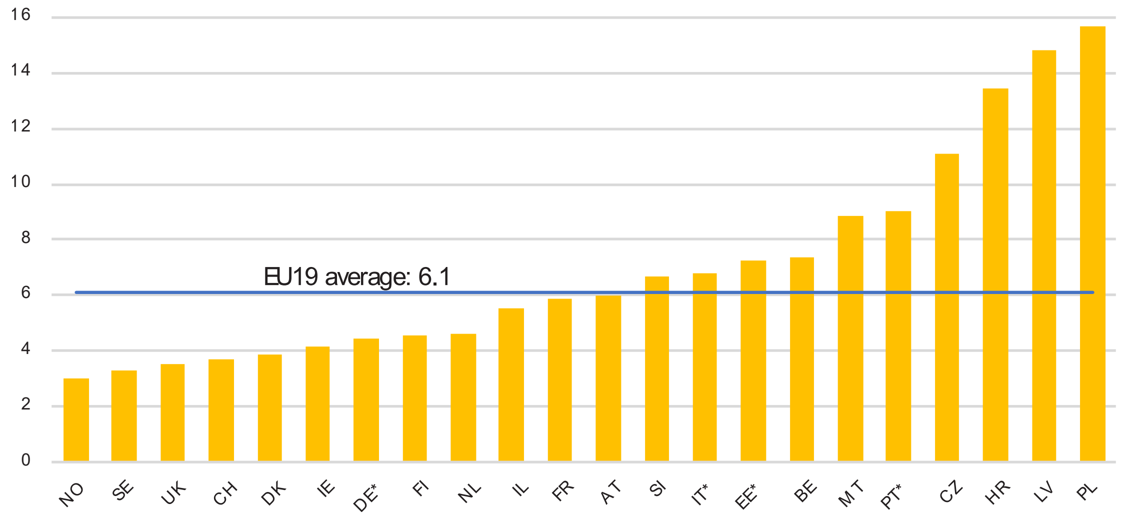
we explore below, the level of road deaths varies substantially. Variations are found between countries, over time, and between types of vehicle, types of road and types of driver.

Variations between countries

5.88 The differences in road death rates between countries are stark. In 2015, in the UK, there were 28 road deaths for every million people in the population. The comparative figure for the US was 109.[370] Per billion vehicle miles travelled, 11.5 people were killed in the US,[371] compared with 5.5 in the UK.[372]

5.89 There are also substantial differences in death rates between EU states. The following graph, taken from the 11th Road Safety Performance Index Report June 2017,[373] gives road deaths per billion vehicle kilometres, averaged over the last three years for which data is available. It shows that road deaths in Poland, Latvia and Croatia are almost four times higher than in Norway, Sweden, the UK and Switzerland.

Figure 1: Road deaths per billion vehicle kilometres in selected European countries[374]



5.90 These differences illustrate why standards of "safe enough" are likely to differ between jurisdictions. To take a simple example: if an automated vehicle resulted in eight deaths

police. However, a considerable proportion of non-fatal casualties are not known to the police, as hospital, survey and compensation claims data all indicate a higher number of casualties than police accident data would suggest.

370 Department for Transport statistics: RAS52001 at https://www.gov.uk/government/statistics/reported-road-casualties-great-britain-annual-report-2016.

371 National Highway Traffic Safety Administration figures: see https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812318.

372 Department for Transport statistics: RAS52001 at https://www.gov.uk/government/statistics/reported-road-casualties-great-britain-annual-report-2016 and TRA01 at https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra#traffic-volume-in-miles-tra01.

373 P 17.

374 European Transport Safety Council, *11th Road Safety Performance Index Report* (June 2017) p 17.

per billion miles travelled, it would be regarded as safer than conventional vehicles in the USA but as more dangerous than conventional vehicles in the UK.[375]

Variations over time

5.91 Secondly, road deaths vary over time. In Great Britain, the overall number of deaths in 2016 (1,792) was only a quarter of what it was in 1930 (7,074) - even though there are now many more cars on the road. Recent Governments have placed considerable emphasis on reducing deaths on the roads, with the result that the number of deaths has reduced by 44% since 2006.[376]

Variations between road users

5.92 Some road users are much more vulnerable than others. Figure 2 is taken from the 2016 Annual Report for Reported Road Casualties in Great Britain. It shows the casualty and fatality rates per billion passenger miles by road user type. The most striking feature is how much greater the risk is for motorcyclists than for car occupants: with 100 motorcycle fatalities per billion miles travelled, compared with 2 for car occupants.

5.93 As far more miles are travelled in cars than on motorcycles, overall more people were killed in cars than on motorcycles. In 2016, 816 car occupants died, compared to 318 motorcyclists. However, the huge difference in comparative risks means that the appropriate comparison is not always straightforward. One of the challenges will be to know when to compare casualty rates from automated cars with *overall* casualty rates, and when to compare them with casualty rates for other car users.

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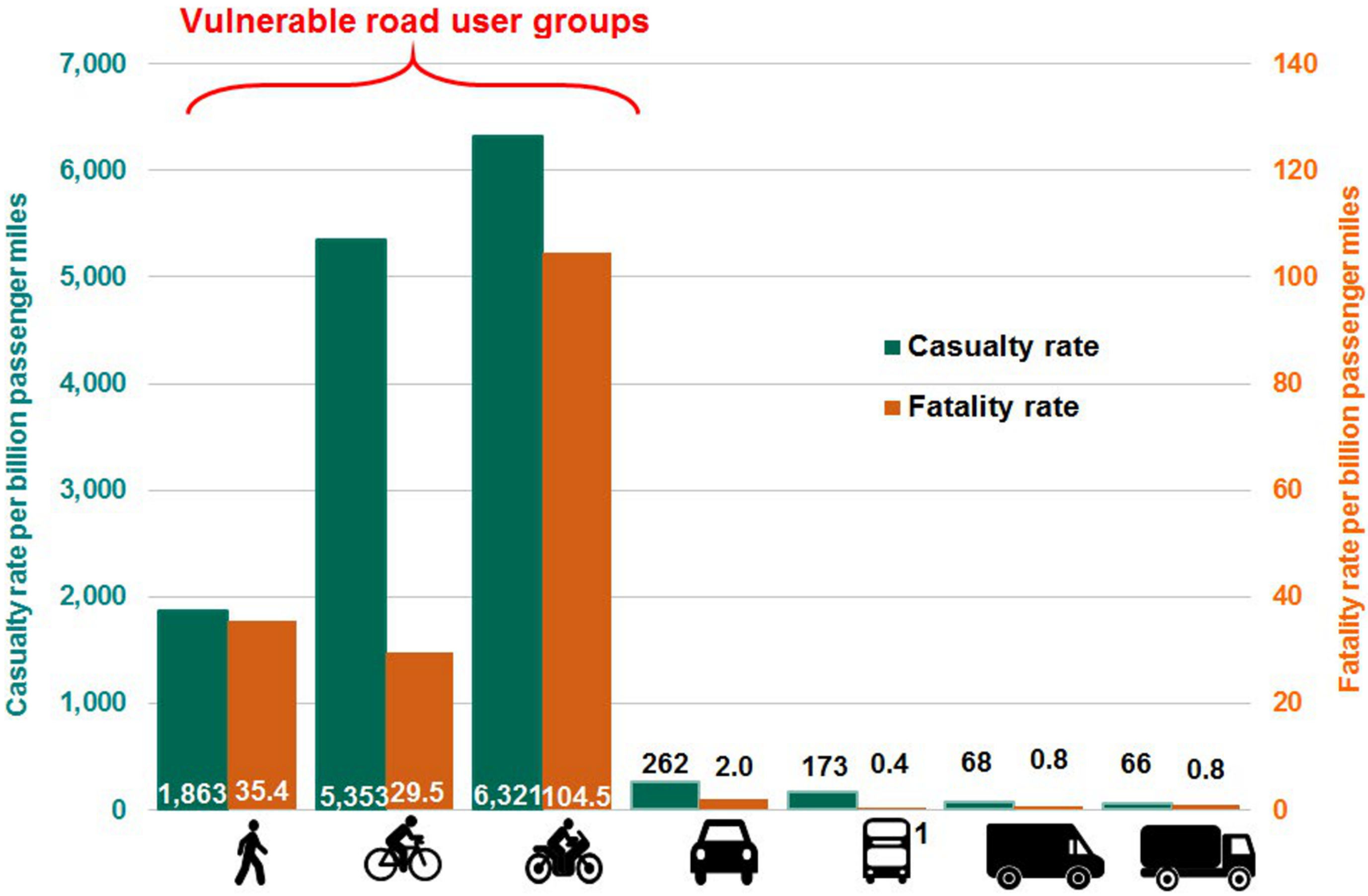
375 2016 levels reported at: http://www.iihs.org/iihs/topics/t/general-statistics/fatalityfacts/state-by-state-overview. These overall figures mask substantial differences between US states, from 6.6 in Massachusetts and Rhode Island to 18.8 in South Carolina. Analysis by Charlotta Mellander of the Martin Prosperity Institute suggests that high road fatality rates are correlated with sparse population density, poverty and Republican voting (which reflects a balance accorded to the different goals of low regulation or low fatalities). https://www.citylab.com/transportation/2015/10/the-geography-of-car-deaths-in-america/410494/.

376 Department for Transport, *Reported Road Casualties in Great Britain: 2016 Annual Report* (released in September 2017).

Figure 2: Casualty and fatality rates per billion passenger miles by road user[377]



377 Department for Transport, *Reported Road Casualties in Great Britain: 2016 Annual Report*, p 7.

5.94 Even within car occupants, there are differences based on age of driver (those aged 17 to 24 have more accidents)[378] and type of road (when compared by miles travelled, motorways are safer).[379] Again, this leads to questions about whether the safety record of an automated feature used mainly by older drivers on motorways should be compared with the fatality rates for all road users, for car users, or for cars driven by those aged over 24 on motorways. The same is true of the other development paths. As the National Transport Commission in Australia put it:

> If we seek to measure the safety of an automated vehicle against human-driven low-speed passenger shuttles, we would have a very different yardstick than if we were to measure automated vehicle safety against high speed motor cycle riding.[380]

The need to extend comparisons to non-fatal accidents

5.95 So far, we have focused on fatalities, because the fatality figures are the most reliable, especially across time and place. However, the number of deaths is (thankfully) too small to provide reliable samples to test safety within immediate time-frames.[381] It will be necessary to look beyond fatalities or, possibly, personal injuries to obtain wider data about collisions.

5.96 Within Great Britain, there are two key data sources. The STATS19 database is used by the police to report traffic accidents that result in personal injury. This is supplemented by the Road Accident In-Depth Studies (RAIDS) database, which is more limited in its geographical scope but provides higher level data about the causes of accidents.[382]

5.97 We welcome observations on the challenges of comparing the accident rates of automated vehicles with those of human drivers. Are existing sources of data sufficient, or does there need to be new obligations on operators and insurers to notify collisions to a central database?

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[378] Department for Transport, *Facts on Young Car Drivers* (June 2015) p 3: “Young car drivers made up 18 per cent of all car drivers involved in reported road accidents in 2013. However, this is considerably higher than the 5 per cent of miles they account for”.

[379] Department for Transport, *Reported Road Casualties in Great Britain: 2016 Annual Report*, pp 17 to 19.

[380] National Transport Commission, *Regulatory options to assure automated vehicle safely in Australia, Discussion paper* (June 2017) p 29.

[381] N Kaira and M Paddock, Rand Corporation, *Driving to Safety: How many miles of driving would it take to demonstrate autonomous vehicle reliability?* (2016).

[382] R Cuerden, Chief Scientist, Transport Research Laboratory, *UK road collision investigation and the case for a Road Collision Investigation Branch,* Conference presentation, PACTS Conference (22 March 2017).

Consultation Question 16.

(1) What are the challenges of comparing the accident rates of automated driving systems with that of human drivers?

(2) Are existing sources of data sufficient to allow meaningful comparisons? Alternatively, are new obligations to report accidents needed?

Chapter 6: Civil Liability

6.1 In this chapter we consider how injured parties would be compensated in the event of an accident caused by an automated vehicle when it was driving itself. We outline the provisions of the recent Automated and Electric Vehicles Act 2018 (AEV Act) on this issue. The aim of the legislation is to provide a quick and smooth path to compensation for death, personal injury or property damage caused by an automated vehicle.

6.2 Under the AEV Act, once an insurer has settled a claim with the injured party it may then reclaim damages from other parties liable for the accident. This might include the manufacturer of the vehicle, for example.

6.3 Our provisional view is that the AEV Act provides the necessary statutory basis for compensating victims where automated vehicles cause damage. However, we seek views on whether further guidance or clarification is required on some aspects of the Act. We focus on the meaning of causation; the operation of the contributory negligence provisions; and the need to retain data.

6.4 On balance, we do not think that a review of the law on manufacturer's liability is a priority at this stage, but again we ask for views on this.

MOTOR INSURANCE: THE CURRENT LAW

The requirement for compulsory insurance

6.5 Since 1930, all those who use a motor vehicle on the road must take out compulsory third-party motor insurance.[383] This is designed to cover the driver's liability to those who are killed or injured on the road or who suffer damage to property.

6.6 The UK's compulsory motor insurance scheme is complex. It has been developed and amended many times since 1930, and is now underpinned by an EU Directive.[384] The law is set out in Part 6 of the Road Traffic Act 1988, which states that a person "must not use a motor vehicle on a road or other public place" without insurance for third party risks.[385] Under section 145(3), the policy must insure a person "in respect of any liability which may be incurred by him… caused by, or arising out of, the use of the vehicle". The policy must provide unlimited cover for death or personal injury, and up to £1.2

383 Originally found in the Road Traffic Act 1930, s 35.

384 The five iterations of EU motor insurance directives are now to be found in the consolidated text of Directive 2009/103/EC, Official Journal L 263 of 7.10.2009, pp 11 to 31, at http://www.cobx.org/content/default.asp?PageID=58&DocID=27195.

385 Road Traffic Act 1988 (RTA), s 143(1)(a). There are exemptions for Government vehicles, such as those owned by local authorities, the police or heath service: see RTA 1988, s 144(2). There is also a little used alternative if the person deposits £500,000 with the courts: s 144(1).

million for property damage.[386] Using a vehicle without insurance is a criminal offence.[387]

6.7 In background paper 1, we explore this offence in detail, and discuss who “uses” a vehicle for the purposes of insurance.[388] In the vast majority of circumstances, the user is the driver or the driver’s employer. Essentially, drivers must take out insurance against their own liability. That liability principally arises under the law of negligence, and applies where the driver breaches a duty of care owed to other road users. In other words, the existing system only comes into play if the driver is at fault in causing the injury or damage.

Drivers’ responsibilities for roadworthiness

6.8 As a general principle, drivers and their employers are responsible for the roadworthiness of vehicles. In background paper 1, we explain that these obligations are set out in the Road Vehicles (Construction and Use) Regulations 1986, and are enforced through the criminal law.[389]

6.9 Where an accident is caused by a defect in the vehicle, the starting point is that the insured person (that is the driver or their employer) is liable for the accident. However, where the defect is latent and not discoverable by the exercise of reasonable care, it is open to the insured to show that they took all reasonable care in the circumstances. For conventional vehicles, this is a high threshold. To escape liability, the defendant needs to show considerable evidence of the inspections and repairs carried out.

6.10 The leading case dates from 1970: *Henderson v Henry E Jenkins & Sons*.[390] The brakes in a lorry failed suddenly, causing the lorry to kill a man. The failure was due to brake fluid escaping through a hole that could not have been detected visually during the lorry’s weekly inspections. The defendants argued that they could not be held responsible for a latent defect in the lorry. Lord Donovan held that:

> The plea of "latent defect" made by [the defendants] had to be made good by them. It was for them to show that they had taken all reasonable care, and that despite this, the defect remained hidden.[391]

6.11 The House of Lords found that the defendants had failed to discharge "the evidential burden of proof" to show that they had exercised all reasonable care in the circumstances. In particular, the defendants had not provided evidence about whether the vehicle had been exposed to unusual risks of corrosion requiring the exercise of particular care, or that such care had been taken.

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386 RTA 1988, s 145(4)(b), as amended by Motor Vehicles (Compulsory Insurance) Regulations SI No 2016/1193 reg 2(2) (31 December 2016).

387 RTA 1988, s 143.

388 Background paper 1, paras 1.33 to 1.45.

389 Background paper 1, paras 1.29 to 1.32.

390 [1970] AC 282, [1969] 3 WLR 732.

391 Above, p 299A.

6.12 As vehicles have become more complex, it has become more difficult to expect drivers to understand and guard against latent defects. However, we have been told that in practice, drivers' insurers continue to pay claims where a vehicle defect may be the cause of an accident, mainly because it is so difficult to distinguish between driver fault and vehicle defects. Insurers would not necessarily continue to take this approach for automated vehicles, when owners cannot be expected to understand defects in automated driving systems and there is no human driver to bear even partial responsibility for an accident.

THE AUTOMATED AND ELECTRIC VEHICLES ACT 2018 (AEV ACT)

6.13 In 2016, the Government identified a need for new insurance provisions where an automated vehicle rather than a human driver causes an accident.[392] These provisions are set out in Part 1 of the AEV Act. The Government has explained their purpose as follows:

> In the case of an automated vehicle being operated in automated mode… accidents could take place not as a result of human fault, but because of a failure in the vehicle itself, for which the only recourse available to an otherwise uninsured victim might be to sue the manufacturer through the courts. This Part extends compulsory motor vehicle insurance to cover the use of automated vehicles in automated mode, so that victims (including the 'driver') of an accident caused by a fault in the automated vehicle itself will be covered by the compulsory insurance in place on the vehicle.[393]

6.14 As we discuss in Chapter 2, the Secretary of State must keep a list of vehicles that are capable, at least in some circumstances, of "safely driving themselves".[394] The Act defines "driving itself" as "operating in a mode in which it is not being controlled, and does not need to be monitored, by an individual".[395] An "automated vehicle", for the purposes of the Act, is a vehicle on this list. The list system is designed to allow manufacturers, owners and insurers to know if the new insurance provisions in the legislation apply to the vehicle.

A new form of liability

6.15 The AEV Act takes a radical new approach to motor insurance. Rather than requiring insurers to indemnify road users against their own existing liability, it creates a wholly new form of liability which arises directly on insurers. The central provision is section 2(1), which states that:

> (1) Where—
>
> (a) an accident is caused by an automated vehicle when driving itself,

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392 Department for Transport, *Pathway to Driverless Cars: proposals to support ADAS and automated vehicle technologies* (July 2016).

393 Automated and Electric Vehicles Act 2018, Explanatory Notes, para 12.

394 See AEV Act, s 1(1), as set out at para 2 55. To be listed, a vehicle must also be capable of being lawfully used when driving itself on roads or public places in Great Britain: AEV Act, s 1(1)(b).

395 AEV Act, s 8(1).

(b) the vehicle is insured at the time of the accident, and

(c) an insured person or any other person suffers damage as a result of the accident,

the insurer is liable for that damage.

6.16 Section 2(2) sets out an alternative form of liability for vehicles owned by the Crown or public bodies (such as local authorities, the police and the health service). As these vehicles are not required to be insured,[396] liability is placed on the owner. Otherwise liability under section 2(2) is identical. In the discussion that follows, we focus on section 2(1), which applies to private and commercial vehicles insured through a third-party insurer.

6.17 For automated vehicles, the policy of compulsory insurance must include insurance against this new form of liability.[397] In other words, the driver's liability and the automated vehicle's liability must be insured under the same policy. This prevents disputes about whether the driver or the automated driving system is to blame, which could delay or hinder access to compensation.

What if the vehicle is uninsured?

6.18 The new section 2(1) liability only applies where the automated vehicle is insured at the time of the accident. Although a failure to insure would be a criminal offence under section 143(a) of the Road Traffic Act 1988, it might still occur.

6.19 For other forms of insurance, where a driver is uninsured or cannot be traced, the Motor Insurance Bureau (MIB) steps in as an insurer of last resort. However, for the MIB agreements to apply, there must be a claim against the untraced or uninsured person, which the MIB then pays.[398] This cannot apply to the AEV Act provisions, as under section 2(1), without insurance, the liability does not arise at all.[399] The Government is currently in discussions with the MIB about amendments to the agreements to provide cover for victims, if an automated vehicle is "driving itself" while uninsured.

A no-fault liability?

6.20 In principle, the insurer is liable for any accident "caused by an automated vehicle when driving itself", irrespective of fault.[400] However, this must be read subject to three further

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396 RTA 1988, s 144(2).

397 AEV Act 2018, sch 1 para 19(2) amends s 145 of the RTA 1988. It provides that the policy required by s 145 "must also provide for the insurer's obligations to the insured person under s 2(1)" of the AEV Act 2018.

398 The MIB Untraced Drivers Agreement (2017) refers to a "person alleged to be liable" (para 3).

399 This is because, under s 2(1)(b), it is a condition of liability that the vehicle is insured. The alternative liability under s 2(2) only applies to vehicles which are exempt from normal insurance provisions because they are owned by public bodies.

400 No fault insurance for damage resulting from automated vehicles was also the preferred option of a study for the European Parliament by Dr Tatjana Evas, *A common EU approach to liability rules and insurance for connected and autonomous vehicles* (February 2018). See http://www.europarl.europa.eu/RegData/etudes/STUD/2018/615635/EPRS_STU(2018)615635_EN.pdf

provisions. As we discuss below, these relate to contributory negligence; fault by the insured; and secondary claims.

Contributory negligence by the injured party

6.21 First, damages are reduced by any contributory negligence on the part of the victim. Under section 3(1) of the AEV Act, where "the accident, or any damage resulting from it, was to any extent caused by the injured party" the amount of the liability is subject to a reduction under the normal principles of contributory negligence.[401]

6.22 We consider the details of how this works at paragraphs 6.31 to 6.39 below.

Claims by the insured

6.23 Typically, compulsory motor insurance only covers the insured driver against their liability to others. It does not cover injury to insured drivers themselves.[402]

6.24 Under the AEV Act, this has been changed for automated vehicles. If a vehicle is driving itself, the human sitting in the driving seat may not be at fault in any way. The general principle is that the insured may therefore claim for personal injury to themselves.[403] However, the AEV Act creates exceptions to this:

(1) Under section 3(2), the insurer is not liable to the person in charge of a vehicle where the accident "was wholly due to the person's negligence in allowing the vehicle to begin driving itself when it was not appropriate to do so".

(2) Under section 4(1), the policy may exclude or limit the insurer's liability to the insured if the accident arose from either:

(a) software alterations made by the insured which are prohibited under the policy.[404] If the insured is not the policyholder[405] the test is whether, at the time of the accident, the insured knows that such alterations are "prohibited under the policy";[406] or

(b) a failure to install safety-critical software updates that the insured "knows or ought reasonably to know, are safety-critical".[407]

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401 Under the Law Reform (Contributory Negligence) Act 1945.

402 An insurance policy may cover injury to the insured, but this is not part of the scheme for compulsory insurance.

403 However, they may not claim for damage to the vehicle itself, or for goods carried for reward in the vehicle, or for goods in the custody of the insured or the person in charge of the vehicle: s 2(3).

404 AEV Act, s 4(1)(a).

405 For example, if the insurance was taken out by an employer or other family member to cover them.

406 AEV Act, s 4(2).

407 AEV Act, s 4(1)(b).

6.25 The AEV Act takes a strong line against prohibited software alterations and failures to install safety-critical software. Where these lead to injury to third parties, the insurer must pay the third party, but may recover the amount from the insured.[408]

Secondary claims

6.26 The AEV Act is designed to ensure that victims receive compensation smoothly and quickly. It is not designed to allocate ultimate responsibility for the accident. It therefore works on the principle that the insurer must pay the claim and, having done so, may bring a secondary claim against any other person responsible for the accident.

6.27 Under section 5, once the insurer has settled their liabilities to the injured party, the insurer may then bring an action against "any other person liable to the injured party in respect of the accident".[409]

6.28 In many cases, the secondary claim will be against another road user, such as the driver of another vehicle involved in the accident.[410] However, secondary claims could also be brought against the manufacturer or the retailer. We discuss these possibilities later in the chapter.

IS THERE A NEED FOR FURTHER REVIEW?

6.29 Part 1 of the AEV Act prepares the way for vehicles that drive themselves. It enables those who are injured by an automated vehicle through no fault of their own to receive compensation quickly and smoothly.

6.30 It is not the purpose of our review to re-open the principles underlying the new insurance provisions. We are, however, interested in receiving views on whether any further guidance or clarification is required. Three possible issues arose from our initial discussions with stakeholders: the effect of contributory negligence; the meaning of an accident "caused by" an automated vehicle; and the need to retain data. We examine each below.

Contributory negligence

6.31 Under section 3(1) of the AEV Act, where the accident was "to any extent caused by the injured party", the amount of the insurer's liability is subject to "whatever reduction under the Law Reform (Contributory Negligence) Act 1945 would apply".

6.32 The Law Reform (Contributory Negligence) Act 1945 (1945 Act) allocates damages where more than one party is at fault. Section 1(1) of that Act states that it applies where

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408 AEV Act, s 4(4). Clearly, such recovery will be subject to the means available to the insured.

409 The insurer must bring a claim against the secondary defendant within 2 years. For England and Wales, see Limitation Act 1980 s 10A, inserted by the AEV Act 2018, sch 1, para 9. For Scotland, see Prescription and Limitation (Scotland) Act 1973, s 18ZC, inserted by the AEV Act, sch 1, para 3.

410 There is also the possibility of a claim against the highway authority: see *Bowes v Highland Council* [2018] CSIH 38. However, the courts have usually rejected arguments that highway authorities are liable to road users for inadequate signage, except in the most unusual circumstances. See *Gorringe v Calderdale* [2004] UKHL, [2004] 1 WLR 1057. Highways England settle approximately 20% of claims made against the company for damage to vehicles using the strategic road network.

"any person suffers damage as the result partly of his own fault *and partly of the fault of any other person or persons*" (emphasis added).[411] In these circumstances, any recoverable damages are to be reduced:

> to such extent as the court thinks just and equitable having regard to the claimant's share in the responsibility for the damage.

6.33 There is, however, a difficulty in applying the 1945 Act to claims against the insurer under section 2(1). This is because the 1945 Act only applies where there is fault by at least two parties. However, under section 2(1) the insurer will not be at fault at all. Instead, the insurer is simply made liable for accidents caused by "an automated vehicle when driving itself".

6.34 The AEV Act approaches this problem in a rather complex way. First, section 3(1) pegs the amount of the liability under the 1945 Act to the amount which:

> would apply to a claim in respect of the accident brought by the injured party against a person other than the insurer or vehicle owner.

Thus, the court is asked to imagine that the claim is brought against someone else.

6.35 Then section 6(3) states that for the purposes of section 3(1), the 1945 Act has effect:

> as if the behaviour of the automated vehicle were the fault of the person made liable for the damage by section 2 of this Act.

6.36 The provisions require the reader to imagine two counter-factual situations: first, that the claim is brought against someone other than the insurer, and secondly that the insurer is at fault because of the behaviour of the automated vehicle. The combined effect of these provisions can be quite difficult to follow.

6.37 These provisions might suggest that the courts should treat the issue as if a human driver had been involved. We think that this could be an undesirable distraction. Take an example in which a person cycling without lights at night is hit by an automated vehicle. A human driver would have had difficulty in seeing the unlit cyclist. If the appropriate comparator claim is with a hypothetical human driver, the cyclist would bear considerable responsibility for the accident. However, the failure to have lights might have very little effect on an automated vehicle equipped with LIDAR. The concern is that section 3(1) could be used to apply standards of human fault to quite different claims involving automated vehicles.

6.38 It is also unclear what happens if the injured party is *wholly* responsible for their injuries. Could the claimant's damages be reduced by 100%, to zero? Although 100% reductions

[411] Fault is defined in the 1945 Act in s 4 for England and Wales and in s 5(a) for Scotland.

for contributory negligence have been awarded in some cases,[412] such reductions have been criticised in others.[413] One of the leading Scottish text books on the subject says:

> It is submitted that 100 per cent deduction is not possible under the Law Reform (Contributory Negligence) Act 1945 since in those circumstances the pursuer would be solely responsible and not "share in the responsibility of the damage".[414]

It remains to be seen how the courts will deal with an insurer's submission that it is just and equitable to for a claimant under section 2(1) of the AEV Act to be awarded nothing on grounds of contributory negligence.

6.39 We welcome views on whether section 3(1) is sufficiently clear and certain to work in practice, or whether further guidance or clarification of the provisions is needed.

Causation

6.40 For liability to arise under section 2(1), the accident must be "caused by" the automated vehicle. Section 8(3) adds that an accident includes "two or more causally related accidents" and that an accident caused by an automated vehicle includes "an accident that is partly caused by an automated vehicle". Otherwise, the meaning of causation is left to the courts, applying the general principles developed in cases concerning civil liability.

6.41 The traditional test of causation in civil law is the "but for" test. On this basis, the question is, but for the automated vehicle, would the accident have occurred? However, even events which meet the "but for" test may not be held to be causative if they are too remote or other events intervene.

6.42 The courts do not apply a rigid formula. As a leading text puts it, "judges tend to shy away from both scientific and philosophical formulae of causation, preferring to adopt what is said to be a broad common-sense approach".[415] Lord Justice Sedley stated in *Smith v Youth Justice Board* that "causation is, in essence, a question of fairness" and that "a succession of consequences which in fact and in logic is infinite will be halted by the law when it becomes unfair to let it continue".[416]

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412 *McMullen v NCB* [1982] ICR 148; *Jayes v IMI* (*Kynoch) Ltd* [1985] ICR 155. These cases involved a breach of statutory duty, which s 2(1) of the AEV Act 2018 is akin to.

413 *Brumder v Motornet Service and Repairs Ltd* [2013] EWCA Civ 195, [2013] 1 WLR 2783; *Anderson v Newham College of Further Education* [2002] EWCA Civ 505, [2003] ICR 212. For discussion, see *Clerk and Lindsell on Torts* (22nd ed 2017) p 215.

414 J Thomson, *Delictual Liability* (5th ed 2014), para 6.13. The footnote to the quoted sentence reads: "If the pursuer is solely responsible, the defender will escape liability because either his breach of duty is not the *causa causans* or the pursuer is *volens*: see *ICI v Shatwell* [1965] AC 656. Compare *McEwan v Lothian Buses* 2006 SCLR 592 where the Lord Ordinary (Emslie) considered at para 32 that there was no logical reason why there could not be 100 per cent contributory negligence if the degree of fault on the part of the defender was regarded as too small to warrant an apportionment."

415 *Clerk and Lindsell on Torts (*22nd ed 2017) p 54.

416 *Smith v Youth Justice Board for England and Wales* [2010] EWCA Civ 99.

A "purposive approach" to interpreting causation

6.43 In deciding issues of causation, the courts look at the purpose of the provision - that is, they tend to take a "purposive approach". As Lord Nicholls stated in *Kuwait Airways*, decisions over causation often involve "a value judgment on responsibility":

> In making this judgment the court will have regard to the purpose sought to be achieved by the relevant tort, as applied to the particular circumstances.[417]

6.44 The interpretation of section 170 of the Road Traffic Act 1988 illustrates the courts' approach. Section 170 imposes a duty on drivers to stop and report accidents. It applies where "owing to the presence of a mechanically propelled vehicle on a road or other public place, an accident occurs".[418] This very broad wording merely requires that "the presence" of the vehicle led to the accident. There does not have to be a collision or any fault by the driver. The duty has been held to apply when a passenger was injured stepping off an open platform bus.[419]

6.45 However, despite the broad wording, the provision does not extend to remote consequences. As Lord Goddard put it, the duties would not apply:

> if a person about to cross a road sees a motor-car, changes his mind and steps back instead of going on, and happens to knock down a pedestrian, for that would be nothing to do with the driver of the motor-car.[420]

6.46 Applying these principles to the AEV Act, we do not think that section 2(1) would apply where a cyclist is so surprised to see an automated vehicle that they lose control and run into a pedestrian. However, it is not possible to separate elements of causation from issues of fault completely. If the cyclist had been frightened by an automated vehicle which was changing lanes erratically, then the courts may well find that the accident was at least partly[421] caused by the vehicle, even if it did not touch the cyclist.

Possible disputes

6.47 We have been asked how the AEV Act might apply if another human driver crashes into the back of an automated vehicle, shunting it into the car in front. In these circumstances, the automated vehicle is in the chain of causation, but not at fault. It is possible that the automated vehicle insurer might have to pay for the damage to the car in front, but would then be able to recoup this money from the insurer of the human driver at fault.[422] Alternatively, a court might hold that the accident was not caused by

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417 *Kuwait Airways Corp v Iraq Airways Co* [2002] UKHL 19, [2002] 2 AC 883 at [74].

418 RTA 1988, s 170(1).

419 See *Quelch v Phipps* [1955] 2 QB 107 and K McCormac and P Wallis (eds), *Wilkinson's Road Traffic Offences* (28th ed 2017) at 7-16.

420 *Quelch v Phipps* [1955] 2 QB 107, 111.

421 See para 6.41 above.

422 We note however the interaction of s 5 (giving a right to subrogation) and s 3 (contributory negligence). It is uncertain if the contributory negligence provision could operate in this scenario, in which case the insurer or owner would be fully liable under s 2.

the automated vehicle at all.[423] We hope that the insurance industry will be able to find an easy and cost-effective method of resolving cases of this type.

6.48 The issue becomes more difficult if the human driver at fault is uninsured. Typically, the MIB would not pay a claim if another insurer is also liable to pay it. Therefore, if the automated vehicle insurer was initially liable under section 2(1), the loss would rest with that insurer and could not be recouped. Cases such as this may result in a dispute between the automated vehicle insurers and the MIB, which would have to be resolved informally or by the courts.

6.49 Similar issues would be raised where fault by an uninsured pedestrian or cyclist leads to a collision between an automated vehicle and a third party. An example might be where an automated vehicle swerves to avoid an erratic cyclist, and hits a parked car. If the automated vehicle insurer is required to compensate the owner of the parked car, then the loss may rest with the insurer, as it would not be able to recover if the cyclist has no money.

6.50 Again, disputes of this type will need to be resolved by the courts. Where the issue involves a serious criminal offence, such as causing death by driving without insurance, the courts have been explicit in requiring an element of fault before a driver can be held to have caused an accident.[424] In the context of section 2(1), the courts are likely to be less concerned with fault and more concerned with the need to compensate victims. However, it is not possible to predict the outcome of cases: each will depend on its facts.

6.51 We welcome views on whether further guidance is needed on issues of causation. On balance, we see merit in leaving matters to the courts, to decide on the facts which come before them. No-one can foresee the full effect of automated vehicles, or the many different possible circumstances surrounding the accidents which might result. Furthermore, the courts have long experience of dealing with causation issues to provide fair, common-sense outcomes. That said, we understand insurers' desire for greater certainty, so that they can price insurance and avoid lengthy or costly litigation.

Data retention and the limitation period

6.52 For personal injury, the limitation period under Part 1 of the AEV Act is the same as that for other personal injury cases. A claimant must bring an action against the insurer within three years from the date of the accident or from the date the injured person had

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423 In particular, we note the effect of s 8(3)(a), which can be read as providing that where there are two causally related accidents (ie, (i) crash between "human driver" and AV which caused (ii) the shunt between automated vehicle and car in front) these are considered as a single accident. If so, the accident, thus understood, is not caused (wholly or partly) by the automated vehicle for the purpose of s 2(1)(a) or s 2(2)(a).

424 See *R v Hughes* [2013] UKSC 56, [2013] 1 WLR 2461 discussed in detail in background paper 2 at paras 2.14 to 2.20.

knowledge of the possibility of a claim.[425] The time limit for property damage only is three years from the date of the accident.[426]

6.53 However, the limitation period can be longer in some circumstances. If the injured person dies, the limitation period is three years following their death, or from their personal representative's knowledge of the possibility of a claim.[427] If the injured person was a child, the limitation period would begin to run from the date they reach the age of 18. If the injured person was under a disability, the limitation period would run from the time they were no longer under a disability (or else the end of their life).[428]

6.54 In the normal course of events, insurers will use vehicle-collected data to verify that the vehicle was in the alleged location, was driving itself, and that the alleged damage took place. The problem is that automated vehicles generate a large amount of data, possibly too much to store. We have been told that during testing an automated vehicle can generate several terabytes of data a day.[429] This leads to questions of what data will need to be preserved if insurers are to be in a position to defend claims, especially those brought a long time after the alleged incident.

6.55 Automated vehicles are likely to have event data recorders. The European Union has proposed standardising the format of the data, to ensure that it covers a minimum dataset and that it can be downloaded using a standardised tool.[430]

6.56 The Association of British Insurers has also been in discussions with vehicle manufacturers to ensure that insurers are provided with adequate data to assess claims. They have set out a minimum list of data requirements following all incidents, including minor crashes which would not be sufficient to trigger seat-belt pretensioners or airbags. The aim would be to preserve a limited list of data covering a minimum of 30 seconds before and 15 seconds after the incident, which would be stored for at least six months. The list would include a time stamp, the GPS location, what automated mode was in use at the time and any record of driver intervention.[431]

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425 England and Wales: para 11 of the schedule to the AEV Act 2018 inserts a new section 11B into the Limitation Act 1980. The relevant provision is s 11B(2)(b). Scotland: para 3 of the schedule inserts s 18ZA into the Prescription and Limitation (Scotland) Act 1973: see s 18ZA(2)(b).

426 England and Wales: Limitation Act 1980 s 11B(2)(a). Scotland: Prescription and Limitation (Scotland) Act 1973, s 18ZA(2)(a).

427 England and Wales: Limitation Act 1980, s 11B(5). Scotland: Prescription and Limitation (Scotland) Act 1973, s 18ZA(7). This only applies if the person dies within 3 years of either the accident or their date of knowledge of the claim.

428 England and Wales: Limitation Act 1980, s 28. Scotland: Prescription and Limitation (Scotland) Act 1973, ss 17(3) and 18(3).

429 A terabyte of data is equivalent to 500 hours of video footage or 17,000 hours of music.

430 European Commission, *Access to In-Vehicle Data and Resources, Final Report* (May 2017). We also note the focus on making vehicle data available to service providers as part of its third EU Mobility Package, presented in May 2018, see https://ec.europa.eu/transport/modes/road/news/2018-05-17-europe-on-the-move-3_en.

431 Thatcham/ABI, *Regulating Automated Driving* (July 2017) Annexe B: Data information, p 32.

6.57 This system is likely to work well when the automated vehicle detects an incident, such as a collision. It may not work when the incident does not involve a direct collision and the automated driving system is unable to detect that the accident has taken place. One example would be where a cyclist is injured when they swerve out of the way of the automated vehicle. Another would be where the automated vehicle stops unnecessarily, causing the car behind it to stop, and a third vehicle to run into the car behind. In these cases, the automatic storage of minimum data requirements might not be triggered. If an accident victim claims months or years later, it may be difficult to retrieve any data on the incident.

6.58 We seek views on whether, a claimant should only be permitted to bring a claim under the AEV Act if they have notified the police or the insurer about the alleged incident within a set period.[432] If so, how long should that period be? The aim of such a provision would be to enable the insurer to preserve relevant data before it is automatically deleted.

6.59 During our initial discussions, views on this issue were mixed. On one view, the issues are not qualitatively different from those that arise in any accident claim made at a late stage. The courts have proved themselves capable of sifting the evidence, bearing in mind the credibility of the witnesses. The alternative view is that with automated vehicles, insurers are more reliant on computer data and less on human witnesses. Indeed, with highly automated vehicles, no human may have been present in the vehicle. This means that once data has been deleted, it will be very difficult for the insurer to know whether the vehicle was present at the scene and, if so, what took place.

[432] As we discuss in Ch 7 and background paper 1, under the current law, drivers are required to report accidents to the police. However, there is no such obligation on the victims of accidents.

Consultation Question 17.

6.60 We seek views on whether there is a need for further guidance or clarification on Part 1 of Automated and Electric Vehicles Act 2018 in the following areas:

(1) Are sections 3(1) and 6(3) on contributory negligence sufficiently clear?

(2) Do you agree that the issue of causation can be left to the courts, or is there a need for guidance on the meaning of causation in section 2?

(3) Do any potential problems arise from the need to retain data to deal with insurance claims? If so:

(a) to make a claim against an automated vehicle's insurer, should the injured person be required to notify the police or the insurer about the alleged incident within a set period, so that data can be preserved?

(b) how long should that period be?

SECONDARY CLAIMS

6.61 As we have seen, Part 1 of the AEV Act is designed to ensure that victims of accidents with automated vehicles are compensated quickly and smoothly. It is not intended to allocate final responsibility for the accident. That will often be a matter for secondary claims, brought by the insurer to recoup the damage. The insurer will often be in a better position than the injured party to bring these more difficult, possibly contested claims.

6.62 Secondary claims may be brought against anyone who is liable to the injured party for the damage which the insurer has paid. This could cover a wide range of parties. Where some other driver was at fault, the claim is likely to be against that driver's insurer. However, as we explore below, where the automated driving system was defective, the claim is most likely to be brought against the manufacturer, though it is also possible to claim against the supplier of the automated driving system or of any defective part.

6.63 Furthermore, the buyer under a contract for the sale of goods may bring an action against a business seller if the goods are not of satisfactory quality. This would allow the owner of an automated vehicle to sue the retailer, not only for damage to the vehicle but also for injury to themselves. Where the insurer had paid the owner for the injury, the insurer would have a secondary claim against the retailer.

CLAIMS AGAINST MANUFACTURERS

6.64 The main causes of action against a manufacturer are under the Consumer Protection Act 1987 (the 1987 Act) or under the tort of negligence. We look at the main principles of each, to consider their implications for automated vehicles.

Product liability under the Consumer Protection Act 1987

6.65 A strict liability regime for defective products is set out in Part I of the 1987 Act. The Act implements an EU directive (the Product Liability Directive 1985) which required EU Member States to bring in a system of strict liability for defective products.[433] The preamble to the directive sets out the rationale:

> Liability without fault on the part of the producer is the sole means of adequately solving the problem, peculiar to our age of increasing technicality, of a fair apportionment of the risks inherent in modern technological production.[434]

6.66 The European Commission is currently reviewing whether the directive is fit for purpose, given new developments such as the internet of things and autonomous systems. It intends to issue a guidance document on the interpretation of the directive in light of technological developments by mid-2019.[435]

When does the 1987 Act apply?

6.67 Although the title of the 1987 Act refers to consumers, the strict liability regime covers damage *by* any product. It would therefore apply irrespective of whether the automated vehicle is a consumer car, commercial lorry, or bus.

6.68 However, the regime only covers damage done *to* individuals or their property. Section 5(1) of the 1987 Act states that damage means death, personal injury or damage to property.[436] However, section 5(3) specifically excludes damage to property unless the property is of a description "ordinarily intended for private use, occupation or consumption" and which the claimant actually intends to use in this way. In other words, where property damage is caused by a defective automated vehicle, the law will operate differently depending on the nature of the property damaged. The 1987 Act would apply to damage done to a consumer car or home. However, it would not apply to damage done to property of a commercial nature, such as a lorry or shop. Nor would it apply to damage to an ordinary "consumer type" car, if the car was being used in the course of business.

6.69 The 1987 Act also excludes damage done to the defective product itself[437] and damage totalling less than £275.[438]

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433 Product Liability Directive 85/374/EEC, Official Journal L 210 of 7.8.1985 pp 29 to 33.

434 Product Liability Directive 85/374/EEC, Official Journal L 210 of 7.8.1985 pp 29 to 33, Recital 2.

435 See https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A237%3AFIN (visited 24 September 2018). On this basis the Guidance will be issued during the proposed implementation period until 31 December 2020, while the UK would continue to be bound by EU law.

436 Consumer Protection Act 1987, s 5(1).

437 Product Liability Directive 85/374/EEC, Official Journal L 210 of 7.8.1985 pp 29 to 33, art 9(b); Consumer Protection Act 1987, s 5(2).

438 Consumer Protection Act 1987, s 5(4).

The definition of "product"

6.70 The 1987 Act describes a product as "any goods or electricity" including "a product which is comprised in another product, whether by virtue of being a component part or raw material or otherwise".[439]

6.71 This definition clearly covers an automated vehicle, or a component of an automated vehicle, such as the automated driving system. It is less clear, however, whether it covers an over-the-air update, which is purely software, and not incorporated within a physical medium.[440]

6.72 The UK courts have sometimes drawn a distinction between software stored on a physical medium such as a disk, which can be considered a product, and software stored intangibly such as on the cloud, which cannot. In the Court of Appeal case of *St Albans CDC v International Computers Ltd*,[441] Sir Iain Glidewell commented that:

> Computer disks, as tangible media, qualified as "goods" … A computer program, as intangible software, did not so qualify.[442]

6.73 This contrasts with the decision of the Court of Justice of the European Union (CJEU) in *UsedSoft GmbH v Oracle International Corp.*[443] Here the CJEU held that downloaded software with a perpetual licence was the "functional equivalent" of a physical product. Although it did not rule specifically that downloaded software was a product, it opened the door to this argument.[444]

6.74 The issue is controversial. Some stakeholders have expressed concerns that, if software engineers are responsible for all harm caused by their mistakes, this may have the result of concentrating liabilities on entities who, or whose insurers, may not be able to bear them.[445]

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439 Consumer Protection Act 1987, s 1(2). See also Product Liability Directive 85/374/EEC, Official Journal L 210 of 7.8.1985 pp 29 to 33, art 2.

440 In the European Commission's recent public consultation, many consultees thought that the application of the Product Liability Directive might be problematic or uncertain in its application to new technologies. Problems might arise, for example, where software is installed after purchase, where automated tasks are based self-learning algorithms or where products are purchased as a bundle with related services. See European Commission, *Brief Factual Summary on the Results of the Public Consultation on the Rules on Producer Liability for Damage Caused by a Defective Product* (2017) p 3. http://ec.europa.eu/docsroom/documents/23471, discussed in Pinsent Masons, Legal aspects of connected and automated cars, White Paper, May 2018, at p 8.

441 *St Albans City and District Council v International Computers Ltd* [1997] FSR 251.

442 Similarly, in a non-binding statement, Mr Justice Akenhead said that in principle software could be "goods" if sold in a physical medium, given the non-exclusive definition in s 61(1) of the Sale of Goods Act 1979; *The Mayor and Burgesses of the London Borough of Southwark v IBM UK Limited* [2011] EWHC 549 at [96].

443 *Usedsoft GmbH v Oracle International Corp* (Case C-128/11), ECLI:EU:C:2012:407.

444 For further discussion, see G Howells, 'Strict Liability' in G Howells et al (ed), *The Law of Product Liability* (2nd ed 2007) para 4.62.

445 See, M Jamieson, "Liability for Defective Software" (2001) *The Journal of the Law Society of Scotland* http://www.journalonline.co.uk/Magazine/46-5/1000702.aspx; and more generally J Turley, "Can You Get

6.75 In practice, the distinction between goods and software would only become an issue if the update and vehicle were produced by different entities. If the vehicle and update had a single producer, it is likely that they would be considered together as a single product.

The definition of "producer"

6.76 Under the Product Liability Directive, a producer is defined widely as "the manufacturer of a finished product, the producer of any raw material or the manufacturer of a component part". It also includes "any person who, by putting his name, trade mark or other distinguishing feature on the product presents himself as its producer,"[446] or anyone who imported the product into the EU.[447]

6.77 In the case of an automated vehicle it would therefore cover the main manufacturer and any component manufacturer. The main manufacturer is liable for any defect in a component part, though they may be able to bring a further claim against the component manufacturer for negligence.

What is a "defect"?

6.78 Section 3(1) of the 1987 Act states that a product is defective if "the safety of the product is not such as persons generally are entitled to expect". Section 3(2) provides a non-exhaustive list of factors to be considered. These include the manner in which the product has been marketed, its get-up, the use of any mark in relation to the product, and any instructions and warnings provided.[448]

6.79 The UK courts have considered how to approach the issue of defectiveness. In *A v NBA,*[449] Mr Justice Burton set out a three-stage approach to whether a product is defective, which:

(1) identifies the harmful characteristic that caused the injury,

(2) determines whether the product performed as intended and/or

(3) considers the circumstances.

6.80 However, this approach was criticised by Mr Justice Hickinbottom in *Wilkes v DePuy* as "self-evidently circular: proof of a causal connection between defect and damage cannot rationally, or even conceptually, be attempted without ascertainment of whether there

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Sued for Bad Code? Legal Liability is Still User Defined in the World of Software" (2016) *Electronic Engineering Journal*, available at https://www.eejournal.com/article/20161116-liability/.

446 Product Liability Directive 85/374/EEC, Official Journal L 210 of 7.8.1985 pp 29 to 33, art 3(1).

447 Product Liability Directive 85/374/EEC, Official Journal L 210 of 7.8.1985 pp 29 to 33, art 3(2). See also the Consumer Protection Act 1987, s 1(2).

448 This reflects the broad approach in Directive 85/374/EEC art 6, though the list of factors in the Consumer Protection Act 1987 is longer.

449 *A v National Blood Authority* [2001] 3 All ER 289.

is a defect".[450] In his view, the key issue is whether a product meets the level of safety people are *entitled* to expect, taking into account all the circumstances.[451]

6.81 A product can be defective under the 1987 Act without the cause of the defect being known. In *Wilkes,* Mr Justice Hickinbottom commented that while it may be helpful to show the cause of the lack of safety, this was not necessary. All a claimant had to show was that the damage was caused by the defect.[452] This is important for automated vehicles where, given the complexities of machine learning, it may be difficult or impossible to show why or how the software became unsafe.

6.82 The regulatory regime is highly relevant. In *Wilkes,* Mr Justice Hickinbottom stated that while "the simple fact of regulatory approval is not an automatic defence," it was nevertheless "evidence (and, in an appropriate case, powerful evidence) that the level of safety of the product was that which persons generally were entitled to expect."[453] In other words, it will often be difficult for a claimant to argue that they are entitled to a greater level of safety than the minimum safety level imposed by regulation.

6.83 This has important consequences for automated vehicles. It creates a somewhat paradoxical situation where the more permissive the safety regime is surrounding the testing and use of automated vehicles, the less likely a product liability case is to succeed in the event of an accident.

6.84 Finally, a vehicle may be defective because of the way it has been marketed or through inadequacies in instructions and warnings.[454] This is particularly relevant where advertisements or manuals fail to highlight the limitations of the system.

Defences

6.85 Manufacturers have a variety of defences to strict liability, where, for example, defects arise from compliance with mandatory regulations.[455]

6.86 For our purposes, the most important is the "state of the art" defence. A producer has a complete defence if it can show that the state of scientific and technical knowledge at the time when it put the product into circulation was not such as to enable the existence of a defect to be discovered.[456]

6.87 The state of the art defence is particularly relevant to automated vehicles as the technology is new and may give rise to novel and unexpected problems. However, if manufacturers are aware of a safety risk, the absence of a means to remove the risk

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450 *Anthony Frederick Wilkes v DePuy International Limited* [2016] EWHC 3096 (QB), [58]. The case involved defective hip replacements.

451 At [71]. This view has been endorsed by Andrews J in *Gee v DePuy* [2018] EWHC 1208 at [95].

452 At [73].

453 At [101]. See also *Gee v DePuy* [2018] EWHC 1208 at [176].

454 Consumer Protection Act 1987, s 3(2)(a).

455 Product Liability Directive 85/374/EEC, Official Journal L 210 of 7.8.1985 pp 29 to 33, art 7(d).

456 Product Liability Directive 85/374/EEC, Official Journal L 210 of 7.8.1985 pp 29 to 33, art 7(e) and Consumer Protection Act 1987, s 4(1)(e).

may not constitute a defence. In *A v NBA*, Mr Justice Burton held that hepatitis-infected blood was defective even though at the time no test was available to determine whether blood was infected. The fact that the defendants knew that blood *could* be infected meant that they could not rely on the state of the art defence.[457]

A compensatory rather than a punitive regime

6.88 The final point to make about the product liability regime is that it is intended to compensate the victim, not to punish the producer. Damages under the 1987 Act appear to be limited to compensation for injury, death and/or damage to consumer property. It is highly unlikely that aggravated or punitive damages would be available.[458]

6.89 This can be contrasted with the US approach. US courts have imposed punitive damages in several product liability cases to punish and deter producers whose conduct was particularly objectionable.[459] For example, in *Grimshaw v Ford Motor Company,* one of the claimants was severely burned and another killed when their Ford Pinto car burst into flames following a rear-end collision.[460] The evidence suggested that the manufacturer of the car had known about the possibility of such fires from its previous tests, and had refused to change the design for cost reasons. The court held that this conduct justified the imposition of punitive damages, commenting that:

> the conduct of Ford's management was reprehensible in the extreme. It exhibited a conscious and callous disregard of public safety in order to maximize corporate profits... Ford's tortious conduct endangered the lives of thousands of Pinto purchasers.[461]

6.90 The jury awarded damages of $125 million, eventually reduced to $3.5 million.[462] This was intended to have a deterrent effect given the financial resources of the manufacturer.[463]

6.91 US courts have also imposed punitive damages for failing to warn consumers of risks. In *Hasson v Ford Motor Company,* the California Supreme Court upheld an award of punitive damages against a manufacturer that failed to warn that vehicle brakes could fail if they were not properly maintained.[464] More recently in *Warren v Shelter Mutual Insurance Co*, the Louisiana Supreme Court held that punitive damages were

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457 At [77].

458 *Clerk and Lindsell* (22nd ed 2017) p 852 comment that: “Despite the liberalisation of the law on exemplary damages in *Kuddus v Chief Constable of Leicestershire*, it is suggested that they are not available in an action under the 1987 Act. The Directive refers to “damage caused by death or personal injuries” and “damage to, or destruction of, any item of property”, which seems to be limited to compensatory damages.

459 It should be noted that US product liability law varies by state. In Tennessee, for example, a manufacturer cannot be liable for punitive damages if they comply with federal safety rules, however inadequate those rules may be.

460 *Grimshaw v Ford Motor Company* (1981) 119 Cal App 3d 757, 174 Cal Reporter 348.

461 At [34].

462 At [1].

463 At [34].

464 *Hasson v Ford Motor Company* (1982) 32 Cal.3d 388, 138 Cal Reporter 705.

appropriate where a manufacturer had failed to warn the consumer that a boat's hydraulic steering system would fail if a small amount of fluid leaked out.[465]

6.92 In the US, product liability claims are often not simply about compensation, but also involve blame-allocation. It is unlikely that claims under the 1987 Act would play this role within the UK. In a scenario involving an automated vehicle, where an insurer brings a claim against a manufacturer, this will usually be a commercial dispute between two parties with significant resources at their disposal. It is unlikely to satisfy public demands for accountability following a tragedy. Insofar as the courts would have a role in allocating blame, this is likely to be a matter for criminal liability, discussed in Chapter 7.

Liability in negligence

6.93 In addition to claims under the 1987 Act, an insurer could bring a claim against a manufacturer in negligence.

6.94 It is well established that manufacturers owe a duty of care to the eventual consumer of their products.[466] This would also extend to others who are injured by the products in foreseeable circumstances. To obtain damages, the claimant must show that a duty was owed; that it was breached; that the breach caused a loss to the claimant; and that the loss was not too remote. The claimant is required to prove that the manufacturer's conduct fell below that of the reasonable manufacturer in the circumstances. The focus is therefore on showing fault by the defendant, rather than on whether the product met the safety standard people are entitled to expect.

6.95 Establishing fault can be difficult, especially for new technologies such as artificial intelligence, where it is not clear what skills are required of a "reasonable" manufacturer or software designer. However, a claimant does not have to show exactly "what went wrong" for a negligence claim to succeed.[467] In *Carroll v Fearon,* the Court of Appeal held that, where the manufacturer must have been at fault, it was not necessary to identify the specific error in the manufacturing process.[468]

6.96 The main benefit of bringing an action in negligence rather than under the 1987 Act is that a wider range of damages is available. First, it is possible to claim for damage to commercial property. Secondly, it is possible to claim for pure economic loss, such as disruption to a business. Furthermore, a defendant cannot rely on the specific defences available under the 1987 Act.[469] For these reasons, actions in negligence for defective products continue to be brought alongside, or instead of, actions under the 1987 Act.

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465 *Warren v Shelter Mutual Insurance Company* (2017) No 2016-C-1647.

466 *Donoghue v Stevenson* [1932] AC 562.

467 In *Grant v Australian Knitting Mills* [1936] AC 85, p 102, Lord Wright stated: "The appellant is not required to lay his finger on the exact person in all the chain who was responsible, or specify what he did wrong. Negligence is found as a matter of inference from the existence of the defect taken in connection with all the known circumstances". See also *Mason v Williams & Williams Limited* [1955] 1 All ER 808 and *Viscount Simonds in Davie v New Merton Board Mills Limited* [1959] AC 604.

468 *Carroll v Fearon* [1999] ECC 73, at [17] to [26].

469 See Consumer Protection Act 1987, s 4.

6.97 Furthermore, in principle, aggravated or punitive damages may be available for negligence in England and Wales.[470] Although it was previously thought that these were not available,[471] it has now been established that in principle such damages are available for any common law tort.[472] That said, no such damages have yet been awarded in the England and Wales in a case involving manufacturers' liability. Only a very determined claimant would be prepared to turn down an offer of compensatory damages to pursue a claim on the remote chance that aggravated or punitive damages would be awarded. This is because a claimant who rejects an offer under Part 36 of the Civil Procedure Rules and then receives no more than the rejected offer would be liable for the costs of the action from the date of the rejection.[473]

CLAIMS AGAINST RETAILERS UNDER CONTRACT LAW

6.98 Purchasers of automated vehicles also have a contractual claim against the business which sold the vehicle to them, if the vehicle is not of satisfactory quality. Claims against retailers may be particularly important if a purchaser wishes to claim for damage to the vehicle itself, as this form of damage is not covered by either the AEV Act provisions or by the 1987 Act. However, contractual liability is not confined to damage to the vehicle, and may also include personal injury to the purchaser.

6.99 The main terms of contracts for the sale of goods are set out in statute. However, these only apply if the retailer is a business. A purchaser would have very few rights against another consumer in a private sale of a second-hand vehicle.[474]

6.100 Following the Consumer Rights Act 2015, there is a distinction between contractual liabilities owed by business retailers to consumers and those owed to other businesses.

Business-to-consumer contracts

6.101 Under the Consumer Rights Act 2015, every business-to-consumer contract for the sale of goods contains certain statutory non-excludable terms. Goods must be of satisfactory quality. Section 9(2) states that goods must "meet the standard that a reasonable person would consider satisfactory", taking account of relevant circumstances. This includes any public statement about the specific characteristics of the goods made by the producer, including statements made in advertising or labelling.[475]

6.102 Section 9(3) then lists various aspects of quality, including "fitness for all the purposes for which goods of that kind are usually supplied"; "safety"; and "durability".

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470 Aggravated and punitive damages for negligence are not available under Scots law.

471 See *AB v South West Water Services Ltd* [1993] QB 507.

472 *Kuddus v Chief Constable of Leicestershire* [2001] UKHL 29, [2002] AC 122; Prof M Jones, Prof A Dugdale and M Simpson QC, *Clerk and Lindsell on Torts* (22nd ed 2017) p 819.

473 The Civil Procedure Rules apply to England and Wales. Broadly comparable considerations apply to Scottish actions where a Pursuers' Offer has been made: see Rules of the Court of Session 1994, Ch 34A and (for Sheriff Court actions) Ordinary Cause Rules 1993, Ch 27A.

474 Note that neither the Consumer Rights Act 2015 nor the implied terms relating to fitness for purpose and satisfactory quality under the Sale of Goods Act 1979 apply to private sales.

475 Consumer Rights Act 2015, s 9(5) and (6).

6.103 If a court were to find that a vehicle was not of the safety standard which people are entitled to expect, it is likely that consumers would bring claims against the retailer for repair or replacement of the vehicle,[476] or for damage to the vehicle itself.

Business-to-business contracts

6.104 Contracts between businesses also have statutory terms. Under the Sale of Goods Act 1979, every business-to-business contract for the sale of goods includes an implied term that goods are of satisfactory quality.[477] As with the consumer legislation, this means that goods must "meet the standard that a reasonable person would regard as satisfactory". This standard has several aspects, including safety.

6.105 The main difference is that in consumer contracts, terms cannot be excluded by contract. In business-to-business contracts, implied terms can be excluded, but only to the extent that it is reasonable to do so.[478]

Could the retailer recoup the cost of claims from the manufacturer?

6.106 This raises the question of whether a retailer who is required to pay damages to its business or consumer customers could pass these costs on to the manufacturer. The answer would depend on the contract between the retailer and the manufacturer. If the contract included a term excluding the manufacturer's contractual liability, a court would need to decide whether the term "satisfies the requirement of reasonableness" set out in the Unfair Contract Terms Act 1977.[479]

CIVIL LIABILITY OF MANUFACTURERS AND RETAILERS: IMPLICATIONS

6.107 Under the AEV Act, claims for death and personal injury will be paid initially by the automated vehicle insurer, as will claims for property damage of up to £1.2 million. It will then be a commercial matter for the insurer to decide whether to bring a secondary claim against the manufacturer or supplier, either under the 1987 Act, negligence or (where the damage was sustained by a buyer) in contract.

6.108 During initial discussions, insurers suggested that different insurance companies would take different approaches. Some may enter into business arrangements with manufacturers, and will therefore be reluctant to become embroiled in litigation with their business partners. Others may take the view that the benefits of litigation outweigh the costs, and that a more litigious approach would enable them to keep premiums low.

6.109 If insurers do decide to litigate, the type of action will depend on the type of damage. Claims for death, personal injury and damage to consumer property are likely to be brought under Part 1 of the 1987 Act. Claims relating to damage to commercial vehicles or other commercial property would need to be brought under the common law of negligence.

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[476] Consumer Rights Act 2015, s 23.

[477] Sale of Goods Act 1979, s 14(2A).

[478] England and Wales: Unfair Contract Terms Act 1977, s 6(1A). Scotland: Unfair Contract Terms Act 1977, s 20(1)(a).

[479] See Unfair Contract Terms Act 1977, s 6(1A), s 11 and sch 2.

6.110 It will be relatively rare for injured parties to sue parties other than the insurer directly. However, they may do so to recoup pure economic loss, such as business interruption, under the law of negligence. Vehicle owners may bring actions against the retailer in the event of damage to the automated vehicle itself.

6.111 In some cases, compensation claims may be low. This is especially true where an accident results in the death of a child, where damages are generally limited to bereavement damages and the cost of a funeral.[480] In England and Wales, the bereavement damages are capped at £12,980.[481] Any claim for aggravated or punitive damages would be extremely difficult, and is likely to risk a significant costs award.

6.112 Under section 3(1) of the 1987 Act, the central question is whether the safety of an automated vehicle falls below the standard which "persons generally are entitled to expect". In practice, the courts are likely to follow the standard set by regulators, rather than lead in this area. As the judge stated in *Wilkes,* although the simple fact of regulatory approval is not an automatic defence, it can be powerful evidence of the level of safety the public is entitled to expect.[482]

6.113 One possible exception is the importance that section 3(2) of the 1987 Act accords to instructions, warnings and the way that the product has been marketed. As discussed in Chapter 5, the system of type approval does not consider marketing terms or the instructions provided in owners' manuals. These issues are likely to become much more significant in civil litigation.

6.114 The test under the Consumer Rights Act 2015 is likely to be similar. Again, the court is required to consider whether the goods "meet the standard a reasonable person would consider satisfactory", bearing in mind public statements made about the goods.

6.115 On balance, our initial conclusion is that litigation over manufacturers' or other suppliers' liability will play a relatively limited role in compensating victims, setting standards or allocating blame for defective automated vehicles. We say this for three reasons:

(1) The main avenue for providing compensation will be through insurers, under the provisions of Part 1 of AEV Act. Litigation against manufacturers will then be a commercial matter for the insurer;

(2) The main means of setting standards will be through regulation. If the system passes relevant testing (and there is no impropriety by the manufacturer), it is unlikely that the courts would themselves seek to impose a different, more stringent standard.

(3) The main means of allocating blame will be through the criminal justice system. The relatively low level of damages for deaths, coupled with the difficulties of

480 England and Wales: Fatal Accidents Act 1976 ss 1 to 5. Scotland: Damages (Scotland) Act 2011, s 4(3).

481 See Fatal Accidents Act 1976 s 1A(3). In Scotland, there is no cap. Instead, damages would be assessed by a court under the Damages (Scotland) Act 2011.

482 At [101]. In practice, the test under the Consumer Rights Act 2015 is likely to be similar.

obtaining aggravated or punitive damages, means that civil litigation will not be an important form of accountability.

6.116 For these reasons, we do not see a general review of manufacturers' or suppliers' liability as a priority at this stage. However, we think that there is one issue which might usefully be reviewed, namely the application of product liability to software updates. As we saw, there is some doubt about whether Part 1 of the 1987 Act applies to defective software in the absence of a physical medium. We also ask if there are any other issues which need to be addressed.

Consultation Question 18.

6.117 Is there a need to review the way in which product liability under the Consumer Protection Act 1987 applies to defective software installed into automated vehicles?

Consultation Question 19.

6.118 Do any other issues concerned with the law of product or retailer liability need to be addressed to ensure the safe deployment of driving automation?

Chapter 7: Criminal liability

7.1 The regulation of road traffic relies heavily on criminal offences, with most offences aimed at the human driver of a motor vehicle. Drivers have many responsibilities. They are not only responsible for controlling the speed and direction of the vehicle, they also have responsibilities for their own condition (to be qualified and fit to drive); for insurance; for the roadworthiness of the vehicle; for reporting accidents, and even for the conduct of passengers (such as ensuring that children wear seatbelts). In background paper 1a, we analyse 69 offences which may be committed by a driver.[483]

7.2 Some of these responsibilities are not confined to drivers. As we discuss in background paper 1, road traffic legislation uses a variety of terms which extend responsibilities more widely, such as "using a vehicle", or being "in charge" of a vehicle. However, even when the legislation uses other terms, drivers are still central to the allocation of responsibilities. Drivers are always "users", and always "in charge", even if responsibilities are sometimes extended to non-drivers.

7.3 In this chapter we consider four ways in which the current system of road traffic offences will need to adapt to the challenges of automated driving.

(1) Some offences may prevent types of automated driving. We consider the need to remove any legal blocks to the deployment of safe automated vehicles.

(2) Some offences arise directly out of the way that the vehicle is driven - that is they arise from "the dynamic driving task" of controlling steering, acceleration and braking. This applies to a wide variety of offences, from dangerous and careless driving, to speeding and going through a red traffic light. With driver assistance systems, the human driver will continue to be responsible for these offences. However, as automation increases there comes a point at which the human user ceases to be in control of the dynamic driving task. In these cases:

(a) We tentatively propose legal clarification that when a vehicle is driving itself, the human user is not a driver and not liable for any offences which arise out of the dynamic driving task

(b) We then consider alternative ways of dealing with infractions which occur while vehicles are driving themselves. The fault may lie with a variety of actors, such as the person responsible for the vehicle who fails to update software. Where the fault lies with the automated driving system itself, we tentatively propose that the entity which vouches for the automated driving system should be subject to a system of regulatory sanctions, including warnings, fines and withdrawal of authorisation.

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483 This is not a full list of offences: it does not include offences under local bylaws or those which apply only to agricultural or commercial vehicles. However, it does include all the offences listed in the Magistrates Court Sentencing Guidelines, which are those most commonly committed in England and Wales.

(3) As discussed in Chapter 3, even highly automated vehicles may exceed their operational design domain during a journey. This might be planned (where a vehicle leaves a motorway) or it might be unplanned (when sudden fog or snow disrupts the sensors). This means that certain users who are not driving may still need to be capable of driving. We tentatively propose legislation to recognise a new status, the "user-in-charge" of an automated vehicle, who must be qualified and fit to drive.

(4) Some offences do not arise directly out of the way a vehicle is driven. We consider the many other responsibilities placed on drivers - ranging from obligations relating to insurance and roadworthiness, to duties following an accident, to offences concerning where a vehicle is driven and left. Without a driver as the central lynchpin of accountability, where should these responsibilities fall?

(a) As a default position, we suggest that these responsibilities should be allocated to the user-in-charge of the vehicle.

(b) In some circumstances, vehicles may be authorised for use without a user-in-charge. Where a licensed fleet operator provides mobility as a service, we think that insurance and maintenance obligations should fall on the licensed operator. In other cases, we see a need to review the responsibilities of a registered keeper to insure and maintain a vehicle, and to deal with vehicles that are left in inappropriate places.

7.4 Finally, we consider aggravated offences (mostly under the Road Traffic Act 1988) where faults by drivers cause death or serious injury to other road users. These apply only to human drivers. We then consider other possible criminal offences relating to death or serious injury caused by interference with vehicles or road signs, or where developers or manufacturers cut safety corners in bringing automated driving systems to market. We ask if further offences might be needed.

OFFENCES INCOMPATIBLE WITH AUTOMATED DRIVING

7.5 We found no offences which completely prevent automated driving. However, a few offences might prevent particular types of automation.

7.6 In 2017, concerns were expressed that laws prohibiting the use of mobile phones while driving appeared incompatible with remote-control parking. Typically, this driver-assistance feature allows a driver to carry out a parking manoeuvre from outside the vehicle by using a command device such as a mobile phone. In December 2017, the Centre for Connected and Autonomous Vehicles consulted on reforms to address the issue,[484] and the law has now been changed. In June 2018 the UK updated regulation 110 of the Road Vehicles (Construction and Use) Regulations 1986, which had prohibited drivers from using hand-held mobile devices while driving.[485] The amended

[484] Centre for Connected and Automated Vehicles, *Remote Control Parking and Motorway Assist, Proposals for amending Regulations and the Highway Code* (December 2017).

[485] Reg 110 also prohibits other hand-held interactive communication devices which transmit and receive data (such as a tablet): see reg 110(2)(b) and (4).

regulation permits the use of remote control parking devices within six metres of the vehicle.

7.7 Another example is Regulation 107 of the Road Vehicles (Construction and Use) Regulations 1986. This prevents a person from leaving a motor vehicle on a road where the vehicle:

> is not attended by a person licensed to drive it unless the engine is stopped and any parking brake with which the vehicle is required to be equipped is effectively set.[486]

7.8 This does not necessarily require a licensed person within the vehicle. A vehicle may still be "attended" by a person who is near the vehicle or in a remote control centre. However, Regulation 107 would appear to be incompatible with some forms of highly automated vehicles, such as where the vehicle is empty and not remotely controlled.[487] The United States Uniform Law Commission's draft Bill on highly automated vehicles for example specifically provide that:

> An automated vehicle under automated operation shall not be considered unattended or abandoned solely because an individual is not in or near the vehicle, unless the vehicle is not lawfully registered, poses a risk to public safety, or unreasonably obstructs other road users.[488]

7.9 We seek views on whether Regulation 107 should be amended, and whether other offences raise similar issues.

7.10 We have also considered the effect of Regulation 104 of the Construction and Use Regulations. This states that

> No person shall drive, or cause or permit any other person to drive, a motor vehicle on a road if he is in such a position that he cannot have proper control of the vehicle or have a full view of the road and traffic ahead.

7.11 In our view, this provision does not necessarily require a driver. Instead, it simply provides that if a vehicle has a driver, the driver must be in a position to have proper control and a full view. We think that if a vehicle did not have a person driving it, no-one would be liable for the offence.[489] However, the definition of a driver is a flexible one, and would include a person or persons outside the vehicle.[490] For example, if the vehicle were controlled by a remote driver who did not have a full view of the traffic ahead, then the remote driver would commit this offence. Enforcement authorities might look widely

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486 Road Vehicles (Construction and Use) Regulations 1986, reg 107(1).

487 We have considered whether the phrase "a person licensed to drive the vehicle" could be interpreted as including an automated driving system. This interpretation is theoretically possible, but would involve a creative approach to statutory language.

488 See National Conference of Commissioners on Uniform State Laws, Draft Highly Automated Vehicles Act, July 2018, at s 8(f).

489 Note too, that it is not possible to "cause or permit any other person to drive" a vehicle unless there is a person who drives the vehicle. For a discussion of the meaning of "cause or permit", see background paper 1 paras 1.21 to 1.24.

490 Discussed at para 2.66.

to find an identifiable human driver responsible for complying with this regulation. We welcome observations on this point.

Consultation Question 20.

7.12 We seek views on whether regulation 107 of the Road Vehicles (Construction and Use) Regulations 1986 should be amended, to exempt vehicles which are controlled by an authorised automated driving system.

Consultation Question 21.

7.13 Do other offences need amendment because they are incompatible with automated driving?

OFFENCES RELATING TO THE WAY A VEHICLE IS DRIVEN

7.14 Many offences arise directly from the performance of the dynamic driving task, in that they are committed through the control of steering, brakes and acceleration. Examples include dangerous driving, driving without due care and attention, failing to comply with traffic signs and exceeding speed limits.

7.15 With driver assistance systems, the human driver remains fully responsible for these offences.[491] However, there comes a point at which a vehicle no longer requires a human driver to monitor the environment or undertake any part of the dynamic driving task. In our provisional view, when the automated driving system is engaged and conducting the entire dynamic driving task, complying with traffic law becomes the responsibility of the automated driving system entity[492] - not the human user in the vehicle. Below we ask if it would be helpful to provide human users with a "safe harbour" to clarify when they are not liable for criminal offences arising from the dynamic driving task. We then consider alternative ways of dealing with driving behaviour which would currently be considered an offence, where responsibility lies with the automated driving system entity.

A legal "safe harbour" for human users while the vehicle is driving itself?

7.16 As discussed in Chapter 2, the concept of driver is flexible. Without amendment, the flexible concept of driver may be interpreted too widely. It could apply to a human user in the vehicle even if the vehicle is operating at a level where the system has made the

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491 As an example, in April 2018, a driver pleaded guilty to dangerous driving after he moved into the passenger seat on a motorway at 40 miles per hour, leaving his Tesla vehicle under the control of its "autopilot" programme. He was disqualified from driving for 18 months and sentenced to 100 hours community service: see https://www.bbc.co.uk/news/uk-england-beds-bucks-herts-43934504.

492 We discuss the role of the Automated Driving System Entity, vouching for the safety of the Automated Driving System, at paras 4.107 to 4.109.

decisions, and the human is not required to monitor the system or the environment. Michael Cameron's report for New Zealand's Law Foundation noted that:

> for some offences, it is possible that blameless operators/passengers in driverless vehicles could be held criminally responsible if the vehicle they are travelling in makes a mistake. As well as being unfair, this could discourage public use and acceptance of driverless technology.[493]

7.17 In Chapter 3 we noted that the Automated and Electric Vehicles Act 2018 (AEV Act) places a duty on the Secretary of State to keep a list of all motor vehicles which "may lawfully be used when driving themselves". We tentatively propose that automated driving systems which drive themselves should have a user-in-charge in position to operate the controls, unless the vehicle is specifically authorised to function without one. A user-in-charge must be qualified and fit to take over the driving task. However, a user-in-charge would not be a driver for purposes of civil and criminal law while the system is appropriately engaged. For systems which are authorised to function without a user-in-charge, all occupants would have the status of passengers - and again, would not be drivers for legal purposes.

7.18 As discussed in Chapter 6, where such a vehicle causes an accident "when driving itself on a road or other public place", primary civil liability for the accident will rest with the insurer, not the human user. Here we ask whether a similar principle should apply to those criminal offences which arise directly from the dynamic driving task. We are concerned with a vehicle which is listed under section 1 of the AEV Act as capable of driving itself and which has its automated driving system legally and correctly engaged. In these circumstances, we tentatively propose legal clarification that the human user should not be considered a driver for purposes of criminal offences arising from the dynamic driving task.

7.19 We have considered possible arguments against providing a "safe harbour" for human users (including those we describe as "users-in-charge"). One is that criminal liability might deter people from using vehicles which have a relatively poor safety record. Another is that a user who is fined could pass on the fine to the responsible entity. However, we do not think that this would be an appropriate use of the criminal law. A criminal penalty is not simply an economic disincentive but also represents public censure.

493 M Cameron, *Realising the potential of driverless vehicles* (The New Zealand Law Foundation, 2018), p 9, https://www.lawfoundation.org.nz/wp-content/uploads/2018/04/Cameron_DriverlessVehicles_complete-publication.pdf.

Consultation Question 22.

7.20 Do you agree that where a vehicle is:

(1) listed as capable of driving itself under section 1 of the Automated and Electric Vehicles Act 2018; and

(2) has its automated driving system correctly engaged;

the law should provide that the human user is not a driver for the purposes of criminal offences arising from the dynamic driving task?

7.21 Rather than being classified as a driver, we envisage that a user-in-charge would be subject to specific criminal provisions. As we discuss below, we tentatively propose specific provisions relating to qualifications and fitness to drive. We are also consulting on other requirements. In Chapter 3, for example, we ask if users-in-charge who are subjectively aware of a risk of serious injury should take reasonable steps to avert that risk. A user-in-charge in these circumstances who failed to take reasonable steps would be guilty of a specific criminal offence.

Consultation Question 23.

7.22 Do you agree that, rather than being considered to be a driver, a user-in-charge should be subject to specific criminal offences? (These offences might include, for example, the requirement to take reasonable steps to avoid an accident, where the user-in-charge is subjectively aware of the risk of serious injury (as discussed in paragraphs 3.47 to 3.57)).

A new system of sanctions for automated vehicles

7.23 If human drivers are no longer responsible for dynamic driving offences committed when a vehicle is driving itself, what should happen if such a vehicle carries out a manoeuvre which (if done by a human) would amount to an offence?

7.24 It is Government policy that automated driving systems should observe the standards enforced by road traffic offences.[494] However, infractions may still occur. Thought needs to be given to how these infractions will be dealt with.

[494] Road rules are often subject to explicit and implicit exceptions and tolerances. For example, guidance from the Association of Chief Police Officers (ACPO) (now known as the National Police Chiefs Council (NPCC)) provides that human drivers may exceed the speed limit by 10% plus 2 miles before facing a fixed penalty notice: see http://library.college.police.uk/docs/appref/ACPO-Speed-Enforcement-Guidance.pdf. In Ch 9 we ask if similar tolerances should apply to automated vehicles.

7.25 The issue has been considered by the National Transport Commission (NTC) in Australia, who note that "existing road traffic penalties are clearly aimed at influencing the behaviour of human drivers".[495] Without adaptation, they are unlikely to be appropriate or effective when applied to manufacturers, for example. NTC argue that breaches of road traffic laws are important indications of a possible broader failure to design safe automated vehicles. Any enforcement therefore needs to be part of a feedback loop, aimed at improving safety.[496] NTC comment that:

> These breaches may be better managed through other avenues such as issuing of improvement notices or entering into enforceable undertakings to encourage a greater focus on safety by the automated driving system entity, rather than relying on existing low monetary penalties.[497]

7.26 NTC recommends that every automated driving system (ADS) should be backed by an Automated Driving System Entity (ADSE).[498] The entity would apply for authorisation and would be subject to a range of regulatory sanctions if things go wrong:

> The safety assurance system could include a range of compliance and enforcement options including graduated sanctions and penalties. These could include improvement notices, infringement notices, enforceable undertakings, suspension and withdrawal of ADS approval.[499]

7.27 We tentatively propose a similar system. Developers or manufacturers who wish to gain authorisation for their automated systems would have to stand behind the system. In other words, each automated driving system listed under the 2018 Act would need to be backed by an entity or ADSE. In the event of failures or infringements, the ADSE would be subject to a system of graduated regulatory sanctions. These could include improvement notices, fines and where necessary suspension or withdrawal of approval.

7.28 Below we consider how such a system might work, starting with an example - speeding. We ask if a similar procedure should apply to the full range of dynamic driving task offences.

Speeding: an example

7.29 We have used speeding as an example for three reasons: speed limit violations are common; they range from relatively minor to more serious infractions; and the police have provided guidelines on the principles behind enforcement. In particular, police

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495 NTC Australia, *Changing driving laws to support automated vehicles, Discussion Paper* (October 2017) p 77.

496 NTC Australia, *Changing driving laws to support automated vehicles, Policy Paper* (May 2018), para 8.2.1.

497 NTC Australia, *Regulatory options to assure automated vehicle safety in Australia*, Discussion Paper (July 2017) p 94.

498 The concept of an ADSE is introduced at para 4.107 and following.

499 NTC Australia, *Changing driving laws to support automated vehicles, Policy Paper* (May 2018) para 8.2.1.

guidelines emphasise that enforcement should be proportionate, targeted, consistent and transparent.[500] We explore these guidelines more fully in background paper 1.

7.30 Automated vehicles can be programmed not to exceed speed limits.[501] However, speeding offences might still occur, for a variety of reasons:

(1) the highway authority may have failed to inform the software provider of a change to the speed limit, or may have indicated it in an unclear way;

(2) the person responsible for the vehicle may have failed to update the software;

(3) the owner or a third party may have uploaded unauthorised software, which is not in accordance with set standards;

(4) the software update may be faulty;

(5) the original program may be faulty; or

(6) the software programmer may have deliberately ignored legal requirements.

7.31 Under the current law, if a speed camera detects a vehicle driving at 37 miles an hour in a 30 mile an hour area, the police will serve “a notice of intended prosecution” on the registered keeper. Under section 172 of the Road Traffic Act 1988, the registered keeper is then required to provide the police with information about the identity of the driver.[502]

7.32 We tentatively propose that if a vehicle was driving itself at the time of the speeding, the registered keeper should be required to say so, and to provide the relevant data to the police.[503] The police would then investigate why the speeding infringement occurred. The issue might be resolved by liaising with the Highway Authority to provide better traffic signs. Alternatively, a prosecution could be brought against the person responsible for the vehicle[504] for failing to update software or for installing unauthorised software.

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500 Association of Chief Police Officers Speed Enforcement Policy Guidelines 2013.

501 For a discussion of how far automated driving systems might be allowed to exceed speed limits, see paras 9.40 to 9.47.

502 The notice must be sent within 14 days of the offence and must specify the nature of the alleged offence and the time and place where it is alleged to have been committed: Road Traffic Offenders Act 1988, s 1. A notice is not necessary if the police provided an oral warning at the time of the offence or if, at the time of the offence, the driver was involved in an accident and was aware of the accident or ought to have been aware it: Road Traffic Offenders Act 1988, s 2. The notice of intended prosecution can be sent to the registered keeper or the driver. These are often the same person. If the notice is sent to the driver, they simply have to confirm that they were the driver.

503 This would require a small change to s 172 of the Road Traffic Act 1988, so that the registered keeper would be required either to provide information about the identity of the driver, or to state that the vehicle was driving itself.

504 We intend to consider the issue of who is responsible for an automated vehicle in the next consultation paper, alongside a discussion of licensed operators. We envisage that responsibility could be allocated to the licensed operator or the registered keeper.

7.33 If, however, the problem appears to lie with the software itself, rather than with maintenance, we think that the issue should be submitted to the regulatory authority proposed in paragraph 4.102. The authority would then investigate possible sanctions against the ADSE.[505] Regulators would have a flexible range of graduated sanctions, including improvement notices, enforceable undertakings, fines, suspension and (in the most serious cases) withdrawal of ADS approval. The regulatory sanctions applied by the Financial Conduct Authority against authorised financial providers might act as a model.[506] The aim would be to learn from infractions to improve the safety of automated vehicles.

Other offences relating to how the vehicle is driven

7.34 Speeding is only one example. We tentatively suggest that a similar approach should apply whenever an ADS causes a vehicle to behave in way which would be an offence if carried out by a human driver. In other words, if the police have reason to think that an ADS is responsible for the behaviour, the police should refer the matter to the regulatory authority for further investigation. The regulatory authority should use this investigation to improve safety. They would also have power to impose a range of regulatory sanctions against the ADSE.

7.35 At the end of this chapter, we consider aggravated offences, where driving causes death or personal injury. We explore whether in these extremely serious cases corporate entities or individuals might have committed more serious offences, such as manslaughter.

Consultation Question 24.

7.36 Do you agree that:

(1) a registered keeper who receives a notice of intended prosecution should be required to state if the vehicle was driving itself at the time and (if so) to authorise data to be provided to the police?

(2) where the problem appears to lie with the automated driving system (ADS) the police should refer the matter to the regulatory authority for investigation?

(3) where the ADS has acted in a way which would be a criminal offence if done by a human driver, the regulatory authority should be able to apply a range of regulatory sanctions to the entity behind the ADS?

(4) the regulatory sanctions should include improvement notices, fines and suspension or withdrawal of ADS approval?

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505 We follow the NTC in Australia by referring to the "automated driving system" as the ADS and the entity behind the ADS as the "automated driving system entity" or "ADSE".

506 Financial Services and Markets Act 2000, Part XIV.

RESPONSIBILITIES OF USERS-IN-CHARGE

7.37 We have suggested that users-in-charge should not be criminally liable for offences arising out of how the vehicle is driven while the system is correctly engaged. However, they may be called on to drive, either following a planned handover or after the vehicle has achieved a minimal risk condition and come to a stop. Users-in-charge would have legal duties to make sure this can happen safely. In Chapter 3, we tentatively proposed that a user-in-charge should be required to be qualified and fit to drive. Here we consider the implications of this proposal for criminal law.

Qualified and physically fit to drive

7.38 It is currently a criminal offence for a person to drive without a licence[507] or while disqualified.[508] A further two offences relate to physical fitness to drive, namely:

(1) Driving with eyesight which fails to comply with the prescribed requirements;[509] and

(2) Driving with a licence the application for which included a declaration regarding a disability which the driver "knew to be false".[510]

7.39 We tentatively propose that these offences should apply not only to drivers but also to users-in-charge.

Drink and drugs

7.40 Under the current law it is a criminal offence to be in charge of a motor vehicle while unfit to drive through drink or drugs.[511] It is also an offence to be in charge of a motor vehicle with alcohol levels over the prescribed limits.[512]

7.41 These offences are not confined to drivers but extend to all those "in charge of a motor vehicle". It is highly likely that these offences would already apply to a user-in-charge. As discussed in background paper 1, being "in charge of a vehicle" covers a person who is not driving but who is sitting in the driving seat and might drive in the future.[513]

7.42 On this basis, legal reform is not strictly necessary. However, if new legislation is introduced to clarify the duties of a user-in-charge, we think that it would be helpful to spell out that a user-in-charge must not be unfit to drive through drink or drugs or have alcohol levels over the prescribed limits.

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507 Road Traffic Act 1988, s 87.

508 Road Traffic Act 1988, s 103.

509 Road Traffic Act 1988, s 96.

510 Road Traffic Act 1988, s 92(10).

511 Road Traffic Act 1988, s 4(2).

512 Road Traffic Act 1988, s 5(1).

513 *DPP v Watkins* [1989] 2 WLR 966.

Identifying a user-in-charge

7.43 In Chapter 3 we tentatively proposed that a user-in-charge should be in a position to operate the controls. In the immediate future, this means "in the driving seat". For example, if a vehicle is listed as only safe to drive itself with a user-in-charge, it would be a criminal offence for the person in the driving seat to be drunk or disqualified. If a passenger is aware that the user-in-charge is not qualified or fit, the passenger may be guilty of an aiding and abetting offence.[514]

7.44 It is possible that no-one may be in the driving seat. If, for example, all the users are unfit to drive, they might be keen to sit in the back seat. In this case, one solution would be to create a new offence of being carried in a vehicle which requires a user-in-charge and does not have one. This would apply to all the occupants in the vehicle.

7.45 We appreciate that these broad principles may leave some uncertainties in practice. As vehicle design changes, the concept of a driving seat may become outdated. Similarly, where no-one is in the driving seat, some occupants might bear more moral responsibility than others. On balance, however, we think that these uncertainties could be overcome by guidance to prosecutors issued by the Crown Prosecution Service in England and Wales and by the Crown Office and Procurator Fiscal Service in Scotland.

Consultation Question 25.

7.46 Do you agree that where a vehicle is listed as only safe to drive itself with a user-in-charge, it should be a criminal offence for the person able to operate the controls ("the user-in-charge"):

(1) not to hold a driving licence for the vehicle;

(2) to be disqualified from driving;

(3) to have eyesight which fails to comply with the prescribed requirements for driving;

(4) to hold a licence where the application included a declaration regarding a disability which the user knew to be false;

(5) to be unfit to drive through drink or drugs; or

(6) to have alcohol levels over the prescribed limits?

514 Under current law, a passenger who aids or abets another person to drive a vehicle while under the influence of alcohol can be found guilty of an offence: *DPP v Anderson* (1991) 155 JP 157; *Smith v Mellors* (1987) 84 Cr App R 279. If a passenger has a degree of legal control of the vehicle, they can be liable for the actual driver's offence, if they are aware of it and fails to prevent it: see *Du Cros v Lambourne* [1907] 1 KB 40. For a broader discussion of accessorial liability for road traffic offences, see K McCormac, P Brown, P Veits, N Watson and J Woodhouse (eds), *Wilkinson's Road Traffic Offences* (28th ed 2017) para 1-198 to 1-207. We envisage that similar rules would apply here.

Consultation Question 26.

7.47 Where a vehicle is listed as only safe to drive itself with a user-in-charge, should it be a criminal offence to be carried in the vehicle if there is no person able to operate the controls?

RESPONSIBILITIES FOR OTHER OFFENCES

7.48 Under the current law, many other responsibilities are placed on drivers, which do not arise from the dynamic driving task. In some cases, the legislation specifies that liability is on the "driver" (such as the duty to report accidents or to ensure children are wearing seatbelts). In other cases, liability is imposed on the "user", but the courts have interpreted the concept of a user primarily with a human driver in mind.

7.49 Here we consider responsibilities for insurance and roadworthiness; offences relating to where a vehicle is driven; and offences relating to where a vehicle is left. We then consider a range of other obligations which it may be difficult for an automated driving system to comply with, including duties following an accident, duties to comply with the directions of a police constable, and ensuring that children wear seat belts.

7.50 In the short-term, we suggest that these responsibilities should be allocated to the user-in-charge. Where automated vehicles are listed as able to drive themselves without a user-in-charge, other solutions will need to be found. In future consultation papers, we intend to look at the responsibility of licensed operators providing mobility as a service. We also intend to review the responsibilities of the registered keeper to insure and maintain vehicles, and prevent them from being left in inappropriate places. In particular, we see a need to impose a new obligation on the registered keeper to keep ADS software up-to-date.

7.51 Future consultations will also consider other positive duties on users-in-charge. These might include duties to be receptive to planned handovers, or not to require automated vehicles to exceed their operational design domain.

(1) Insurance and roadworthiness

7.52 Many offences relate to "using" a vehicle rather than driving it. An example is section 40A of the Road Traffic Act 1988, which states that:

> 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 [its] condition… is such that the use of the motor vehicle involves a danger of injury to any person.

7.53 Several similar offences relate to other aspects of roadworthiness.[515] The main insurance offence, under section 143(1)(a) of the Road Traffic Act 1988, also refers to "using" a vehicle.

Who "uses" a vehicle?

7.54 Background paper 1 looks in detail at who uses a vehicle under the current law. As currently interpreted, it covers the driver and the driver's employer (if the vehicle is being used for the employer's business). It also applies to an owner in the vehicle who is "using the vehicle directly for their own purposes".[516]

7.55 On this basis, under the current case law, an owner of an automated vehicle would be considered a user when they are in it. The same would apply to someone who leased the vehicle over a prolonged period for their exclusive use. It is less clear, however, whether owners would be considered to "use" a vehicle while they are not in it (for example, when an automated vehicle conveys friends and family).[517] The courts may develop the law to hold that an owner uses a car in these circumstances, but the point is untested.

A need for reform?

7.56 In the short term, we think that it would be helpful to clarify that the user-in-charge is a "user" for the purposes of insurance and roadworthiness offences.

7.57 This means that a person who drives a vehicle for part of the journey, and who assumes the role of a user-in-charge for the rest of the journey would need to carry insurance for the whole journey. As we discuss in Chapter 6, it is particularly helpful for the whole journey to be covered by a single insurer, as this would remove the possibility of disputes about which insurer was liable to cover an accident which occurred during the handover period.[518]

7.58 Where automated vehicles may be used without a user-in-charge, responsibilities for insurance and maintenance would need to lie with another person, such as the registered keeper, licenced operator or the person who causes the journey to be made. We intend to look at these issues in a subsequent consultation paper.

(2) Offences related to where a vehicle is driven

7.59 Some offences relate to where a vehicle is driven. For example, under section 34 of the Road Traffic Act 1988, it is an offence to drive a mechanically propelled vehicle on common land, moorland, a footway, bridleway or restricted byway.[519] Under section 21, it is an offence to drive on a cycle track.

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515 In the Road Traffic Act 1988, s 41B deals with breaching weight requirements; s 41C forbids the use of speed assessment equipment detection devices; and s 42 deals with any other construction or use requirement.

516 *Cobb v Williams* [1973] RTR 113, discussed in background paper 1.

517 The increase in shared mobility services puts added strain on these concepts, which will be examined further as part of our consideration of mobility as a service.

518 For a discussion of handover and "blame time", see paras 3.41 to 3.43.

519 In England, Highway Act 1835, s 72 also prohibits driving a motor vehicle (or carriage) along a footway.

7.60 What if a person sets the controls of an automated vehicle to require it to drive on a bridleway or cycle track? This may not be a problem in practice. Some automated driving systems will be "geofenced", where the self-driving technology itself may prevent anyone from requiring the vehicle to drive on non-roads. However, not all systems will necessarily be geofenced in this way. Alternatively, such technological restrictions may be overridden or fail to function.

7.61 We welcome views on whether a person should be criminally liable for setting a driving system to require it to drive in a prohibited place.

(3) Offences related to where a vehicle is left

7.62 Many offences relate to leaving a vehicle. Background paper 1a lists 12 such offences. Some are general, such as leaving a vehicle in a dangerous position contrary to section 22 of the Road Traffic Act 1988. Others are location-sensitive. For example, it is an offence to park a vehicle on a cycle track without lawful authority.[520] Under the Motorways Traffic (England and Wales) Regulations 1982 it is an offence to permit a vehicle to remain at rest on a motorway hard shoulder for longer than is necessary in the circumstances.[521] Similarly under the Motorways Traffic (Scotland) Regulations 1995, there are restrictions on vehicles stopping or remaining at rest on a carriageway, or coming to a rest on a hard shoulder.[522]

7.63 The legislation uses a variety of terms to describe who is liable for offences related to where a vehicle is left. Section 22 applies to "a person in charge of a vehicle". Others relate to a person who parks.[523] Under the Motorways Traffic (England and Wales) Regulations 1982, offences may be committed by anyone who "uses a motorway". There is very little case law on how these various phrases should be interpreted.

7.64 In the early days of highly automated vehicles,[524] a range of problems may cause a vehicle to fail, including problems with the sensors or unexpected weather conditions. If so, the vehicle will achieve a "minimal risk condition". In practice this is likely to mean coming to a stop by the side of the road. In some cases, the law may prevent a vehicle from simply being left in this position (as where the vehicle has come to rest on the hard shoulder of the motorway). Where a vehicle has a user-in-charge, we think it would be helpful to clarify that the user-in-charge is responsible for removing a vehicle that is illegally parked, either by assuming manual driving or (alternatively) by calling a tow-truck.

7.65 Future consultation papers will consider how these responsibilities should be met where a vehicle does not have a user-in-charge. Responsibility for removing illegally parked

520 Road Traffic Act 1988, s 21.

521 Motorways Traffic (England and Wales) Regulations 1982, regs 9 and 7(3)(b). For an account of this offence see background paper 1.

522 The Motorways Traffic (Scotland) Regulations 1995, regs 6 and 8.

523 For example, under Road Traffic Act 1988, s 21 "any person who, without lawful authority… parks a [mechanically propelled] vehicle wholly or partly on a cycle track is guilty of an offence".

524 SAE Level 4.

vehicles might lie with licensed fleet operators providing mobility as a service, or with registered keepers.

Consultation Question 27.

7.66 Do you agree that legislation should be amended to clarify that users-in-charge:

(1) Are "users" for the purposes of insurance and roadworthiness offences; and

(2) Are responsible for removing vehicles that are stopped in prohibited places, and would commit a criminal offence if they fail to do so?

Consultation Question 28.

7.67 We seek views on whether the offences of driving in a prohibited place should be extended to those who set the controls and thus require an automated vehicle to undertake the route.

(4) Other possible duties on users-in-charge

7.68 It has been suggested to us that users-in-charge could be under other positive duties which are specific to driving automation and have no direct equivalent in current law. For example, a user-in-charge could be obliged to take over driving on a planned take-over, to prevent the vehicle from being forced to achieve a minimal risk condition by, for example, coming to a stop by the side of the road. Another possible duty might relate to setting and checking the route, so that it is a criminal offence to require a vehicle to exceed its operational design domain. This chimes with the requirement in the UNECE Resolution on the deployment of highly and fully automated vehicles that a user should "understand if, and when, it is necessary to exercise dynamic control of the vehicle to complete a journey".[525]

7.69 At present, it is difficult to evaluate these suggestions fully. We do not yet understand how disruptive a minimal risk condition might be. Nor do we know how far vehicles will be prevented from exceeding their operational design domains "by design". Different limitations may be enforced in different ways: for example it might be relatively easy to "geofence" a vehicle, so that it cannot exceed a geographic limitation, but more difficult to ensure that weather limitations are not exceeded.

7.70 Our intention is to return to these issues in further consultations.

525 UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), Report of the Global Forum for Road Traffic Safety on its seventy-seventh session ECE/TRANS/WP.1/165 Annex 1, para 5(d).

OBLIGATIONS THAT POSE CHALLENGES FOR AUTOMATED DRIVING SYSTEMS

7.71 Here we consider legal obligations that may raise difficulties for automated driving systems. We outline three topics: the duties that arise after an accident; the requirement to follow the directions of a police officer; and ensuring that children wear seat belts.[526] It is likely that, in practice, many other problems will arise and will need to be considered.

7.72 In the short term, we think that there is a case for allocating these responsibilities to the user-in-charge in the vehicle. Where vehicles do not need a user-in-charge, other solutions will need to be found.

Duties following an accident

7.73 Following an accident, drivers are required to stop and provide identifying details. If, for any reason, they fail to do so, they must report the accident in person to a police station or constable within 24 hours of the accident.[527]

7.74 The law puts considerable emphasis on face-to-face encounters, both at the scene and at the police station. In January 2018, the Department for Transport drew attention to the burden which the need to report accidents in person puts on drivers, businesses and police forces.[528] The Government proposed to amend the legislation to allow police forces to accept accident reports by other means, such as by telephone or an internet page. However, the legislation would not mandate any particular form or reporting: each police force would have discretion to set out its own system.

Applying the duties to automated vehicles

7.75 Where there is a user-in-charge in the vehicle, we see strong reasons to require them to take charge of the situation following an accident. We ask whether the legislation should be amended to place duties following an accident on the user-in-charge in the vehicle.

7.76 The issue becomes more difficult when the vehicle is empty (as where vehicles providing mobility as a service make their way from one passenger to the next). Alternatively, for dedicated vehicles without on-board human controls, none of the passengers in the car might be in a position to assume responsibility for the situation, perhaps because they are young children or because they have been consuming alcohol. In these circumstances, careful thought would need to be given to a protocol for how the vehicle will respond to an accident.

7.77 The first issue is whether an unattended automated vehicle would be required to stop at the scene of an accident. Under the current law, encounters at the scene involve face-to-face interactions. They often have a strong emotional element, including anger, tears, confusion and tight-lipped reticence. These human interactions cannot be replicated where one vehicle is empty. However, stopping would allow other road users

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526 The duties that arise after an accident and the requirement to ensure that children wear seat belts are discussed further in background paper 1.

527 Road Traffic Act 1988, s 170. For further discussion, see background paper 1.

528 Department for Transport, *Reporting road accidents to the police, Consultation* (30 January 2018).

to record details displayed on the vehicle[529] even if human-to-human interaction is missing. It may also be possible to add a human element by requiring automated vehicles to provide other road users with access to a 24-hour human telephone helpline.

7.78 Under the current law, a duty to report arises where a driver fails to stop; or does not provide a name and address; or (in the case of personal injury) does not provide insurance details. In these circumstances, the driver must report the accident to the police.[530] If the Government's reporting proposals are enacted, this would need to be in accordance with the processes set out by each police force. This leads to questions about how far accident reports can be automated. From April 2018, European regulations require all new car models to be equipped with eCall (emergency call) technology. In the event of a serious accident, eCall automatically contacts emergency services.[531] However, at present, eCall is confined to major impacts, such as where an airbag is deployed. Automated reporting may struggle to deal with minor impacts (such as injury to a small dog) which may not be registered on the sensors.

7.79 We ask for observations on how vehicles without a user-in-charge should deal with duties following an accident. Is there a need to reform the law as part of this review? If so, we could address the issue in a subsequent consultation paper. An alternative approach would be to postpone consideration of the issue until after highly automated vehicles have completed road trials and are ready to be put on the market, at which stage we will have more understanding of the practical issues.

Complying with the directions of a police constable

7.80 Under section 35 of the Road Traffic Act 1988, it is a criminal offence for a driver to "neglect or refuse" to stop when directed to do so by a constable in the execution of their duty, or by a traffic officer. Drivers must also comply with a constable's directions to "proceed in, or keep to, a particular line of traffic". Similarly, under section 163 of the Act, it is an offence for a driver to fail to stop "on being required to do so by a constable in uniform or a traffic officer".

7.81 One of the challenges facing automated vehicles is how to deal with directions from police or traffic officers. To comply, the vehicle will need to recognise two things: first, that the direction is given by a police or traffic officer, and secondly, what the direction is.[532] In some cases, the police direction will involve carrying out actions which would, in other circumstances, be breaches of traffic rules (such as reversing on a motorway). In these cases, the automated driving system will need to overcome its inbuilt prohibitions of doing this.

7.82 One way of handling this issue would be to place an obligation to come to a safe stop on the automated driving system. However, where there is a user-in-charge in the vehicle, we think that the obligation to comply with the officer's direction should be on

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529 If this is the desired approach, it would need to be accompanied by a requirement for automated vehicles to display insurance details in a clearly visible place.

530 Road Traffic Act 1988, s 170(3).

531 European Commission, Mobility and Transport, *Intelligent transport systems: the interoperable EU-wide eCall*, https://ec.europa.eu/transport/themes/its/road/action_plan/ecall_en.

532 We discuss adapting rules and standards in Ch 9 at 9.6. to 9.27.

the user-in-charge. In other words, once the vehicle has stopped by itself, the user-in-charge would take over and follow the officer's directions. We tentatively propose that the legislation should be amended to provide that duties to comply with police or traffic officers' directions should apply to users-in-charge.

7.83 This leaves open the question of how an automated vehicle without a user-in-charge will comply with officers' directions. We would be interested to hear how software developers are currently meeting this challenge, and whether there is a need to amend the law.[533]

Ensuring that children wear seat belts

7.84 Under section 15 of the Road Traffic Act 1988, it is an offence for a person to drive a vehicle on a road with a child passenger under 14 years of age who is not wearing the appropriate seat belt or restraint.[534] In summary:

(1) younger children must be in the correct seat for their height or weight, and wear the appropriate restraints. This applies until the child is 135 centimetres tall or reaches their 12th birthday (whichever is first);

(2) children of 12 or 13 years must wear adult seatbelts, as must younger children who are over 135cm tall.[535]

7.85 The law places responsibility on the driver to ensure not only that children start the journey in the appropriate seats with the restraints fastened, but that they continue to keep the restraints fastened throughout the journey.

7.86 If a user-in-charge is present in the vehicle, we think that this responsibility should rest with them. In the absence of a user-in-charge it will be difficult to find a wholly technological solution to ensure that children wear seat belts throughout a journey. Clearly a vehicle could be blocked from starting unless passengers have their seatbelts fastened. However, where a seatbelt is removed mid-journey, it is unlikely to be in the interest of safety for the vehicle simply to come to a halt.

7.87 An alternative approach would be to put responsibilities on parents or adult passengers in the car. In Tennessee, for example, responsibilities have been placed on any adult companion in the car. In the case of an unaccompanied child in a car driven by an

533 One possible solution might be for automated system developers to work with the police to provide standardised systems both for recognising a constable and for providing hand signals. Alternatively, Nissan suggests that the vehicle would call a human-operated call centre for assistance when it does not know what to do, such as when a constable is giving directions (https://www.wired.com/2017/01/nissans-self-driving-teleoperation/.

534 There are various exceptions for buses, coaches and minivans: http://www.childcarseats.org.uk/the-law/other-vehicles-buses-coaches-and-minibuses/. There is also an exception for classic cars which were originally made without seatbelts. Such cars may not carry children under 3 years old, while children over 3 are only allowed to sit in the back seats.

535 Over the age of 14, it is the responsibility of the individual passenger to wear a seat belt in accordance with Road Traffic Act 1988, s 14 and of the Motor Vehicles (Wearing of Seat Belts) Regulations 1993, reg 5.

automated driving system, their parents or guardian are responsible for that child wearing a seatbelt, even if they are not present.[536]

7.88 Where parents or guardians are in the vehicle with their children, the responsibility could lie with them. The issue becomes more difficult when children travel unaccompanied. It may be pushing the boundaries of the criminal law too far to make parents criminally liable for events that happen when they are not there, and over which they have no control. It may also be difficult to place criminal responsibility on strangers simply because they happen to be sharing a ride. We ask for observations on this issue, and whether we need to consider reform as part of this review.

Consultation Question 29.

7.89 Do you agree that legislation should be amended to state that the user-in-charge is responsible for:

(1) duties following an accident;

(2) complying with the directions of a police or traffic officer; and

(3) ensuring that children wear appropriate restraints?

Consultation Question 30.

7.90 In the absence of a user-in-charge, we welcome views on how the following duties might be complied with:

(1) duties following an accident;

(2) complying with the directions of a police or traffic officer; and

(3) ensuring that children wear appropriate restraints.

Consultation Question 31.

7.91 We seek views on whether there is a need to reform the law in these areas as part of this review.

536 Tennessee Code § 55-9-602 (g)(5)(B). Under § 55-9-602(g)(5)(B)(ii)(c), "if the vehicle is operated by an ADS and… if no human person accompanies the child, the parent or legal guardian of the child is responsible for compliance" with the requirement for children to wear seatbelts.

AGGRAVATED OFFENCES

Offences of causing death or injury by driving

7.92 There are six criminal offences of causing death by driving. These relate to deaths caused by dangerous driving;[537] careless driving;[538] careless driving under the influence of drink or drugs;[539] and driving while uninsured; unlicensed; or disqualified.[540] There are also two offences of causing serious injury, which relate to dangerous driving[541] and driving while disqualified.[542] Similarly, where a vehicle is taken without authority, higher penalties apply if an accident occurs. Where it leads to a death, the maximum penalty is 14 years' imprisonment.[543]

7.93 There is a trend towards increasing both the spread of these offences and the level of sentence. In 2016 the Government consulted on a new offence of causing serious injury by careless driving and intends to legislate for this as soon as Parliamentary time allows.[544] It also intends to increase the maximum penalty for causing death by dangerous driving or by driving under the influence of drink or drugs from 14 years to life imprisonment.

7.94 We discuss these offences in background paper 2 as they raise particularly difficult issues. Not only are the sentences for these offences more severe, but the offences themselves have a different dynamic. Professor Ashworth has distinguished between two major functions of the criminal law. The first is "to declare and prohibit those public wrongs that are serious enough to justify the censure of conviction and punishment". The second is to provide sanctions to reinforce regulatory systems.[545] Many road traffic offences are towards the regulatory end of the spectrum, and are sometimes described as "not really criminal".[546] By contrast, offences of causing death or serious injury attract considerable censure. The criminal justice system faces strong public demands to allocate blame and to punish, with many calls for longer prison sentences, as shown in both research[547] and government consultations.[548]

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537 Road Traffic Act 1988, s 1.

538 Road Traffic Act 1988, s 2B.

539 Road Traffic Act 1988, s 3A.

540 Road Traffic Act 1988, ss 3ZB(a) and 3ZC.

541 Road Traffic Act 1988, s 1A.

542 Road Traffic Act 1988, s 3ZD.

543 Theft Act 1968, s 12A.

544 UK Government, Consultation outcome: Driving offences and penalties relating to causing death or serious injury, https://www.gov.uk/government/consultations/driving-offences-and-penalties-relating-to-causing-death-or-serious-injury.

545 A Ashworth, "Positive Duties, Regulation and the Criminal Sanction" (2017) 133 *Law Quarterly Review* 626.

546 A Simester and G Sullivan, *Criminal Law* (4th ed 2010) p 11.

547 Sentencing Advisory Panel, "Attitudes to the sentencing of offences involving death by driving", Research Report 5 (2008).

548 In response to the 2016 consultation, 70% of respondents supported increasing the maximum sentence for causing death by dangerous driving from 14 years to life imprisonment:

7.95 In background paper 2, we consider how offences of causing death or serious injury would apply in an automated environment. Our conclusion is that offences of causing death or injury by driving only apply to a human driver. They would not apply to a user-in-charge, even if the user was uninsured or disqualified. Furthermore, the courts have been reluctant to find a person guilty of a causing death offence in the absence of actual fault. In *R v Hughes,* the Supreme Court held that the defendant's driving must have included some aspect which could properly be criticised and which contributed in more than a minimal way to the death.[549]

7.96 Where automated driving systems cause a death, there will be public demands for accountability. With no human driver to blame, these demands may be directed at other individuals, such as an owner who failed to install the correct software or the entity responsible for the automated driving system (the ADSE). At present, those who cause death through unlawful acts or gross negligence in England and Wales may be guilty of manslaughter offences. In Scotland, the equivalent crime is referred to as culpable homicide.[550]

7.97 Background paper 2 therefore considers the law of manslaughter and culpable homicide, looking first at how it applies to individuals, and then at the statutory offence of corporate manslaughter. We provide a summary below: readers with an interest in this area are referred to background paper 2.[551]

Manslaughter by individuals

7.98 In the event of a death (and assuming no intention to kill) the main offence would be involuntary manslaughter. This is a common law offence, based on court decisions. Two different types of involuntary manslaughter are relevant: "unlawful act manslaughter" and "gross negligence manslaughter".

Unlawful act manslaughter

7.99 Unlawful act manslaughter has three main elements. For the offence to be committed, there must be an unlawful act,[552] which is itself dangerous (in the sense that the risk of some physical harm must be objectively foreseeable), and which causes death.

https://www.gov.uk/government/consultations/driving-offences-and-penalties-relating-to-causing-death-or-serious-injury.

549 *R v Hughes* [2013] UKSC 56 at [28], discussed in background paper 2. For an academic discussion, see G Sullivan and A Simester, "Causation without limits: causing death while driving without a licence, while disqualified, or without insurance" [2012] *Criminal Law Review* 753 at p 753 and D Ormerod, "Case Comment - R v Hughes" [2014] *Criminal Law Review* 234. *R v Hughes* has been followed in Scotland (*Stewart v HM Advocate* [2017] HCJAC 90) and in subsequent English cases (*R v McGuffog* [2015] EWCA Crim 1116; *R v Uthayakumar* [2014] EWCA Crim 123).

550 In *R v Seymour* [1983] 2 AC 493, which concerns a road traffic death, Lord Fraser says that "there is no relevant difference between the crimes of manslaughter and culpable homicide" (at [499E]). Following *R v Adomako* [1994] 1 AC 171, it is unclear whether manslaughter and culpable homicide are still identical in substance.

551 See in particular background paper 2, paras 2.65 to 2.74.

552 The phrase 'unlawful act' connotes an act as opposed to an omission. In *Lowe* [1973] QB 702, the offence of wilful neglect of a child under the Children and Young Persons Act 1933 s 1 was held to be insufficient for unlawful act manslaughter.

7.100 The prospect of automated vehicles which can drive themselves has led to considerable concern that people will maliciously interfere with such vehicles by, for example, hacking into them, interfering with their sensors, or causing them to malfunction by changing traffic signs. If a person is killed as a result of "hacking" (as defined under the Computer Misuse Act 1990 section 3ZA), we believe this could constitute unlawful act manslaughter, provided the following six criteria are met:

(1) The accused does an unauthorised act in relation to a computer;

(2) At the time of doing the act the accused knows that it is unauthorised;

(3) The act causes (or creates a significant risk of) serious damage of a material kind;

(4) The accused intends the act to cause serious damage of a material kind or is reckless as to whether such damage is caused;

(5) A reasonable person would have foreseen that there is a risk of some physical harm to some person from commission of the offence; and

(6) The act causes death.[553]

7.101 Interfering with sensors or traffic signs is prohibited under section 22A of the Road Traffic Act 1988. The offence can be committed in three ways: by causing anything to be on or over a road; by interfering with a motor vehicle; or by interfering with traffic signs or other equipment. The act must be:

(1) done "intentionally and without lawful authority or reasonable cause"; and

(2) in such circumstances that it would be obvious to a reasonable person that to do so would be dangerous.

7.102 There is uncertainty, however, about whether a breach of section 22A is a sufficient basis for unlawful act manslaughter. In *R v Meeking*,[554] a defendant was found guilty of unlawful act manslaughter following a breach of section 22A, where her interference caused a death. The defendant was a passenger in a car, driven by her husband. During an argument, she suddenly put the handbrake on, causing the car to collide with another vehicle. Her husband was killed. The defendant appealed, arguing that pulling on a handbrake was not interfering with a vehicle. The Court of Appeal rejected this argument and upheld the conviction.

7.103 However, the case has been criticised on the grounds that section 22A is essentially a crime of negligence rather than intention or recklessness, which is insufficient to be an unlawful act for the purposes of unlawful act manslaughter. Instead, gross negligence manslaughter would have been more appropriate.[555] It is said that *Meeking* "ought to be treated with considerable caution", on the ground that unlawful act manslaughter

553 For further discussion see background paper 2 paras 2.48 to 2.51; and Chapter 8 from 8.49 onwards.

554 *R v Meeking* [2012] EWCA Crim 641. For the facts of this case, see background paper 2 at para 2.39.

555 A Ashworth, Case Comment [2013] *Criminal Law Review* 333.

"should be read restrictively and should be based on offences that require *mens rea* proper".[556] The issue remains uncertain.[557]

Gross negligence manslaughter

7.104 Gross negligence manslaughter has the potential to cover a wide range of circumstances. The offence of gross negligence manslaughter consists of the following elements:[558]

(1) The defendant owed a duty of care to the victim;

(2) The defendant negligently breached that duty;

(3) It was reasonably foreseeable that the breach would give rise to a serious and obvious risk of death. This is an objective question, based on the knowledge available to the defendant at the time of the breach. The court cannot impute to the defendant's knowledge that would have been obtained had there been no breach of duty;[559]

(4) The death of the victim was caused by the breach; and

(5) In the jury's view, the defendant's conduct was so bad as to be criminal. The Court of Appeal has advised that the jury should be asked whether the behaviour was "truly exceptionally bad", and such a departure from the required standard that it is criminal.[560]

7.105 While unlawful act manslaughter requires an act rather than an omission, gross negligence manslaughter can be committed by omission.[561] For a professional

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556 D Ormerod and K Laird, *Smith, Hogan and Ormerod's Criminal Law* (15th ed 2018) p 575. For a discussion of the same point in a different context, see T Rees and D Ormerod, "Manslaughter - administration of insulin with consent of deceased causing death" [2003] *Criminal Law Review* 478.

557 In 2017 a cyclist named Charlie Alliston was charged with unlawful act manslaughter and wanton and furious driving contrary to s 35 of the Offences Against the Person Act 1861 (see https://www.bbc.co.uk/news/uk-england-41028321). For the unlawful act manslaughter charge, the relevant unlawful act was riding a bicycle without front brakes (contrary to the Pedal Cycle (Construction and Use) Regulations 1983 reg 7(1)(b)(i)). This is a strict liability offence. This generated debate about whether a strict liability offence could form the basis of unlawful act manslaughter. The question was not resolved since he was acquitted of manslaughter: see E Freer, "We need to talk about Charlie: Putting the brakes on unlawful act manslaughter" [2018] *Criminal Law Review* 612. In August 2018, the government consulted on whether there should be a new offence of causing death or serious injury while cycling (https://www.gov.uk/government/consultations/new-cycling-offences-causing-death-or-serious-injury-when-cycling).

558 *R v Adomako* [1995] 1 AC 171, 187.

559 *R v Rose (Honey Maria)* [2018] QB 328. See also Judge Mark Lucraft QC (ed), *Archbold: Criminal Pleading, Evidence and Practice 2019* (67th ed 2018) para 19-123; D Ormerod QC (Hon) and D Perry QC (eds), *Blackstone's Criminal Practice 2019* (2018) para B1.68.

560 *R v Sellu* [2016] EWCA Crim 1716.

561 In *R v Adomako* [1995] 1 AC 171, 187, Lord Mackay stated: 'the essence of the matter… is whether… the conduct of the defendant was so bad in all the circumstances as to amount… to a criminal act or *omission*' (emphasis added).

defendant, the required standard of performance is that of a reasonably competent professional.

7.106 In applying these principles to automated vehicles, it is well established that road users owe duties of care to each other. Duties of care are also owned by those who service vehicles.[562] This means that the offence could apply to all those who are grossly negligent in installing (or failing to install) software, in servicing vehicles, or in interfering with vehicles or roads. It could also apply to individual software developers.

7.107 The issue of whether the duty has been breached will depend on the circumstances. The generality of the gross negligence manslaughter is both a strength and a weakness. Its strength is that it can adapt to new technologies and new dangers. The weakness of the offence is its uncertainty. Karl Laird comments that although prosecutions for gross negligence manslaughter are rare, they have generated a large volume of appeals, many of which involve health care professionals.[563] Adapting this case law to automated vehicles is likely to generate new questions.

Corporate manslaughter

7.108 Under the Corporate Manslaughter and Corporate Homicide Act 2007,[564] an organisation is guilty of corporate manslaughter if the "way in which its activities are managed or organised":

(1) causes a person's death; and

(2) amounts to a gross breach of a duty of care owed by the organisation to the deceased.[565]

7.109 There is also a third requirement: failings by "senior managers" must be a "substantial element" of the breach.[566]

7.110 The trial judge must decide whether the organisation owed the deceased a duty of care.[567] However, the jury must decide if there was a gross breach. The 2007 Act sets out a list of factors for the jury to consider, most of which relate to health and safety legislation. However, "this does not prevent the jury from having regard to any other matters they consider relevant".[568]

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562 In *R v Yaqoob* [2005] EWCA Crim 2169 [34], the Court of Appeal held that it was open to a jury to find that a partner in a taxi firm was under a duty to inspect and maintain vehicles which went beyond MOT and council requirements.

563 K Laird, "The evolution of gross negligence manslaughter" (2018) 1 Archbold Review 6, at p 7. See *R v Rudling* [2016] EWCA Crim 741; *Rose* [2017] EWCA Crim 1168; and the discussion in background paper 2.

564 This Act also applies to Scotland and Northern Ireland

565 Corporate Manslaughter and Corporate Homicide Act 2007, s 1(1).

566 Corporate Manslaughter and Corporate Homicide Act 2007, s 1(3). For a definition of senior managers, see s 1(4), discussed in background paper 2.

567 Corporate Manslaughter and Corporate Homicide Act 2007, s 2(5).

568 Corporate Manslaughter and Corporate Homicide Act 2007, s 8.

7.111 Celia Wells comments that the Act "represents a clear denunciation in the form of naming and shaming where corporate negligence has caused death". However, she criticises the way in which it "insulates individual directors or managers from participatory liability in the offence".[569] She also points out that most companies convicted of corporate manslaughter have been small or medium-sized. It is clearly easier to point to failings by senior managers where individual directors are intimately involved in day-to-day decisions than in large companies with complex management structures, where senior managers are insulated from such difficult decisions.[570] A further problem is that the offence only applies in the event of a fatality. There is no equivalent offence which would apply to serious injuries.

7.112 Corporate manslaughter has the potential to apply to organisations developing automated driving systems. They clearly owe a relevant duty of care, as they are supplying goods or services.[571] The jury would need to consider whether the culture of the organisation ("the way in which activities were managed") led to a "gross breach" of that duty. If so, were failings by senior managers a "substantial element" of that breach? The difficult question of what amounts to a gross breach would be left to the jury, looking at the issue in the round.

Is there a need for new offences to express public censure?

Interfering with a vehicle, road markings or traffic signs

7.113 There is considerable concern that people will obstruct automated vehicles by, for example, interfering with a vehicle's sensors or disrupting road markings or traffic signs. Where it would be obvious to a reasonable person that the interference is dangerous, these actions are already criminal under section 22A of the Road Traffic Act 1988. A breach of section 22A is a serious offence, leading on indictment to a maximum sentence of 7 years' imprisonment.

7.114 However, where such interference leads to death or serious injury, section 22A may not be sufficient to reflect the full force of public censure. As we have seen, unlawful act manslaughter has been used where interfering with a vehicle caused a death, but this has been criticised. The law in this area is uncertain. We seek views on whether there should be a new offence of causing death or serious injury by wrongful interference with vehicles, roads or traffic equipment, contrary to section 22A of the Road Traffic Act 1988.

7.115 This review is only concerned with automated vehicles. Although there may be good reasons to apply any new offence to all deaths or serious injuries caused by breaches of section 22, this would be outside our terms of reference. We therefore limit our question to cases where an automated vehicle is involved in the chain of causation between the act and the death/injury. For example, if the defendant removed a traffic

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569 C Wells, "Corporate Criminal Liability: A Ten Year Review" (2014) *Criminal Law Review* 849, at pp 853-4. For a discussion of the policy underlying corporate crime, see C Wells, *Corporations and Criminal Responsibility,* (2nd ed 2001).

570 Unite the Union have also raised concerns about the disproportionate risk to lower level employees, such as software engineers and coders, even when wrongdoing is sanctioned at the highest level of management: see Electric Vehicles, Autonomous Technology and Future Mobility (February 2018) p 24.

571 Corporate Manslaughter and Corporate Homicide Act 2007, s 2(1)(c)(i).

sign, which led an automated vehicle to collide with a pedestrian who died, the offence would apply. However, if a conventional vehicle collided with the pedestrian, the offence would not apply.

Unsafe actions by the developer

7.116 What if a death or personal injury was caused by undue safety risks, taken by the manufacturer or developer? Possible wrongs include:

(1) claiming to have conducted tests which have not been conducted;

(2) suppressing poor test results;

(3) installing "defeat device" software, so that an automated driving system performs better in tests than in real life; or

(4) disabling safety critical features to increase profits.

7.117 In Chapter 6 we explain why a civil action against the insurer or manufacturer may not address the victim's family's sense of injustice in such circumstances. This leaves an "accountability gap". A charge of corporate manslaughter against the organisation that put the driving system on the road may be one way to fill that gap, but it has some shortcomings. First, it only applies to death, not serious injury. Secondly, it may be difficult to apply to large multi-national companies, where senior managers are far removed from decisions on the ground.

7.118 If it is felt that new offences are required, there are several possible models to follow, including a general duty of safety and corporate offences of "failure to prevent". We refer to these briefly below, and outline them further in background paper 2.

A general duty of safety?

7.119 In Australia, the NTC has suggested that every ADSE should be subject to a general duty of safety. In the event of an incident or near-miss involving an ADS, the national body responsible for safety assurance would investigate. It would then determine whether the risk could reasonably have been managed and whether the duty holder knew, or ought to reasonably have known, about the risk and ways of managing it.[572] The NTC states that detailed consideration of penalties will be undertaken once a preferred policy option has been agreed.[573] However, one possibility might be to impose imprisonment terms on duty holders.[574]

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572 NTC Australia, "Safety Assurance for Automated Driving Systems Consultation Regulation Impact Statement" (May 2018), pp 31 and 32.

573 NTC Australia, "Safety Assurance for Automated Driving Systems Consultation Regulation Impact Statement" (May 2018), p 31.

574 NTC Australia, "Changing driving laws to support automated vehicles, Policy Paper" (May 2018), para 8.2.2. NTC point out that criminal sanctions on the Automated Driving System Entities are outside the scope of their project and would require consultation with, among others, the Attorneys-Generals of state governments.

7.120 Under EU law there is already a general duty of safety. It is set out in the General Product Safety Directive 2001[575] and has been implemented into UK law by the General Product Safety Regulations 2005.[576] The regulations stipulate that producers and distributors must only sell and supply safe products. It is a criminal offence for a producer to sell or supply a dangerous product, with a maximum sentence on indictment of 12 months in prison or a fine of £20,000 or both.[577] However, the general duty plays only a residual role: it does not apply to risks covered by specific EU requirements. Given that vehicles are subject to their own specific safety regime, the general duty has little effect on vehicle manufacturers.

Corporate "failure to prevent" offences

7.121 Several new offences have imposed criminal liability on corporations for "failure to prevent" a harm. The justification for these offences is that the commercial organisation benefits from the wrongdoing, and should therefore be under a duty to take positive steps to prevent it.[578] The first example is section 7 of the Bribery Act 2010, which is based on a Law Commission report.[579] Section 7 states that:

> A relevant commercial organisation ("C") is guilty of an offence under this section if a person ("A") associated with C bribes another person intending—
>
> (a) to obtain or retain business for C, or
>
> (b) to obtain or retain an advantage in the conduct of business for C.

7.122 However, C has a defence if it proves that it "had in place adequate procedures designed to prevent persons associated with C from undertaking such conduct". The emphasis, therefore, is on the organisation to demonstrate that it has taken positive measures to prevent a harm from taking place.

Should the Law Commissions consider a new offence?

7.123 We ask whether the Law Commissions should review the possibility of one or more new corporate offences where wrongs by an ADS developer result in death or personal injury. If so, there are several models to investigate. The Law Commissions would need to issue a further consultation paper, looking in more depth at the advantages and disadvantages of each.

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575 Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001 on general product safety.

576 General Product Safety Regulations 2005 SI No 1803.

577 General Product Safety Regulations 2005 SI No 1803, reg 5 and 20(1).

578 C Wells, "Corporate Failure to Prevent Economic Crime - A Proposal" [2017] *Criminal Law Review* 426.

579 Reforming Bribery (2008) Law Com No 313.

Consultation Question 32.

7.124 We seek views on whether there should be a new offence of causing death or serious injury by wrongful interference with vehicles, roads or traffic equipment, contrary to section 22A of the Road Traffic Act 1988, where the chain of causation involves an automated vehicle.

Consultation Question 33.

7.125 We seek views on whether the Law Commissions should review the possibility of one or more new corporate offences, where wrongs by a developer of automated driving systems result in death or serious injury.

Chapter 8: Interfering with automated vehicles

8.1 Concerns have been expressed that automated vehicles will encourage people to commit new forms of mischief and crime. Examples include standing in front of an automated vehicle to obstruct its movement; spraying paint or mud over its sensors; deliberately obscuring signs or white lines; or hacking into the software to cause it to crash. People may also steal vehicles or take them without consent.

8.2 Many of these behaviours can be applied to conventional vehicles and are already covered by the criminal law. It is already a crime, for example, to obstruct the highway; to damage a vehicle; or to tamper with a vehicle's mechanism. As far as hacking into a vehicle's software is concerned, it is already a crime to gain unauthorised access to a computer. This becomes a more serious offence if it creates a significant risk of serious damage.

8.3 That said, automated vehicles may introduce new vulnerabilities. Research by Transport Systems Catapult has highlighted concerns by members of the public about personal security, as they are demoted from drivers "to helpless and hapless passengers vulnerable to attack".[580] One fear, for example, is that people may surround a car such that it cannot move. The research concludes that, although "many of the issues addressed are covered by laws and could be left to existing law enforcement methods", this may not be a sufficient deterrent.[581] Instead, it recommends that the industry works on technological solutions to prevent problems.

8.4 We hope that technological solutions can be found to the potential problems which have been identified. This chapter, however, has a more limited purpose. Our focus is on whether the current law covers the behaviours which generate concern, or whether it leaves any gaps. Below we outline the main offences in this area and consider how they might apply to automated vehicles. We seek views on whether reform is needed.

8.5 As we explore below, for some offences, the law differs between England and Wales on the one hand, and Scotland on the other. We welcome comments on the need for reform in both jurisdictions, though some respondents may wish to respond only for England and Wales or only for Scotland.

CAUSING DANGER TO ROAD USERS

England and Wales

8.6 In England and Wales, the offence is drafted in broad terms. Section 22A(1) of the Road Traffic Act 1988 states that:

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580 Transport Systems Catapult, *Taxonomy of Scenarios for Automated Driving, Technical Report* (April 2017) p 82. The authors provide a taxonomy of possible offences which includes pranks "for novelty or ludicracy", such as playing chicken to test the system; moving or upending the vehicle; and car surfing or unsolicited towing, p 88.

581 As above, p 82.

A person is guilty of an offence if he intentionally and without lawful authority or reasonable cause --

(a) causes anything to be on or over a road, or

(b) interferes with a motor vehicle, trailer or cycle, or

(c) interferes (directly or indirectly) with traffic equipment,

in such circumstances that it would be obvious to a reasonable person that to do so would be dangerous.

8.7 Dangerous is defined as giving rise to a danger "either of injury to any person while on or near a road, or of serious damage to property on or near a road".[582] Traffic equipment includes traffic signs and anything else "lawfully placed on or near a road by a highway authority".[583]

8.8 This is a very general offence, which would include many of the dangerous behaviours thought to be of concern, such as defacing traffic signs or white lines. It would also include interfering with the vehicle itself by, for example, blocking a sensor or shining a laser pointer at a light detection and ranging system (LIDAR),[584] if this was an obviously dangerous thing to do. In Chapter 7, we considered whether a breach of section 22A which causes death would amount to unlawful act manslaughter.[585]

Scotland

8.9 Section 22A(1) of the Road Traffic Act 1988 does not extend to Scotland. Instead, damage to roads is dealt with by section 100 of the Roads (Scotland) Act 1984. This makes it a criminal offence for a person without lawful authority or reasonable excuse:

(1) to deposit anything on a road so as to damage the road;

(2) to paint or otherwise inscribe or affix upon the surface of a road or upon a tree, traffic sign, milestone, structure or works on or in a road, a picture, letter, sign or other mark; or

(3) by lighting a fire within, or by permitting a fire for which he is responsible to spread to within, 30 metres of a road, to damage the road or endanger traffic on it.

8.10 Section 100 covers depositing anything on a road, or inscribing or affixing something on a traffic sign. However, it is not as broad as the English offence of causing danger

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582 Road Traffic Act 1988, s 22A(2).

583 Road Traffic Act 1988, s 22A(3).

584 The Laser Misuse (Vehicles) Act 2018 creates a new offence of "shinning or directing a laser beam towards a vehicle". Although the Act was motivated by concerns about lasers being shone at aircraft, it covers a wide variety of vehicles, including trains, ships and motor vehicles (s 1(6)). However, the offence only applies if the laser beam "dazzles or distracts, or is likely to dazzle or distract, *a person* with control of the vehicle" (s 1(1)(b), emphasis added). This means that it would not apply to an automated vehicle without a person in control.

585 At para 7.103 we conclude that the point is uncertain. We therefore ask if there should be a new aggravated offence of causing death or serious injury through a breach of s 22A at para 7.124.

to road users under section 22A of the Road Traffic Act 1988. In particular, section 100 does not cover interfering with other vehicles. This may not leave as much of a gap as first appears, as section 25 of the Road Traffic Act 1988 does apply to Scotland. As we discuss below, this covers tampering with vehicle brakes or "other part of its mechanism".

8.11 A further potential gap is that section 100 only applies to some forms of interference with traffic signs. It covers "painting or otherwise inscribing or affixing" a mark, but does not apply to moving a sign, even if this would raise safety concerns.

8.12 Below, we seek views on whether section 22A should be extended to Scotland.

OBSTRUCTION

England and Wales

8.13 Under section 137 of the Highways Act 1980, it is an offence wilfully to obstruct free passage along a highway. Convictions under this provision are frequently made for acts of protest, and include blocking traffic flow by standing on a crossing.[586]

8.14 It seems this obstruction offence would cover deliberately blocking the progress of an automated vehicle by standing in front of it. However, it would not necessarily cover stepping out in front of a vehicle, requiring it to stop temporarily. At this point it is uncertain how road users may interact with automated vehicles, and whether it may be necessary to extend the reach of this offence to discourage such dangerous behaviour.

Scotland

8.15 In Scotland, there is no specific offence relating to obstruction, instead such behaviour would be covered by a range of more general summary offences. Under section 129(2) of the Roads (Scotland) Act 1984, an offence is committed by:

> A person who, without lawful authority or reasonable excuse, places or deposits anything on a road so as to obstruct the passage of, or to endanger, road users…

8.16 Section 100(a) of the Roads (Scotland) Act 1984 may also be relevant, whereby it is an offence to deposit anything whatsoever on a road so as to damage the road. Together, these offences include placing or depositing anything on a road which either damages that road, or obstructs the passage of, or endangers other road users.

8.17 Below we ask if further offences might be needed.

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586 *James v DPP* [2015] EWHC 3296 (Admin); [2016] 1 WLR 2118.

CRIMINAL DAMAGE

England and Wales

8.18 Damaging vehicles is covered by the Criminal Damage Act 1971. Section 1(1) states that:

> A person who without lawful excuse destroys or damages any property belonging to another intending to destroy or damage any such property or being reckless as to whether any such property would be destroyed or damaged shall be guilty of an offence.

8.19 Section 1(2) creates a more serious offence where the defendant commits criminal damage with intent to endanger the life of another, or is reckless as to whether the life would be endangered.[587]

8.20 Criminal damage can be temporary and reversible, and includes putting water-soluble paint on a pavement.[588] On the other hand, spit on a raincoat was not criminal damage as it was so easily removed; the coat had not been rendered imperfect or inoperative.[589] On this basis, spraying paint at a vehicle's sensors would amount to criminal damage. Deliberately pouring muddy water over a sensor is less clear cut, but we think it would amount to criminal damage if it rendered the sensor inoperative, even temporarily. The issue is a matter of fact and degree, as determined by a court.[590]

8.21 Section 10(5) of the Criminal Damage Act 1971 provides that modifying the contents of a computer "shall not be regarded as damaging" the computer unless its impairs its physical condition. Actions designed to disrupt the way that an automated vehicle processes information will be regarded as hacking, discussed below, rather than criminal damage.

8.22 It is also an offence to possess anything intending to use it to destroy or damage any property belonging to another.[591] This might extend, for example, to carrying a "laser pointer", if it was intended to be used to damage an automated vehicle.[592]

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587 To prove intention or recklessness, it is relevant to consider the destruction or damage which the defendant intended to cause but not the destruction or damage that was caused (see *Dudley* [1989] Crim LR 57). In *Webster and Warwick* [1995] 2 All ER 168 a defendant threw a coping stone from a parapet onto a train. The Court of Appeal held that the jury could infer that the defendant had been recklessness about the dangers that would be caused by the train roof shattering, even though the offence did not apply to dangers caused directly by the stone hitting someone.

588 *Hardman v Chief Constable of Avon and Somerset* [1986] Crim LR 330 (Crown Court (Bristol)).

589 *A (A Juvenile) v R* [1978] Crim LR 689.

590 *Roe v Kingerlee* [1986] Crim LR 735 (DC).

591 Criminal Damage Act 1971, s 3. This also includes possessing anything with intent to cause or permit another to use it to damage property.

592 The Telegraph, http://www.telegraph.co.uk/technology/news/11850373/Self-driving-cars-can-be-hacked-using-a-laser-pointer.html.

Scotland

8.23 The equivalent offences in Scotland are malicious mischief and vandalism.[593]

8.24 Malicious mischief is defined by Hume as "great and wilful damage done to the property of another… with circumstances of tumult and disorder".[594] However, a more modern conception of the crime is simply injury or destruction of another's property.[595]

8.25 A special form of malicious mischief is vandalism. Section 52(1) of the Criminal Law (Consolidation) (Scotland) Act 1995 states:

> …any person who, without reasonable excuse, wilfully or recklessly destroys or damages any property belonging to another shall be guilty of the offence of vandalism.

8.26 In *Black v Allan,*[596] Lord Justice-General Emslie stated that vandalism and the common law offence of malicious mischief are distinct. He held that vandalism on grounds of reckless destruction or damage requires conduct to be reckless in that it creates an obvious and material risk of the damage which actually occurred. The common law offence of malicious mischief, on the other hand, requires that the accused should have known they were likely to cause damage,[597] or that they showed "a deliberate disregard of, or even indifference to, the property of others".[598]

8.27 These offences seem readily applicable to automated vehicles.

TAMPERING WITH VEHICLES

8.28 This offence covers England, Wales and Scotland. Under section 25 of the Road Traffic Act 1988 it is an offence to get into a motor vehicle or to tamper with "the brake or other part of its mechanism" while the vehicle is on a road or in a local authority parking place, without lawful authority or reasonable cause.

8.29 In *JS (A Child) v DPP,* the court explained:

> The term "tampering" is not defined by the Road Traffic Act 1988. It bears its ordinary, everyday meaning. It clearly means something more than mere "touching". The Oxford English Dictionary defines tampering as "interfering with something without authority or so as to cause damage".[599]

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593 G H Gordon, *Criminal Law of Scotland,* (4th ed 2016) vol 2, para 29.01. There is also an offence of "theft by destruction" which requires prior "asportation" (that is detachment, movement or carrying away). If A steals B's motor vehicle, drives it away and subsequently destroys it, that is theft by destruction, whereas if A destroys B's motor vehicle without first stealing it, that is malicious mischief.

594 D Hume, *Commentaries on the Law of Scotland Respecting Crimes* (4th ed 1844) vol 1, p 122.

595 J HA MacDonald, *A Practical Treatise on the Criminal Law of Scotland* (5th ed 1948) p 84.

596 1985 SCCR 11 at [13].

597 G H Gordon, *Criminal Law of Scotland* (4th ed 2016) vol 2, para 29.14.

598 *Ward v Robertson* 1938 JC 32 at [36].

599 [2017] 4 WLR 102 at [14].

8.30 The word "mechanism" is not defined, In *JS (A Child) v DPP* it was not contested that exposed ignition wires on a stolen motorbike were part of the mechanism. On this basis, we think that sensors would also be considered part of the mechanism. If so, the provision could be used if the danger was not sufficiently obvious to fall with section 22A of the Road Traffic Act 1988, and the damage was too temporary to amount to criminal damage.

8.31 Below we ask whether the term "mechanism" is broad enough to include sensors, or whether legislative amendment is necessary.

UNAUTHORISED VEHICLE TAKING

England and Wales: "taking a conveyance without authority"

8.32 In England and Wales, theft requires proof of an intention to permanently deprive the owner of the property.[600] This can be hard to establish for offences of "joyriding", where the vehicle may only be taken temporarily. There is therefore a specific offence of taking vehicles without authority. Under section 12 of the Theft Act 1968:

> a person shall be guilty of an offence if, without having the consent of the owner or other lawful authority, he takes any conveyance for his own or another's use or, knowing that any conveyance has been taken without such authority, drives it or allows himself to be carried in or on it.[601]

8.33 A conveyance includes anything "constructed or adapted for the carriage of a person or persons whether by land, water or air" subject to the following exception:

> It does not include a conveyance constructed or adapted for use only under the control of a person not carried in or on it.[602]

Thus, although prams and pushchairs are constructed to carry a person, they are exempted because they are controlled by a person outside them.

8.34 At present, a conveyance includes all motor vehicles that have driving seats (including cars, vans and lorries). As Wilkinson puts it:

> Presumably the presence of a seat for the driver shows that a conveyance is constructed for the carriage of a person.[603]

8.35 We welcome views on whether the offence of taking a conveyance without authority should be extended to cover all motor vehicles.

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600 Theft Act 1968, s 1(1). In Scotland, intent to permanently deprive is not needed (*Black v Carmichael* 1992 SLT 897).

601 There is also an offence of aggravated vehicle taking, where a vehicle is taken contrary to section 12, and the vehicle is then driven dangerously or damage occurs. This raises similar issues to the other aggravated driving offences, and we will discuss it in that context in background paper 2, paras 2.5 to 2.6.

602 Theft Act 1968, s 12(7).

603 *Wilkinson's Road Traffic Offences* (28th ed 2017) para 15-06.

8.36 However, if the vehicle could not carry a person, it would not come within the definition of a conveyance. And even if the vehicle could carry a person, it would currently be exempted if it could only be controlled by a person outside the vehicle. Take an example in which a group of people picked up a pizza delivery vehicle and put it in a ludicrous place, such as the top of a bus shelter. Under the current law, this would not appear to be a criminal offence.

8.37 We welcome views on whether the offence of taking a conveyance without authority should be extended to cover all motor vehicles that are built for use on roads. This would remove two potential gaps in the current law. First, the law does not cover conveyances (such as delivery vehicles) which do not carry people. Secondly, the law does not cover passenger vehicles without driving controls, which cannot be controlled by a person in the vehicle.

Scotland: "taking and driving away a motor vehicle"

8.38 In Scotland the equivalent offence is section 178 of the Road Traffic Act 1988, which states that:

(1) A person who in Scotland

(a) takes and drives away a motor vehicle without having either the consent of the owner of the vehicle or other lawful authority, or

(b) knowing that a motor vehicle has been so taken, drives it or allows himself to be carried in or on it without such consent or authority…

…is… guilty of an offence.

8.39 The Scottish offence refers to "a motor vehicle", rather than to "any conveyance constructed or adapted for the carriage of a person". It is therefore not dependent on the presence of a driving seat and it would cover all automated vehicles.

ATTEMPTED THEFT AND TAKING: INTERFERENCE WITH MOTOR VEHICLES

England and Wales

8.40 Under section 9 of the Criminal Attempts Act 1981, it is an offence to interfere with a motor vehicle or trailer (or with anything carried in a motor vehicle or trailer) with a specified intention. The intention must be that one of the following offences will be committed:

(1) theft of the motor vehicle or trailer or part of it;

(2) theft of anything carried in or on the motor vehicle or trailer; or

(3) unauthorised taking of a conveyance, under section 12(1) of the Theft Act 1968.

8.41 Interference involves more than just looking into or touching a vehicle.[604] However, opening a door or putting pressure on a door handle would be sufficient.[605]

8.42 This offence seems readily applicable to automated vehicles.

Scotland

8.43 Equivalent offences in Scotland are the common law offences of opening lockfast places with intent to steal and attempted theft of a motor vehicle.[606] In the context of automated vehicles, there is little difference between these crimes. However, for the offence of opening lockfast vehicles with intent to steal, it is not necessary for the prosecutor to specify whether the intent is to steal from the vehicles or to steal the vehicles themselves.[607]

8.44 Again, these offences seem readily applicable to automated vehicles.

UNAUTHORISED TOWS AND RIDES

8.45 In an automated environment, where vehicles are unattended, people may find new ways to be towed by vehicles or to be carried by them without permission. Examples might include climbing onto a lorry or attaching a tow rope to it.

8.46 Section 26 of the Road Traffic Act 1988 applies to Scotland, England and Wales. It already appears to be broad enough to cover this behaviour. Section 26(2) is used to control "skitching", where a person (typically a skateboarder or roller-skater) "takes or retains hold of a motor vehicle or trailer" for "the purpose of being drawn".[608]

8.47 However, the offence is wider than this. Section 26(1) covers anyone who "retains hold of, or gets on to, a motor vehicle or trailer while in motion on a road" for the purposes of being carried, "without lawful authority or reasonable cause".[609]

8.48 This offence therefore covers a range of ways of taking unauthorised rides from automated vehicles.

HACKING: UNAUTHORISED ACCESS TO A COMPUTER

8.49 Hacking is defined as gaining unauthorised access to data in a system or computer.[610] As cars increasingly incorporate "over the air" software, they have become vulnerable

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604 *Reynolds and Warren v Metropolitan Police* [1982] Crim LR 831.

605 *Blackstone's Criminal Practice* (28th ed 2018) B4.139; *R v Malcolm Russell* [2009] EWCA Crim 324.

606 G H Gordon, *Criminal Law of Scotland* (4th ed 2016) vol 2, para 22.48. "Lockfast" has been defined as "secured under lock and key against interference": see http://www.dsl.ac.uk/entry/snd/lockfast.

607 *McLeod v Mason* 1981 SCCR 75.

608 Road Traffic Act 1988, s 26(2).

609 Road Traffic Act 1988, s 26(2).

610 https://en.oxforddictionaries.com/definition/hack.

to hacking. Concerns about hacking being used to override control of an automated vehicle are widely reported.[611]

8.50 The main hacking offences are found in the Computer Misuse Act 1990, which covers the whole of the UK. For our purposes, the most relevant offences are:

(1) unauthorised access to any program or data held in a computer (section 1);

(2) unauthorised access to computer material as in section 1, with intent to commit or facilitate commission of further offences (section 2);

(3) unauthorised acts in relation to a computer, with intent to impair the operation of any computer or program; or to impair the reliability of data; or to prevent or hinder access to a program (section 3)[612]; and

(4) unauthorised acts, performed intentionally or recklessly, which cause or create a significant risk of serious damage of a "material kind" (section 3ZA). Material kinds of damage include loss of human life, human injury or "disruption of facilities for transport".[613]

8.51 Lord Hoffmann has defined a computer as "a device for storing, processing and retrieving information".[614] Existing vehicles already use computers. They may have anything up to 100 electronic control units embedded within them, ranging from door control units, windscreen wipers and tyre sensors to the engine control module. Each of these control units is effectively a computer which could be hacked.[615] For example, one could mimic the transmitters used for keyless vehicle entry to steal a vehicle.[616] In theory, a hacker could gain entry through a tyre sensor, for example, to disable the vehicle.

8.52 The Computer Misuse Act 1990 would cover hacking offences involving an automated driving system. Any act done intentionally or recklessly to impair the operation of an automated driving system would be an offence under section 3. If the act created a significant risk of death, serious injury or serious traffic disruption, that would amount to an aggravated offence under section 3ZA. An offence under section 3ZA carries a maximum sentence of life imprisonment.

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611 For example, http://www.bbc.co.uk/news/business-41367214 (last visited 7 September 2018), https://www.carmagazine.co.uk/car-news/tech/tesla-fights-back-in-car-hacking-war/.

612 The section also applies if the person is reckless as to these consequences (s 3(3)).

613 Computer Misuse Act 1990, s 3ZA(3).

614 *DPP v McKeown* and *DPP v Jones* [1997] 2 Cr App R 155 HL, p 163. Applying this definition, Lord Hoffmann held that an intoximeter was a computer. However, the clock in the same box as the intoximeter was not necessarily part of the computer, as it simply supplied information and did not affect the storing, processing or retrieval of information.

615 For further details of how this can be done, see C Smith, *The Car Hacking Handbook* (2016). In the foreword, Smith writes "a car is a collection of connected computers - there just happen to be wheels attached".

616 https://www.express.co.uk/life-style/cars/859355/car-stolen-theft-UK-crime-rising-technology-hacker.

8.53 Under section 3A of the Computer Misuse Act 1990, it is also an offence to make, adapt, supply or offer to supply any article,[617] intending it to be used to commit an offence under section 1 or section 3ZA. This would criminalise the supply of software programs or devices intended to be used to hack vehicles.

8.54 These offences would appear to be adequate. However, we are not aware of any convictions so far under the Computer Misuse Act 1990 involving the hacking of motor vehicles.

8.55 Clearly, dealing with cyber security is not simply a matter for the criminal law. It is also necessary to design systems that will withstand attacks. The government has therefore issued guidance for parties in the manufacturing supply chain on the principles of cyber security for connected and automated vehicles.[618] We also note the work being undertaken by the United Nations in this area in respect of over-the-air software updates.[619]

CONCLUSION

8.56 Many concerns have been expressed about how humans will interact with automated vehicles, with suggestions that people will deliberately obstruct or damage vehicles, hack into them or take advantage of them in new ways.

8.57 Most of these suggested behaviours are already criminal offences. For example, it is already an offence to obstruct, damage, take or hack a vehicle. In England and Wales, it is also an offence to interfere with vehicles or traffic equipment, or cause something to be on a road in way which a reasonable person would see as obviously dangerous. In Scotland, it is an offence to deposit anything a road or inscribe or affix something on a traffic sign so as to damage the road or endanger traffic on it.

8.58 We seek views on whether any new criminal offences are required to cover interference with automated vehicles. Even if behaviours are already criminal, there may be advantages to providing a new label, to clarify to all concerned that some forms of interference with automated vehicles are unacceptable.

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617 Computer Misuse Act 1990, S3A(4) In this section “article” includes any program or data held in electronic form.

618 https://www.gov.uk/government/publications/principles-of-cyber-security-for-connected-and-automated-vehicles/the-key-principles-of-vehicle-cyber-security-for-connected-and-automated-vehicles.

619 UN Task Force on Cyber Security and Over-the-Air Issues, Draft Recommendation, UNECE WP.29 GRVA, 20 September 2018, at https://www.unece.org/fileadmin/DAM/trans/doc/2018/wp29grva/GRVA-01-17.pdf.

Consultation Question 34.

8.59 We seek views on whether the criminal law is adequate to deter interference with automated vehicles. In particular:

(1) Are any new criminal offences required to cover interference with automated vehicles?

(2) Even if behaviours are already criminal, are there any advantages to re-enacting the law, so as to clearly label offences of interfering with automated vehicles?

8.60 This chapter has identified three possible gaps or uncertainties in the current law. We ask specific questions about these issues.

Consultation Question 35.

8.61 Under section 25 of the Road Traffic Act 1988, it is an offence to tamper with a vehicle's brakes "or other mechanism" without lawful authority or reasonable cause. Is it necessary to clarify that "other mechanism" includes sensors?

Consultation Question 36.

8.62 In England and Wales, section 12 of the Theft Act 1968 covers "joyriding" or taking a conveyance without authority, but does not apply to vehicles which cannot carry a person. This contrasts with the law in Scotland, where the offence of taking and driving away without consent applies to any motor vehicle. Should section 12 of the Theft Act 1968 be extended to any motor vehicle, even those without driving seats?

Consultation Question 37.

8.63 In England and Wales, section 22A(1) of the Road Traffic Act 1988 covers a broad range of interference with vehicles or traffic signs in a way which is obviously dangerous. In Scotland, section 100 of the Roads (Scotland) Act 1984 covers depositing anything on a road, or inscribing or affixing something on a traffic sign. However, it does not cover interfering with other vehicles or moving traffic signs, even if this would raise safety concerns. Should section 22A of the Road Traffic Act 1988 be extended to Scotland?

Chapter 9: "Machine Factors" - Adapting road rules for artificial intelligence decision-making

9.1 Driving rules have been developed to be interpreted and applied by human drivers. They often leave a considerable margin of appreciation, both in how drivers interpret them and in how the police enforce them. In Chapter 3 we considered the body of research into human-machine interactions, often referred to as "human factors". In this chapter we consider issues arising from the "machine" side of that interface. In particular, we consider the challenges of taking the "analogue" legal rules and developing them into a "digital highway code" to govern the actions of highly automated vehicles.

9.2 We start by exploring how even apparently straightforward road rules are subject to many explicit and implicit exceptions. For highly automated vehicles which drive themselves, these exceptions will need to be applied by artificial intelligence rather than by humans. Drafting rules for artificial intelligence will be a difficult exercise, which involves policymakers and engineers working together to give precision to areas that are currently a matter of human discretion. The challenge is to define when rules must be applied strictly and when they should be subject to exceptions in the interests of safety and traffic flow.

9.3 It is easier to address this issue by looking at practical examples rather than abstract generalisations. We initiate the debate by asking three sample questions. These relate to when automated vehicles may mount the pavement; exceed the speed limit; or edge through pedestrians. Our aim is to give practical examples of broader questions about when automated vehicles should be allowed (or required) to depart from road rules.

9.4 We then look at three issues which have generated particular public concern:

(1) *Ethics*. There is considerable media interest in how automated vehicles should decide ethical issues (often encapsulated in hypothetical scenarios about life or death decisions, known as "trolley problems"). Under our terms of reference, we have been asked to avoid judging between different ethical approaches: this is a matter for the political process rather than a legal reform body. However, we welcome the work being undertaken by others in this field and will bear it in mind in our future work.

(2) *Avoiding bias in the behaviour of automated driving systems*. We consider the recommendations of House of Lords Select Committee on Artificial Intelligence on ways of preventing prejudice in algorithmic decision-making.

(3) *Transparency*. We consider how far the decisions made by automated vehicles should be explainable. We ask whether the safety assurance system should require developers to publish their ethics policies (including the costs assigned to human injuries).

9.5 Finally, we ask whether there are other issues which the Law Commissions should address in the course of this three-year review.

RULES AND STANDARDS

9.6 Laws lie on a spectrum between determinate rules or more open-textured standards. Dr Adam Snow notes an ongoing tension, which dates back to the initial regulation of vehicles.[620] This tension is:

> between prescriptive regulations which target behaviour, regardless of the risk of harm (eg speeding) and those that target behaviour where the risk of harm is manifest (eg dangerous driving).[621]

9.7 The main standards are set out in rule 144 in the Highway Code, which states:

You must not:

(1) Drive dangerously

(2) Drive without due care and attention

(3) Drive without reasonable consideration for other road users.

9.8 Dangerous driving is an offence under section 2 of the Road Traffic Act 1988, while careless and inconsiderate driving is an offence under section 3 of that Act. These standards are accompanied by many rules about complying with speed limits, traffic signs and traffic regulation orders, and not driving in places other than a road.[622]

9.9 It is tempting to assume that while standards are problematic, rules are easy to code. Clearly, standards are central to developing driving automation. Ensuring that automated vehicles act safely and considerately needs to be the focus of the development task and regulation, and is discussed in Chapters 4 and 5. However, coding legal rules also has significant challenges, as discussed below.

9.10 An experiment in coding speed limits showed that "even relatively narrow and straightforward 'rules' can be troublingly indeterminate in practice".[623] Every rule has exceptions. Some exceptions are explicit: for example, traffic restriction orders

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620 A Snow, 'Automated Road Traffic Enforcement: Regulation, Governance and Use A review' (2017). He compares the speed limits in the Locomotive Act 1865 with the offence of "wanton and furious driving" in the Offences Against the Person Act 1861.

621 A Snow, above, p 7. This distinction has also been described in terms of explicit and implicit endangerment offences: see R A Duff, Criminal Endangerment, Defining Crimes, Essays on the Special Part of the Criminal Law, OUP. Explicit endangerment offences have the advantage of only criminalising those who actually endanger others, but they "generates the familiar defects of uncertainty in the law's content, and unpredictability and inconsistency in its application" (p 60).

622 For a list of these offences, see background paper 1a.

623 LA Shay and others, "Do robots dream of electric laws? An experiment in the law as algorithm" in *Robot Law* (ed R Calo and others) (Edward Elgar Publishing 2016), p 278.

designating bus lanes state that vehicles may enter the bus lane "for so long as may be necessary to avoid an accident".[624] However, many other exceptions are implicit.

9.11 Even simple rules about speed limits, giving way, or not crossing white lines are subject to "common sense" interpretations when they are applied in practice. Both the behaviour of drivers and the actions of enforcers involve a degree of discretion. These interpretations will often be difficult to code, as the digital code running in automated driving systems requires a degree of precision that is absent from "analogue" law.[625]

Challenging driving scenarios

9.12 The transport research agency, Transport Systems Catapult, considered driving scenarios which may be particularly challenging for automated vehicles in a 2017 report for government.[626] The report provides a framework to analyse situations which call for "common sense driving", where the rules fail to operate clearly. Abnormal situations can lead to abnormal behaviour:

> Examples of abnormal behaviour that can be found on the UK highway network might include (but not limited to) responding to emergency vehicles, navigating temporary traffic management measures, responding to children that are near the carriageway, overtaking an unsteady cyclist travelling uphill, overtaking broken down vehicles etc.[627]

9.13 The report highlights the chaotic conditions that exist in an urban environment, and greater reliance on human common sense in negotiating these, including increased vulnerability to antisocial behaviour.[628]

9.14 One example where the rule may be uncertain is whether a car may overtake a bus that has broken down on a pedestrian crossing. Rule 191 of the Highway Code states that "you MUST NOT overtake the moving vehicle nearest the crossing or the vehicle nearest the crossing which has stopped to give way to pedestrians". However, this does not necessarily prohibit overtaking a vehicle which is stationary because it has broken down.

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624 See Bus Lane Adjudication Service Joint Committee, Working Group for the Review of Bus Lane Traffic Regulation Orders Specimen Articles and Traffic Regulation Order for Bus Lanes, section 5, para 5. See for example, Bedford Borough Council, Traffic Regulation Order, Bedford Borough Council (Bus lanes and bus only streets, the Borough of Bedford) Consolidation Order 2014, Article 11(1).

625 See LA Shay and others, "Do robots dream of electric laws? An experiment in the law as algorithm" in *Robot Law* (ed R Calo and others) (2016). They note particular problems arising from the "ambiguous translation process between human-readable laws on the books and machine-processable algorithms required by automated systems".

626 Transport Systems Catapult, *Taxonomy of Scenarios for Automated Driving: Technical Report* (April 2017). The report noted that edge case circumstances arise routinely and therefore are inevitable.

627 Above, p 6.

628 Above, p 82.

The tension between safety and rule-following

9.15 In most cases, standards and rules have the same objectives: to make the roads safer. However, in some cases, following a rule in an overly literal way could reduce safety.

9.16 Where rule-following is incompatible with safety, the law is nuanced. English judges have been wary about a general defence of necessity, which would justify breaking clear rules. Lord Bingham's speech in *Hasan*[629] underlined judicial anxieties that such a defence could encourage defendants to claim that they were being reasonable in breaking the law, by choosing the lesser of two evils.[630] However, the courts have recognised that a constable may direct people to disobey traffic regulations if that is reasonably necessary for the protection of life and property.[631] In other cases, prosecutors have considerable discretion not to prosecute where a relatively minor rule was broken in the interests of safety.

9.17 Consider the example of a child running out in front of an automated vehicle too suddenly for the car to avoid the child through braking alone. Should the vehicle break the rules by swerving onto an apparently empty pavement to avoid the child, contrary to section 72 of the Highways Act 1835?[632] For human drivers, the priority is to avoid the child. Abiding by the rule is less important, and no prosecutor would bring a case under the 1835 Act in such circumstances. In fact, failing to swerve could amount to dangerous or careless driving, on the basis that these "standards based" offences trump minor rules.[633]

9.18 However, the issue is controversial. Despite the strong arguments in favour of swerving, some developers have argued that an automated vehicle should never swerve if doing so involved breach of a road rule. Instead, the developer's duty of care would be discharged by activating the brakes: as the vehicle would have followed all the road rules, no liability would be incurred. One stakeholder even expressed the view that one wouldn't expect a tram to go off the rails to avoid someone on the tracks: neither should an automated vehicle be expected to deviate from its path.

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629 *R v Hasan* [2005] 2 WLR 709.

630 For discussion, see D Ormerod and K Laird, *Smith, Hogan and Ormerod's Criminal Law* (15th ed 2018) p 369.

631 *Johnson v Phillips* [1975] 3 All ER 682, and compare with *Wood v Richards* [1977] RTR 201.

632 In England, the Highways Act 1835 imposes a penalty "if any person shall wilfully ride upon any footpath or causeway by the side of any road made or set apart for the use or accommodation of foot passengers; or shall wilfully lead or drive any horse, ass, sheep, mule, swine, or cattle or carriage of any description, or any truck or sledge, upon any such footpath or causeway". The significant element is that it covers a person who wilfully drives a carriage of any description on a footpath. The equivalent provision in Scotland is s129(5) of the Roads (Scotland) Act 1984.

633 Failing to have a proper and safe regard for vulnerable road users is likely to be characterised as dangerous driving, see the detailed guidance issued by the Crown Prosecution Service, https://www.cps.gov.uk/legal-guidance/road-traffic-offences-guidance-charging-offences-arising-driving-incidents.

9.19 Swerving has dangers: if a vehicle swerved off-road to avoid a child, it would risk hitting unknown numbers of undetected pedestrians.[634] Swerving would involve a deliberate choice and could lead to legal liability if, for example, another road user was hit.

9.20 However, failing to swerve would give automated vehicles fewer options than a human driver. In a public law context, Professor Rebecca Williams has noted the dangers of an increased rigidity of policies at the expense of appropriate assessment of specific cases.[635] There are possible analogies between unduly "fettering the discretion" of public officials and limiting the range of options open to an automated driving system to act appropriately in the circumstances.[636]

9.21 The UNECE Resolution on the deployment of highly and fully automated vehicles states that automated driving systems should "make road safety a priority" and "endeavour to safely tolerate errors" of other road users to minimize their effects.[637] This suggests that simply complying with strict rules would not necessarily discharge developers' responsibilities to prioritise road safety. Even if the other road user is at fault, the automated driving system should take action to avoid a collision.

9.22 The imposition of strict rules may lead to benefits in some circumstances and to disadvantages in others. As one developer pointed out, the vehicle needs to be able to weigh the various "costs" of each option,[638] and usually the cost of hitting a human would be "astronomical" compared to the cost of leaving the road.

Developing a "digital highway code"

9.23 In 2018, FiveAI, a software developer for self-driving cars and urban mobility solutions, published a white paper recommending the introduction of a code of practice for developers to promote the safety of automated driving systems.[639] This highlights the need for a Digital Highway Code:

> [W]e need a publicly-available, machine-readable and complete set of those traffic laws and driving codes and conventions, a Digital Highway Code (DHC).

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634 As discussed in Ch 6, under the Automated and Electric Vehicles Act 2018, a vehicle is unlikely to be required to pay compensation to a person at fault, as this would be discounted through the doctrine of contributory negligence. However, if a vehicle swerves to avoid a person at fault and injures a bystander, a court may determine that the collision was "caused" by the automated vehicle, triggering liability.

635 R Williams, "Algorithmic decision-making and public law" (forthcoming publication).

636 Public officials are expected to exercise human judgment by taking account of relevant considerations, disregarding irrelevant considerations and not applying policies in an overly rigid way. Although the analogy is far from exact, Williams argues that algorithms should also be sensitive to context and not overly rigid in the application of rules. When the range of options available to a vehicle is unduly restricted, the dangers are similar to those caused by fettering the discretion of public officials: see R Williams, "Algorithmic decision-making and public law" (forthcoming publication).

637 UNECE "Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic" (2018), Report of the Global Forum for Road Traffic Safety on its seventy-seventh session ECE/TRANS/WP.1/165 Annex 1, paras 4(a) and 4(c) respectively.

638 In this context, any injury or damage would be considered a cost, though it may not be calculated in monetary terms.

639 FiveAI (contributors: P Koopman and M Wagner), *Certification of Highly Automated Vehicles for Use on UK roads* (2018) p 10, https://five.ai/certificationpaper.

That DHC must include exception handling rules, for example: when and how exactly can a vehicle cross a centre dividing line, if present, to avoid a lane obstruction; when would it be acceptable to mount a sidewalk; what should a driver be permitted to do if traffic lights are defective and so on. These conventions should extend to polite behaviour on the road in that jurisdiction, including when the Highly Automated Vehicle should let other road users merge into our lane, to what extent does the highly automated vehicle have a responsibility to ensure the most efficient use of the road network etc.[640]

9.24 We accept that a Digital Highway Code may be desirable. However, it will also be extremely difficult to produce, given the complexity of the driving rule book and the huge variety of implicit interpretations and exceptions. What is at stake here is much more than simply producing a digital map of road rules.[641] It involves formalising the "exception-handling rules" which are currently implicit in "common sense" driver behaviour, personal value judgements and prosecutorial discretion. It involves policymakers and developers working together in a way which is unprecedented.

9.25 The scope for converting laws into machine-readable form has given rise to a distinct branch of legal informatics often referred to as computational law. The process of coding law involves reconciling a culture clash between the purposive judgments of lawyers and the more determinate, deductive reasoning of engineers.

9.26 The differences in reasoning can be seen in HLA Hart's famous hypothetical example. How should one interpret the rule: "no vehicles in the park"?[642] An engineer will ask for a definition: the lawyer might reply that a vehicle includes any wheeled conveyance used to transport a person. However, when the engineer replies that pushchairs are therefore prohibited, the lawyer will disagree, citing a "purposive interpretation": pushchairs are generally allowed in parks, so if the park had wished to ban them, they would have said so explicitly. At this point, the engineer may despair, as the lawyer fails to understand the nature of a definition.

9.27 The need to provide determinate rules "can be, and is, consciously architected by lawmakers".[643] However, it will require overcoming these differences of approach. As Bryant Walker Smith put it, "lawyers and engineers can - and should - speak the same robot language".[644] We welcome views on how this collaboration can best be furthered.

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640 Above, at p 10.

641 Work is underway to provide digital maps to show local road rules, including temporary speed limits. However, automated vehicles will not necessarily depend on maps to be aware of rules: some may read signs as they progress. For a discussion of the complexity of road signs and the difficulties this causes, see Alan Thomas, *Real-world conditions will limit AV safety gains,* ITS International (March/April 2017) pp 24-26.

642 See HLA Hart, "Positivism and the Separation of Law and Morals" (1958), 71 *Harvard Law Review* 593, pp 608-15.

643 H Surden, "The Variable Determinacy Thesis", (2011) 12 The Columbia Science and Technology Law Review 1, p 81, http://www.stlr.org/cite.cgi?volume=12&article=1.

644 B Walker Smith, "Lawyers and Engineers should speak the same robot language" in *Robot Law* (ed R Calo and others) (2016), p 101.

Consultation Question 38.

9.28 We seek views on how regulators can best collaborate with developers to create road rules which are sufficiently determinate to be formulated in digital code.

THREE SAMPLE QUESTIONS

9.29 Developing a full Digital Highway Code is not something which the Law Commissions can do in three years, nor are we necessarily the right bodies to do so.[645] However, developers are entitled to ask regulators for guiding principles about how far to encode the letter of the rule, and how far rules should be subject to exceptions in the interests of safety and traffic flow.

9.30 At this stage, we are merely "dipping our toes in the water" of this debate, by asking three sample questions. When should an automated vehicle mount the pavement, exceed the speed limit or edge through pedestrians? We do not have any preconceived ideas on these issues. Rather, we are interested to hear views.

Should automated vehicles ever mount the pavement?

9.31 Under section 34(1) of the Road Traffic Act 1988 it is an offence for a person "without lawful authority" to drive a vehicle on a "footpath, bridleway or restricted byway".[646] This is subject to an exception. Under section 34(4):

> A person shall not be convicted of an offence under this section with respect to a vehicle if he proves to the satisfaction of the court that it was driven in contravention of this section for the purpose of saving life or extinguishing fire or meeting any other like emergency.

There is very little case law on what this exception covers, mainly because the Crown Prosecution Service uses its discretion to only prosecute cases where it deems it appropriate to do so.

9.32 As mentioned above, it is also a crime to drive on a footpath under section 72 of the Highway Act 1835.[647] Among other things, this makes it a criminal offence to "wilfully… drive [a] carriage of any description… upon… [a] footpath". As the Act is written in an older style it does not include any explicit exceptions.

9.33 Some stakeholders have suggested a core rule requiring automated vehicles to stay on the road at all times. The logic is that although human drivers may sometimes mount a clear pavement without obvious danger, automated vehicles may be less able to recognise and predict pedestrian behaviour on the pavement with the same accuracy.

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645 Responses to Consultation Question 38 will inform the way forward on this.

646 Road Traffic Act 1988, s 192 defines "footpath" as a way over which the public have a right of way on foot only. In general usage this is also referred to as "footway" (for footpaths adjacent to a highway), "kerb" or "pavement". For the Scots definition of a "footpath/footway", see Road (Scotland) Act 1984, s 151.

647 The Highway Act 1835 applies only to England; s129(5) of the Roads (Scotland) Act 1984 makes equivalent provision for Scotland.

Preventing automated vehicles from leaving the road would make the actions of the vehicle simpler to program and understand. However, this could provide automated vehicles with a narrower range of options than human drivers.

9.34 Initial discussions have raised three reasons why an otherwise careful and law-abiding driver might mount the kerb in an urban environment. The first is to avoid an accident - such as where a vehicle swerves to avoid a child unexpectedly running out into the road or a motor-cycle which has lost control on the bend. As we have discussed, views on this are split.

9.35 A second reason is to allow emergency vehicles to pass. The Highway Code Rule 219 advises drivers to "avoid" mounting the kerb. It provides the following advice about letting emergency vehicles through:

> Consider the route of such a vehicle and take appropriate action to let it pass, while complying with all traffic signs. If necessary, pull to the side of the road and stop, but try to avoid stopping before the brow of a hill, a bend or narrow section of road. Do not endanger yourself, other road users or pedestrians and avoid mounting the kerb. Do not brake harshly on approach to a junction or roundabout, as a following vehicle may not have the same view as you.

9.36 There is a subtle difference between advising drivers to "avoid" a behaviour and prohibiting it. Where the only way for an emergency vehicle to negotiate a narrow, blocked street is for a vehicle to mount the kerb, driver behaviour and prosecutorial discretion is more nuanced than the Highway Code might suggest. Again, we would be interested to hear whether a rule preventing automated vehicles from mounting pavements might have untoward consequences for emergency vehicles.

9.37 A third reason would be to pass a vehicle coming in the other direction in a narrow street. Again, this is undesirable, but may sometimes be necessary to allow traffic flow. We welcome views.

Consultation Question 39.

9.38 We seek views on whether a highly automated vehicle should be programmed so as to allow it to mount the pavement if necessary:

(1) to avoid collisions;

(2) to allow emergency vehicles to pass;

(3) to enable traffic flow;

(4) in any other circumstances?

Consultation Question 40.

9.39 We seek views on whether it would be acceptable for a highly automated vehicle to be programmed never to mount the pavement.

Should highly automated vehicles ever exceed speed limits?

A recent experiment

9.40 At first sight, speed limits appear to be examples of clear, determinate rules, which can be coded into automated vehicles. However, an experiment in the US[648] showed why the task may be more difficult than first appears.

9.41 The experimenters asked a human to drive at the speed limit for just over an hour, recording their speed on an onboard computer. The data was given to 52 programmers, who were asked to write code to determine how many speeding violations had been committed during this period. Some coders were asked to follow "the letter of the law", some "the intent of the law" and some were given further guidelines.

9.42 The 52 programs resulted in widely different numbers of offences, from 0 to 932. Many of these differences resulted from varied approaches to tolerances and clustering (relating to when one speeding offence ends and another begins). However, the experiment also raised more substantive policy issues. One issue related to whether drivers should reduce speed before or after the speed sign. The authors commented that programmers assumed that the driver had ample notice of the speed limit:

> They did not suggest an additional allowance that provides to slow down *after* entering a slower speed zone, although we believe that this allowance is worth consideration in the design of future, real-world systems.[649]

The ACPO guidance: "10% + 2" tolerances

9.43 The National Police Chiefs Council was formerly called the Association of Chief Police Officers (ACPO). ACPO had looked at the principles behind speed limit enforcement policy and issued guidelines, which we discuss in detail in background paper 1.

9.44 The guidelines stress that police officers have discretion over the appropriate enforcement action, though this discretion must be exercised in a way which is proportionate, targeted, consistent and transparent. In broad terms, the guidelines indicate that a fixed penalty notice is only appropriate when the speed exceeds the limit by at least 10% plus 2 miles per hour (for example, where the limit is 30 miles per hour, the speed must exceed 35 miles an hour).

9.45 This raises the question of whether the "10%+2" tolerance should also apply to automated vehicles. There are three main policy arguments for allowing automated

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648 LA Shay and others, "Do robots dream of electric laws? An experiment in the law as algorithm" in *Robot Law* (ed R Calo and others) (2016).

649 Above, p 282.

vehicles to be programmed to exceed the limit, provided that they remain within the ACPO tolerances. These are:

(1) exceeding the speed limit might sometimes be in the interests of safety, for example to overtake a vehicle as quickly as possible to avoid a collision;

(2) some tolerance might prevent overly sharp breaking, for example, on reaching a lower speed limit sign;

(3) It has been suggested by some stakeholders (and disputed by others) that exceeding the speed limit might sometimes be helpful to maintain traffic flow.

9.46 Another possible argument is that automated and driven vehicles should be treated consistently. The alternative view, however, is that automated vehicles should behave better than human drivers and should not simply mimic their bad habits.

9.47 The issue is clearly controversial and we have not yet reached any conclusions. We welcome views.

Consultation Question 41.

9.48 We seek views on whether there are any circumstances in which an automated driving system should be permitted to exceed the speed limit within current accepted tolerances.

Edging through pedestrians

9.49 One of the more difficult challenges faced by automated vehicles is how to cope with groups of pedestrians blocking their path.[650] Several stakeholders reported examples of pedestrians running in front of vehicles. Alternatively, pedestrians may fail to give way, making it difficult for a vehicle to exit from a car park. As one recent study put it:

> Once human road users know that AV [automated vehicle] safety systems are programmed to stop if any obstacle is in their path, they can quickly take advantage of this to push in front of the AV and take priority. If this becomes common knowledge across a whole city, AVs will make little or no progress because they will be forced to yield at every single interaction.[651]

[650] In one trial, pedestrians knowingly obstructed autonomous minibuses once every three hours: R Madigan and others (2016) Acceptance of automated road transport systems (ARTS): an adaptation of the UTAUT model. *Transportation Research Procedia*, 14:2217 to 2226.

[651] C Fox and others (2018), "When should the chicken cross the road? Game theory for autonomous vehicle - human interactions conference paper" (March 2018) Proceedings of the 4th International Conference on Vehicle Technology and Intelligent Transport Systems, pp 431 to 439.

9.50 The study used game theory to model a variety of interactions between automated vehicles and other road users to reach the following conclusion:

> There must be a credible threat of a non-zero probability of causing some collision, in order that the other party cannot take advantage of the AV every time.[652]

9.51 The authors explain:

> It is impossible for an AV to make any progress at all if this is not the case, because given this knowledge, every single other road user could dominate them in any conflict - even pedestrians jumping out in front of them for fun as seen in real-world trials.[653]

9.52 In Chapter 8 we highlighted that when people were asked to imagine being transported by automated vehicles, they expressed concerns about being left as "helpless and hapless passengers vulnerable to attack".[654] One particular fear is that groups of pedestrians might surround the vehicle, effectively holding it prisoner.

9.53 This leads to questions about how human drivers cope with groups of pedestrians, either surrounding them or crossing in front of them, for example on a busy shopping street. In some circumstances, a human driver who has right of way might edge forward. Effectively, this raises some ("non-zero") risk that if a pedestrian does not get out of the way, the vehicle might touch or injure them. As a result, the pedestrian will move. In some contexts, this might be an acceptable way of dealing with pedestrians in the road.

9.54 In other contexts, it would clearly not be acceptable. Under Article 26(1) of the Vienna Convention on Road Traffic 1968, it is prohibited "for road-users to cut across troop columns, files of school-children accompanied by a person in charge, and other processions". There may be other contexts where edging forward would be also to unacceptable, as where a group of pedestrians are gathered around a casualty lying in the road. However, contexts which might be clear to a human driver may be less intelligible to an automated driving system.

9.55 This raises questions about whether it would ever be acceptable for an automated vehicle to drive towards a pedestrian, so that a pedestrian who does not move faces the risk of being touched and (possibly) injured. If so, what could be done to ensure that this is not done inappropriately (as where a casualty is lying in the road)? One suggestion is that it should only be possible if a human occupant takes responsibility for the vehicle's actions at this stage.

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652 Above.

653 As above.

654 Transport Systems Catapult, Taxonomy of Scenarios for Automated Driving, Technical Report (April 2017) p 82. The authors provide a taxonomy of possible offences which includes pranks "for novelty or ludicracy", such as playing chicken to test the system; moving or upending the vehicle; and car surfing or unsolicited towing (p 88).

Consultation Question 42.

9.56 We seek views on whether it would ever be acceptable for a highly automated vehicle to be programmed to "edge through" pedestrians, so that a pedestrian who does not move faces some chance of being injured. If so, what could be done to ensure that this is done only in appropriate circumstances?

Segregating pedestrians

9.57 An alternative approach would be to segregate highly automated vehicles from pedestrians.[655] Local authorities already have significant powers to restrict where automated vehicles are allowed to go or, conversely, to restrict traffic that is not automated.[656]

9.58 One particularly controversial issue is how far it might be appropriate to restrict the actions of vulnerable road users, such as pedestrians or cyclists. One example would be "jaywalking" laws, restricting pedestrians from crossing roads except at pedestrian crossings. The UK has never had jaywalking legislation, and in its recent ratification of the Vienna Convention, the Government said the UK does not consider itself bound by jaywalking provisions.[657]

9.59 To restrict the freedom of movement of pedestrians due to the insufficiencies in automated vehicle functionalities does not appear justified at this time. On the other hand, this possibility could be reconsidered if the overall benefits arising from automated driving technology justified a restriction on the activities of other road users.

THE TROLLEY PROBLEM

9.60 The trolley problem is a thought experiment posited by Phillipa Foot in 1960s.[658] It is used in philosophical discussions to explore how far life and death decisions should be governed by utilitarian considerations ("the greatest good of the greatest number") or by a more categorical approach ("the moral imperative"). In its best-known form it asks how to react to a runaway tram or trolley about to kill five people. In surveys most people say it is morally right to divert the trolley to an alternative track, where it would kill one

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655 These are issues that depend on land use policy, which is outside our terms of reference.

656 See Road Traffic Regulation Act 1984. See the procedures set out in the Local Authorities' Traffic Order (Procedure) (England and Wales) Regulations 1996 (SI 1996/2489) as amended and the Local Authorities' Traffic Orders (procedure) (Scotland) Regulations 1999 (SI 1999/614) as amended. Section 1 of the Road Traffic Regulation Act 1984 allows traffic regulation orders to made for a variety of purposes. This includes, facilitating the passage on the road of any class of traffic (including pedestrians), avoiding danger to persons or other traffic, and preventing the use of the road by vehicular traffic of a kind which is unsuitable having regard to the existing character of the road or adjoining property.

657 See reservation to the Vienna Convention, Article 20(6)(b).

658 P Foot, *The Problem of Abortion and the Doctrine of the Double Effect in Virtues and Vices* (Oxford: B Blackwell, 1978) (originally in the *Oxford Review*, Number 5, 1967.) The term "trolley problem" and some of the development of analysis around it originate from Judith Thompson: 'Killing, Letting Die and the Trolley Problem' *The Monist*, Vol. 59, No. 2, *Philosophical Problems of Death* (April 1976), pp 204 to 217.

person. However, people are much more concerned about deliberately pushing someone in front of the trolley to stop the trolley in its track.[659]

9.61 The phrase "trolley problem" has become a short-hand for ethical dilemmas about how to act in life and death situations. Society accepts that drivers faced with life and death decisions act in the heat of the moment, without considering the full gamut of philosophical debate. However, people are more concerned about how programmers will weigh up the many competing interests, when they may be forced to directly or indirectly make similar decisions in advance.[660]

9.62 Philosophical discussions about how automated driving systems handle life and death decisions have garnered much media interest. Developers and policy makers told us that they are often asked about trolley problems. Typically, the problems posed involve swerving to avoid a person at fault when that risks killing an innocent passer-by, or involve weighing one life against another, such as a child against an older person. The questions raise issues about the concepts such as self-sacrifice, self-preservation, fault, the distinction between act and omission and the relative value of human life.[661]

9.63 That said, many developers find the more abstruse trolley problems to be unhelpfully hypothetical and unrealistic. Professor Ryan Calo, a leading expert in artificial intelligence, wrote in colourful terms that the typical "trolley problem":

> invites us to imagine a robot so poor at driving that, unlike you or anyone you know, the car finds itself in a situation that it *must kill someone*. At the same time, the robot is so sophisticated that it can somehow instantaneously weigh the relative moral considerations of killing a child versus three elderly people in real time. The new trolley problem strikes me as a quirky puzzle in search of a dinner party.[662]

9.64 Bryant Walker Smith notes that the "last minute value judgements" set out in trolley problems are rare. However, the underlying issues often relate to familiar trade-offs which are already integral to engineering and policy making. He notes:

> Engineering is about trade-offs: We replace one set of problems with another set of problems and hope that, in the aggregate, our new problems are smaller

659 For further discussion, see J Greene, *Moral Tribes: Emotion, Reason and the Gap between Us and Them* (2014).

660 See for example I Rahwan's Cambridge TedX 2016 talk, https://www.ted.com/talks/iyad_rahwan_what_moral_decisions_should_driverless_cars_make; Bogost, 'Enough With the Trolley Problem' (2018) *The Atlantic* https://www.theatlantic.com/technology/archive/2018/03/got-99-problems-but-a-trolley-aint-one/556805/. See also the "Moral Machine", a platform for gathering human perspectives on moral decisions made by machine intelligence systems, at http://moralmachine.mit.edu/.

661 Some of the more detailed and abstruse discussion of the trolley problem concerning an individual's background, occupation or personal history. This is data would not be available to a vehicle. Even if it were technically possible to make that data available, to do so would amount to a breach of privacy.

662 See R Calo, "*The courts can handle the deadly Uber Self-driving car crash*, ***but that doesn't mean the law is ready for autonomous vehicles*",** at https://slate.com/technology/2018/03/the-deadly-uber-self-driving-car-crash-is-just-the-beginning.html.

than our old ones. (Take just one example: although antilock brake systems without electronic stability control decrease the risk of fatal collision for those outside the vehicle, they may increase that risk for those on the inside.) Careful design therefore requires selection of system boundaries, assessment of risks and opportunities, and analysis of costs and benefits. None of these decisions are value-free; indeed, cost-benefit analyses performed by administrative agencies may even involve explicit assumptions about the value of a human life.[663]

9.65 As Bryant Walker-Smith points out, decisions are rarely value-free. The questions we have posed above invite discussion of the values behind decisions. This includes discussing how far vehicles should pose possible risks to someone on the pavement, if this would avert a greater risk to someone on the road. The ethical problem is particularly acute when a major risk to a person at fault (such as motor cyclist who has lost control on a bend) is traded against a minor risk to an innocent passer-by. Other ethical issues involve weighing risks to passengers in the vehicle compared to bystanders.[664]

9.66 Ethics run through debates about automated vehicles. We welcome the fact that organisations have started to address how artificial intelligence should make ethical decisions. Work is being carried out by the new Office for Artificial Intelligence,[665] and the new Centre for Data Ethics and Innovation Consultation[666] as well as the Ada Lovelace Research Institute of the Nuffield Foundation.[667] Although the Law Commissions have been asked not to adjudicate on what may or may not be desirable ethical outcomes, we will be guided by developing thinking in this area.

9.67 Automated vehicles, like other systems, will need to assess the risks of each manoeuvre against the risks of its alternatives.[668] As risk-assessment involves calculating the "cost" of an accident against the likelihood of it occurring, each outcome must be assigned some sort of cost, though not necessarily in a monetary form. To help build public trust

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663 See B Walker Smith, *Driving to Perfection*, 2012, at http://cyberlaw.stanford.edu/blog/2012/03/driving-perfection.

664 N Goodall, "Ethical Decision Making During Automated Vehicle Crashes" (2014) 2424 *Transportation Research Record: Journal of the Transportation Research Board* 58 to 65; Sven Nyholm and Jilles Smids, "The Ethics of Accident-algorithms for Self-Driving Cars; an Applied Trolley problem?" (2016) 19 *Ethical Theory and Moral Practice* 1275-1289.

665 A joint office, set up by DCMS and BEIS, see https://www.gov.uk/government/publications/artificial-intelligence-sector-deal/ai-sector-deal#fnref:4.

666 See https://www.gov.uk/government/consultations/consultation-on-the-centre-for-data-ethics-and-innovation/centre-for-data-ethics-and-innovation-consultation.

667 See https://www.adalovelaceinstitute.org.

668 See R Johansson and J Nilsson, Disarming the Trolley Problem – Why Self-driving Cars do not Need to Choose Whom to Kill, Workshop CARS 2016 – Critical Automotive applications: Robustness & Safety, September 2016, Goteborg, Sweden. Johansson and Nilsson argue that autonomous driving systems can solve ethical dilemmas through being programmed in such a way that a system would only undertake a tactical driving choice (for example, selecting its appropriate speed or switching lanes) if it has the operational capacity to safely complete that manoeuvre.

in automated vehicles, there are strong arguments that the thinking behind these costs should be transparent. We address issues of transparency below.

AVOIDING BIAS IN THE BEHAVIOUR OF AUTOMATED DRIVING SYSTEMS

9.68 A further concern about automated vehicles is that even if the decisions are correct overall, they may involve bias against a particular group. While acknowledging the undoubted benefits which automated decision making can bring in terms of accuracy and objectivity, Professor Rebecca Williams has highlighted some of the difficulties in detecting bias in algorithmic decision making:[669]

> The algorithms themselves will contain value judgments, some of which 'may not even have occurred to policymakers, but surface only when the engineers come to design the algorithms and are left to resolve the tradeoffs'.[670] For example, it has been pointed out that there may be different indicia of accuracy; a system which is the most accurately predictive across all cases taken together may also be the most inaccurate in the sense of being inaccurately skewed against one or more particular groups within that aggregate whole.[671]

9.69 There are particular concerns if decisions adversely affect a group of people on the basis of race, gender or other protected characteristics. Such bias is already against the law in various circumstances. Regulators of automated vehicles, as public authorities must, in the exercise of their functions have due regard to eliminating discrimination and advancing equality of opportunity for persons with protected characteristics.[672] Protected characteristics include age, disability, gender and race.

9.70 There are several examples of where bias has crept into vehicle design or to automated systems. Whereas air bags have been proven to save many lives, first generation air bags posed risks to smaller passengers, such as women of small stature, the elderly, and children, through having been developed with adult males in mind.[673] Current facial recognition software may also exhibit a bias towards white, male faces. For non-white and non-male faces, the accuracy of facial recognition systems may decline significantly. [674]

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669 R Williams, "Algorithmic decision-making and public law" (forthcoming publication).

670 Above, at p 12.

671 T Speicher, H Heidari, N Grgić-Hlača, K Gummadi, A Weller and M B Zafar, "A Unified Approach to Quantifying Algorithmic Fairness: Measuring Individual and Group Unfairness via Inequality Indices", *Proceedings of the 24th ACM SIGKDD Conference on Knowledge Discovery and Data Mining*, forthcoming, London, August 2018.

672 Equality Act 2010, s 149.

673 NHTSA determined that 291 deaths were caused by air bags between 1990 and July 2008, primarily due to the extreme force that is necessary to meet the performance standard of protecting the unbelted adult male passenger. See D Glassbrenner, Estimating the Lives Saved by Safety Belts and Air Bags, Washington, D.C.: National Center for Statistics and Analysis, National Highway Traffic Safety Administration, paper 500, undated, available at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.506.777&rep=rep1&type=pdf, referred to in RAND Corporation, Autonomous Vehicle Technology, A Guide to Policy Makers (2016), p 102.

674 See https://www.nytimes.com/2018/02/09/technology/facial-recognition-race-artificial-intelligence.html.

9.71 One issue which may be particularly relevant to automated vehicles is the concern that female cyclists may be disproportionately vulnerable to lorry "blind spots". Slower, more cautious cyclists are more likely to be overtaken by lorries turning left and are more likely to be killed in this way.[675]

9.72 Stakeholders have told us that some key components of automated driving systems are only as good as their training data. The challenge is to provide sufficient training data across a wide enough pool of road users to reduce the risk of biases in the way that a system detects and classifies things and learns behaviours. Research into optimising procedural fairness in machine learning may provide valuable insights.[676]

9.73 We seek views on whether and how datasets which are used for visual recognition can be reflective of the population which an automated vehicle might encounter. This is an aspect of appropriately assessing the operational design domain of an automated vehicle. The data will need to cover all types of vulnerable road users. To take an obvious example, it will need to cover the full range of cyclist behaviour, from lycra-clad speed to cautious kerb-hugging.[677] It will also need to include different types of wheelchair user, blind and partially-sighted pedestrians, as well as older (second-hand) pushchairs and buggies.[678]

9.74 In Chapter 4 we discuss the need for a new safety assurance system. We seek views on how far a safety assurance system should include an audit of training data. The aim would be to ensure that the training data is cast sufficiently wide to allow all road users in the vehicle's operational design domain to be identified accurately and responded to appropriately.

Consultation Question 43.

9.75 To reduce the risk of bias in the behaviours of automated driving systems, should there be audits of datasets used to train automated driving systems?

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675 See https://www.standard.co.uk/lifestyle/london-life/why-women-seem-to-be-more-vulnerable-around-traffic-blackspots-in-london-10341420.html. Although more male cyclists are injured overall, a higher proportion of female cyclists die in collisions with lorries. An analysis of cycling fatalities in Central London between January 2009 and June 2015 showed that of 33 female deaths, 27(82%) were hit by lorries. This compares with 22 of 51 men killed (43%).

676 Nina Grgic-Hlaca, Muhammad Bilal Zafar, Krishna Gummadi, Adrian Weller, "Beyond distributive fairness in algorithmic decision making: feature selection for procedurally fair learning" *The Thirty-Second AAAI Conference on Artificial Intelligence* (AAAI-18) (2018) The paper specifically considers the trade-offs between procedural fairness and accuracy of outcomes.

677 The Telegraph notes: "There is, undoubtedly, a specific problem with women cyclists and heavy lorries in London. Most experts suggest that women are more likely to be cautious at junctions and, as a result, be left in a lorry's blind spot as the vehicle turns left." See https://www.telegraph.co.uk/men/active/recreational-cycling/11702076/The-truth-about-cycling-safety.html.

678 There is a long list of possible users who will need to be considered, including skateboarders, rollerbladers and horse-riders.

TRANSPARENCY

9.76 All the issues we have discussed raise important questions about how far decision making by automated vehicles will be transparent and explainable. This is a difficult issue, which a House of Lords committee has recently examined.

The findings of the Artificial Intelligence Committee

9.77 In 2017, the House of Lords appointed a committee to investigate the economic, ethical and social implications of advances in artificial intelligence (AI).[679] The committee considered how AI affects people in their everyday lives and across a wide variety of sectors, from healthcare to financial services. It included automated vehicles. In their report, the Artificial Intelligence Committee noted that "many witnesses highlighted the importance of making AI understandable to developers, users and regulators".[680] The Committee noted the problems of more complex systems:

> The number and complexity of stages involved in these deep learning systems is often such that even their developers cannot always be sure which factors led a system to decide one thing over another. We received a great deal of evidence regarding the extent and nature of these so-called 'black box' systems.

One context where the House of Lords Select Committee found there is a need to avoid "black box" systems is that of automated vehicles.[681]

9.78 The Committee identified two main approaches to making automated driving systems more understandable: technical transparency and explainability. Technical transparency refers to whether experts can understand how an AI system has been put together.[682] Explainability, by contrast, focusses on whether it is possible to explain the

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679 The Government in its Industrial Strategy White paper defines artificial intelligence as "technologies with the ability to perform tasks that would otherwise require human intelligence, such as visual perception, speech recognition, and language translation." Department for Business, Energy and Industrial Strategy, *Industrial Strategy: Building a Britain fit for the future* (November 2017), p 37: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf.

680 AI in the UK: ready, willing and able? House of Lords Select Committee on Artificial Intelligence, Report of session 2017-2019 (2018) HL 100, para 89.

681 Above, para 94.

682 Professor Chris Reed emphasised the difference between transparency in two scenarios:

(1) In advance: where the decision-making process can be explained in advance of the AI being used

(2) After the fact: where the decision-making process is not known in advance but can be discovered by testing the AI's performance in the same circumstances.

AI in the UK: ready, willing and able? House of Lords Select Committee on Artificial Intelligence, Report of session 2017-2019 (2018) HL 100, para 96.

information and logic used to arrive at the decision taken. In general, the Committee concluded that explainability was the more helpful concept.[683]

The challenges of transparency and explainablity

9.79 Although most people would agree that transparency is desirable in general, the idea of mandating transparency raises difficulties.

9.80 Some witnesses were concerned that requiring more explainability might be at the expense of generating worse outcomes.[684] For example, it can lead to counter-productive outcomes on traffic flow in terms of game theory.[685] Adrian Weller, director of AI at the Turing Institute, has highlighted the importance of clarifying the context and goal of the transparency being sought.[686] He also stresses the risk of "empty" explanations, which soothe users without providing useful information.

9.81 The House of Lords Select Committee noted that an explanation needs to be adjusted to the audience and the context.[687] In the context of an autonomous vehicle the owner may want information about why a car chooses a particular route. An accident investigator may require much more sophisticated information to assess why an autonomous vehicle has behaved in a certain way. Regulators may wish to know how ethical issues have been addressed. There is no "one-size fits all" solution.

9.82 The House of Lords Select Committee identified a need for further guidance on this issue. It recommended that the Centre for Data Ethics and Innovation in consultation with expert bodies:

> should produce guidance on the requirement for AI systems to be intelligible. The AI development sector should seek to adopt such guidance and to agree upon standards relevant to the sectors within which they work under the auspices of the AI Council.[688]

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683 Whilst technical transparency had its place in regulating AI systems, the generation of a full and satisfactory response for the decisions taken by the system was more important in the context of decisions which have a lasting impact on an individual's life.

684 See HL AI Committee Report, Witness Evidence referenced at para 93: Professor Robert Fisher, Professor Alan Bundy, Professor Simon King, Professor David Robertson, Dr Michael Rovatsos, Professor Austin Tate and Professor Chris Williams (AIC0029); Michael Veale (AIC0065); FiveAI Ltd (AIC0128); University College London (UCL) (AIC0135) and Electronic Frontier Foundation (AIC0199).

685 See above, p 58. Game theory examines the conditions under which cooperation naturally emerges in multi-agent populations, (with individuals maximising their own benefit at the expense of broader societal benefits, including the individuals themselves). The classic "prisoner's dilemma" is a well-known example.

686 A Weller, "Challenges for Transparency" [2017] *Computing Research Repository* 56. Accessible at http://arxiv.org/abs/1708.01870. The paper explores possible quantitative and qualitative approaches to measuring whether a decision can be understood. In respect of whether humans can understand a decision, Dr Weller notes the advantages of adopting a successful "transfer of understanding" approach, which could measure the extent to which the performance of the person receiving the information improves.

687 HL AI Committee Report, para 104.

688 AI in the UK: ready, willing and able? House of Lords Select Committee on Artificial Intelligence, Report of session 2017-2019 (2018) HL 100, para 106.

9.83 We will take account of these guidelines in the course of this review.

Responsibility-Sensitive Safety

9.84 Issues of transparency often involve a debate about the relative importance of "deep learning", compared with other more "top down" rules. The deep learning approach allows machines to learn for themselves with little innate structure. While it may produce good outcomes, it is more difficult to explain than a formal system.[689]

9.85 Mobileye have developed a "responsibility-sensitive safety" (RSS) model by which a more formal system can provide a safety-check on the behaviour of an automated driving system.[690] The model's approach is three-fold. It:

(1) formalises what is safe driving;

(2) defines a range of dangerous situations and what the appropriate response is; and

(3) reduces the probability of causing or being involved in such a dangerous situation.

9.86 The research used data from over six million accidents in the United States, which were analysed as falling within 37 scenarios.[691] The responsibility-sensitive safety model is centred upon identifying a safe longitudinal and lateral distance from other road users and obstacles, so as to remain within an acceptable danger threshold. One advantage is that is that it can explain the approach of the automated driving system to each scenario. This safety assurance model has been adopted by Baidu, China's largest internet services provider as part of its testing of automated vehicles pilots.[692]

Transparency in automated vehicles

9.87 As we have seen, there is considerable public interest in how automated vehicles react in situations of danger. Given this, we welcome views on whether developers should disclose their "ethics policies". The sort of information we have in mind are the values associated with human lives compared to other undesirable outcomes (such as property damage); and the approach to dealing with high-risk scenarios, such as a child running out between parked cars. We are interested to hear how far this information can be published, and how far it might be considered confidential.[693]

9.88 We also seek views on other areas where transparency could be beneficial. This might include, for example, the approach taken to wildlife or pets. For example, how would

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689 Gary Marcus, "Deep Learning: a critical appraisal" (2018) accessible at https://arXiv.org/abs/1801.00631.

690 See S Shalev-Shwartz, S Shammah, A Shashua, On a Formal Model of Safe and Scalable Self-driving Cars, Mobileye (2017).

691 See https://www.mobileye.com/responsibility-sensitive-safety/rss_on_nhtsa.pdf.

692 See https://newsroom.intel.com/news/baidu-integrate-mobileyes-responsibility-sensitive-safety-model-apollo-program/.

693 This links to the safety assurance system, discussed at paras 4.102 to 4.111. The safety assurance system could require developers to provide details of their ethics policies alongside the tests carried out.

the vehicle react to a dog running across the road? Other possible issues relate to route choices.[694] To what extent have these been influenced by public traffic management systems, or perhaps by commercial considerations?

Consultation Question 44.

9.89 We seek views on whether there should be a requirement for developers to publish their ethics policies (including any value allocated to human lives)?

Consultation Question 45.

9.90 What other information should be made available?

FUTURE WORK AND NEXT STEPS

9.91 In this paper we have outlined some of the questions that arise through the increasing role of technology in driving. Our next paper will cover Mobility as a Service and the use of automated vehicle technology as part of public transport. We will also consider the responsibilities of registered keepers for updating software, maintenance and insurance. The feedback from this and the next consultations will inform our future plan of work.

9.92 These questions are not exhaustive. Other issues are being considered separately within the wider reform agenda of the Centre for Connected and Autonomous Vehicles (CCAV). This includes the key areas of cyber security, data protection and ethics.[695] It is not our intention to duplicate this work. Nor are we considering land use policy or broader questions of street design and use of the urban space.

9.93 Here we ask whether there are other issues within our terms of reference[696] which we should be covering.

Consultation Question 46.

9.94 Is there any other issue within our terms of reference which we should be considering in the course of this review?

694 Satellite Navigation data can already offer insights in this direction.

695 For an overview of CCAVs guidance on cyber security see https://www.gov.uk/government/publications/principles-of-cyber-security-for-connected-and-automated-vehicles/the-key-principles-of-vehicle-cyber-security-for-connected-and-automated-vehicles. For the government's framework data ethics framework, see https://www.gov.uk/government/publications/data-ethics-framework/data-ethics-framework.

696 The terms of reference for this project are set out in Appendix 1.

Chapter 10: Consultation Questions

CHAPTER 3: HUMAN FACTORS

A new role in driving automation: the "user-in-charge"

Consultation Question 1 (Paragraphs 3.24 - 3.43)

Do you agree that:

(1) All vehicles which "drive themselves" within the meaning of the Automated and Electric Vehicles Act 2018 should have a user-in-charge in a position to operate the controls, unless the vehicle is specifically authorised as able to function safely without one?

(2) The user-in-charge:

(a) must be qualified and fit to drive;

(b) would not be a driver for purposes of civil and criminal law while the automated driving system is engaged; but

(c) would assume the responsibilities of a driver after confirming that they are taking over the controls, subject to the exception in (3) below?

(3) If the user-in-charge takes control to mitigate a risk of accident caused by the automated driving system, the vehicle should still be considered to be driving itself if the user-in-charge fails to prevent the accident.

Consultation Question 2 (Paragraph 3.45)

We seek views on whether the label "user-in-charge" conveys its intended meaning.

Consultation Question 3 (Paragraphs 3.47 - 3.57)

We seek views on whether it should be a criminal offence for a user-in-charge who is subjectively aware of a risk of serious injury to fail to take reasonable steps to avert that risk.

When would a user-in-charge not be necessary?

Consultation Question 4 (Paragraphs 3.59 - 3.77)

We seek views on how automated driving systems can operate safely and effectively in the absence of a user-in-charge.

Consultation Question 5 (Paragraphs 3.59 - 3.77)

Do you agree that powers should be made available to approve automated vehicles as able to operate without a user-in-charge?

When should secondary activities be permitted?

Consultation Question 6 (Paragraphs 3.80 - 3.96)

Under what circumstances should a driver be permitted to undertake secondary activities when an automated driving system is engaged?

Consultation Question 7 (Paragraphs 3.80 - 3.96)

Conditionally automated driving systems require a human driver to act as a fallback when the automated driving system is engaged. If such systems are authorised at an international level:

(1) should the fallback be permitted to undertake other activities?

(2) if so, what should those activities be?

CHAPTER 4: REGULATING VEHICLE STANDARDS PRE-PLACEMENT

A new safety assurance scheme

Consultation Question 8 (Paragraphs 4.102 - 4.104)

Do you agree that:

(1) a new safety assurance scheme should be established to authorise automated driving systems which are installed:

(a) as modifications to registered vehicles; or

(b) in vehicles manufactured in limited numbers (a "small series")?

(2) unauthorised automated driving systems should be prohibited?

(3) the safety assurance agency should also have powers to make special vehicle orders for highly automated vehicles, so as to authorise design changes which would otherwise breach construction and use regulations?

Consultation Question 9 (Paragraphs 4.107 - 4.109)

Do you agree that every automated driving system (ADS) should be backed by an entity (ADSE) which takes responsibility for the safety of the system?

Consultation Question 10 (Paragraphs 4.112 - 4.117)

We seek views on how far should a new safety assurance system be based on accrediting the developers' own systems, and how far should it involve third party testing.

Consultation Question 11 (Paragraphs 4.118 - 4.122)

We seek views on how the safety assurance scheme could best work with local agencies to ensure that is sensitive to local conditions.

CHAPTER 5: REGULATING SAFETY ON THE ROADS

A new organisational structure?

Consultation Question 12 (Paragraphs 5.30 - 5.32)

If there is to be a new safety assurance scheme to authorise automated driving systems before they are allowed onto the roads, should the agency also have responsibilities for safety of these systems following deployment?

If so, should the organisation have responsibilities for:

(1) regulating consumer and marketing materials?

(2) market surveillance?

(3) roadworthiness tests?

We seek views on whether the agency's responsibilities in these three areas should extend to advanced driver assistance systems.

Driver training

Consultation Question 13 (Paragraphs 5.54 - 5.55)

Is there a need to provide drivers with additional training on advanced driver assistance systems?

If so, can this be met on a voluntary basis, through incentives offered by insurers?

Accident investigation

Consultation Question 14 (Paragraphs 5.58 - 5.71)

We seek views on how accidents involving driving automation should be investigated.

We seek views on whether an Accident Investigation Branch should investigate high profile accidents involving automated vehicles? Alternatively, should specialist expertise be provided to police forces.

Setting and monitoring a safety standard

Consultation Question 15 (Paragraphs 5.78 - 5.85)

(1) Do you agree that the new safety agency should monitor the accident rate of highly automated vehicles which drive themselves, compared with human drivers?

(2) We seek views on whether there is also a need to monitor the accident rates of advanced driver assistance systems.

The technical challenges of monitoring accident rates

Consultation Question 16 (Paragraphs 5.86 - 5.97)

(1) What are the challenges of comparing the accident rates of automated driving systems with that of human drivers?

(2) Are existing sources of data sufficient to allow meaningful comparisons? Alternatively, are new obligations to report accidents needed?

CHAPTER 6: CIVIL LIABILITY

Is there a need for further review?

Consultation Question 17 (Paragraphs 6.13 - 6.59)

We seek views on whether there is a need for further guidance or clarification on Part 1 of Automated and Electric Vehicles Act 2018 in the following areas:

(1) Are sections 3(1) and 6(3) on contributory negligence sufficiently clear?

(2) Do you agree that the issue of causation can be left to the courts, or is there a need for guidance on the meaning of causation in section 2?

(3) Do any potential problems arise from the need to retain data to deal with insurance claims? If so:

- (a) to make a claim against an automated vehicle's insurer, should the injured person be required to notify the police or the insurer about the alleged incident within a set period, so that data can be preserved?
- (b) how long should that period be?

Civil liability of manufacturers and retailers: Implications

Consultation Question 18 (Paragraphs 6.61 - 6.116)

Is there a need to review the way in which product liability under the Consumer Protection Act 1987 applies to defective software installed into automated vehicles?

Consultation Question 19 (Paragraphs 6.61 - 6.116)

Do any other issues concerned with the law of product or retailer liability need to be addressed to ensure the safe deployment of driving automation?

CHAPTER 7: CRIMINAL LIABILITY

Offences incompatible with automated driving

Consultation Question 20 (Paragraphs 7.5 - 7.11)

We seek views on whether regulation 107 of the Road Vehicles (Construction and Use) Regulations 1986 should be amended, to exempt vehicles which are controlled by an authorised automated driving system.

Consultation Question 21 (Paragraphs 7.5 - 7.11)

Do other offences need amendment because they are incompatible with automated driving?

Offences relating to the way a vehicle is driven

Consultation Question 22 (Paragraphs 7.14 - 7.19)

Do you agree that where a vehicle is:

(1) listed as capable of driving itself under section 1 of the Automated and Electric Vehicles Act 2018; and

(2) has its automated driving system correctly engaged;

the law should provide that the human user is not a driver for the purposes of criminal offences arising from the dynamic driving task?

Consultation Question 23 (Paragraph 7.21)

Do you agree that, rather than being considered to be a driver, a user-in-charge should be subject to specific criminal offences? (These offences might include, for example, the requirement to take reasonable steps to avoid an accident, where the user-in-charge is subjectively aware of the risk of serious injury (as discussed in paragraphs 3.47 to 3.57)).

Consultation Question 24 (Paragraphs 7.23 - 7.35)

Do you agree that:

(1) a registered keeper who receives a notice of intended prosecution should be required to state if the vehicle was driving itself at the time and (if so) to authorise data to be provided to the police?

(2) where the problem appears to lie with the automated driving system (ADS) the police should refer the matter to the regulatory authority for investigation?

(3) where the ADS has acted in a way which would be a criminal offence if done by a human driver, the regulatory authority should be able to apply a range of regulatory sanctions to the entity behind the ADS?

(4) the regulatory sanctions should include improvement notices, fines and suspension or withdrawal of ADS approval?

Responsibilities of "users-in-charge"

Consultation Question 25 (Paragraphs 7.37 - 7.45)

Do you agree that where a vehicle is listed as only safe to drive itself with a user-in-charge, it should be a criminal offence for the person able to operate the controls ("the user-in-charge"):

(1) not to hold a driving licence for the vehicle;

(2) to be disqualified from driving;

(3) to have eyesight which fails to comply with the prescribed requirements for driving;

(4) to hold a licence where the application included a declaration regarding a disability which the user knew to be false;
(5) to be unfit to drive through drink or drugs; or
(6) to have alcohol levels over the prescribed limits?

Consultation Question 26 (Paragraphs 7.37 - 7.45)

Where a vehicle is listed as only safe to drive itself with a user-in-charge, should it be a criminal offence to be carried in the vehicle if there is no person able to operate the controls?

Responsibilities for other offences

Consultation Question 27 (Paragraphs 7.48 - 7.65)

Do you agree that legislation should be amended to clarify that users-in-charge:

(1) Are "users" for the purposes of insurance and roadworthiness offences; and
(2) Are responsible for removing vehicles that are stopped in prohibited places, and would commit a criminal offence if they fail to do so?

Consultation Question 28 (Paragraphs 7.59 - 7.61)

We seek views on whether the offences of driving in a prohibited place should be extended to those who set the controls and thus require an automated vehicle to undertake the route.

Obligations that pose challenges for automated driving systems

Consultation Question 29 (Paragraphs 7.71 - 7.88)

Do you agree that legislation should be amended to state that the user-in-charge is responsible for:

(1) duties following an accident;
(2) complying with the directions of a police or traffic officer; and
(3) ensuring that children wear appropriate restraints?

Consultation Question 30 (Paragraphs 7.71 - 7.88)

In the absence of a user-in-charge, we welcome views on how the following duties might be complied with:

(1) duties following an accident;
(2) complying with the directions of a police or traffic officer; and
(3) ensuring that children wear appropriate restraints.

Consultation Question 31 (Paragraphs 7.71 - 7.88)

We seek views on whether there is a need to reform the law in these areas as part of this review.

Aggravated offences

Consultation Question 32 (Paragraphs 7.92 - 7.123)

We seek views on whether there should be a new offence of causing death or serious injury by wrongful interference with vehicles, roads or traffic equipment, contrary to section 22A of the Road Traffic Act 1988, where the chain of causation involves an automated vehicle.

Consultation Question 33 (Paragraphs 7.113 - 7.123)

We seek views on whether the Law Commissions should review the possibility of one or more new corporate offences, where wrongs by a developer of automated driving systems result in death or serious injury.

CHAPTER 8: INTERFERING WITH AUTOMATED VEHICLES

Consultation Question 34 (Paragraphs 8.1 - 8.58)

We seek views on whether the criminal law is adequate to deter interference with automated vehicles. In particular:

(1) Are any new criminal offences required to cover interference with automated vehicles?

(2) Even if behaviours are already criminal, are there any advantages to re-enacting the law, so as to clearly label offences of interfering with automated vehicles?

Tampering with vehicles

Consultation Question 35 (Paragraphs 8.28 - 8.31)

Under section 25 of the Road Traffic Act 1988, it is an offence to tamper with a vehicle's brakes "or other mechanism" without lawful authority or reasonable cause. Is it necessary to clarify that "other mechanism" includes sensors?

Unauthorised vehicle taking

Consultation Question 36 (Paragraphs 8.32 - 8.39)

In England and Wales, section 12 of the Theft Act 1968 covers "joyriding" or taking a conveyance without authority, but does not apply to vehicles which cannot carry a person. This contrasts with the law in Scotland, where the offence of taking and driving away without consent applies to any motor vehicle. Should section 12 of the Theft Act 1968 be extended to any motor vehicle, even those without driving seats?

Causing danger to road users

Consultation Question 37 (Paragraphs 8.6 - 8.12)

In England and Wales, section 22A(1) of the Road Traffic Act 1988 covers a broad range of interference with vehicles or traffic signs in a way which is obviously dangerous. In Scotland, section 100 of the Roads (Scotland) Act 1984 covers depositing anything a road, or inscribing or affixing something on a traffic sign. However, it does not cover interfering with other vehicles or moving traffic signs, even if this would raise safety concerns. Should section 22A of the Road Traffic Act 1988 be extended to Scotland?

CHAPTER 9: "MACHINE FACTORS" – ADAPTING ROAD RULES FOR ARTIFICIAL INTELLIGENCE DECISION-MAKING

Rules and standards

Consultation Question 38 (Paragraphs 9.6 - 9.27)

We seek views on how regulators can best collaborate with developers to create road rules which are sufficiently determinate to be formulated in digital code.

Should automated vehicles ever mount the pavement?

Consultation Question 39 (Paragraphs 9.6 - 9.37)

We seek views on whether a highly automated vehicle should be programmed so as to allow it to mount the pavement if necessary:

(1) to avoid collisions;
(2) to allow emergency vehicles to pass;
(3) to enable traffic flow;
(4) in any other circumstances?

Consultation Question 40 (Paragraphs 9.6 - 9.37)

We seek views on whether it would be acceptable for a highly automated vehicle to be programmed never to mount the pavement.

Should highly automated vehicles ever exceed speed limits?

Consultation Question 41 (Paragraphs 9.40 - 9.47)

We seek views on whether there are any circumstances in which an automated driving system should be permitted to exceed the speed limit within current accepted tolerances.

Edging through pedestrians

Consultation Question 42 (Paragraphs 9.49 - 9.55)

We seek views on whether it would ever be acceptable for a highly automated vehicle to be programmed to "edge through" pedestrians, so that a pedestrian who does not move faces some chance of being injured. If so, what could be done to ensure that this is done only in appropriate circumstances?

Avoiding bias in the behaviour of automated driving systems

Consultation Question 43 (Paragraphs 9.68 - 9.74)

To reduce the risk of bias in the behaviours of automated driving systems, should there be audits of datasets used to train automated driving systems?

Transparency

Consultation Question 44 (Paragraphs 9.76 - 9.88)

We seek views on whether there should be a requirement for developers to publish their ethics policies (including any value allocated to human lives)?

Consultation Question 45 (Paragraphs 9.76 - 9.88)

What other information should be made available?

Future work and next steps

Consultation Question 46 (Paragraphs 9.91 - 9.93)

Is there any other issue within our terms of reference which we should be considering in the course of this review?

Appendix 1: Terms of reference

These are the terms of reference for the Automated Vehicles project, undertaken by the Law Commission of England and Wales and the Scottish Law Commission, as given by the Department of Transport (DfT).

Introduction

1.1 Innovation in technology is opening new ways for the travelling public to plan and undertake their journeys. Automated vehicles do not readily fit within existing legal frameworks. Traditional liability models become strained in the absence of a human driver. Automated vehicles will also play a role as part of the increase in on-demand, technology-led, passenger transport provision which does not readily fit within traditional regulatory boundaries.

1.2 DfT has asked the Law Commission to undertake a far-reaching review to deliver by 2021 a modern and robust package of reforms promoting automated vehicles and their use as part of public transport networks and on-demand passenger services.

1.3 The Law Commission will be working closely with CCAV (the Centre for Connected and Autonomous Vehicles) in developing its policy proposals and CCAV's aims will inform the Law Commission's review. The review will be heavily based on consultation, and reflect an iterative approach to policy-making. The independence of the Law Commission, and its experience in reforming complex areas of law, with the benefit of evidence gathered in consultation with experts and stakeholders, mean it is uniquely well placed to undertake this ambitious project.

Scope

1.4 The Law Commission will undertake a review of the regulatory framework for road-based automated vehicles for England and Wales with a view to enable their safe deployment. The Law Commission will also consider how automated vehicles could fit within existing regulation of public transport frameworks and innovative on-demand passenger transport provision, such as Mobility as a Service (MaaS).[697]

1.5 By automated vehicles, we mean a vehicle that is capable of driving "itself". In other words, it is operating in an automated mode in which it is not being controlled, and does not need to be monitored, by an individual for at least part of the journey (Society of Automotive Engineering "SAE" level 4 and above).[698] The project will specifically consider the position of entirely automated vehicles (SAE level 5, or SAE level 4 operating in a dedicated environment, delivering a 'door-to-door' journey in automated mode, within that dedicated environment).

697 https://www.parliament.uk/business/committees/committees-a-z/commons-select/transport-committee/inquiries/parliament-2017/mobility-as-a-service-17-19/

698 Society of Automotive Engineers, "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles" J3016 JUN2018.

1.6 The review is part of a package of reforms being undertaken to support the deployment of automated vehicles in the United Kingdom. In particular, it builds on the work of CCAV in its Code of Practice for testing and piloting, as well as the insurance reforms contained in the Automated and Electric Vehicles (AEV) Bill 2017-19.

1.7 The review will consider the changes necessary to provide a robust and future-proof legal framework supporting the deployment of automated vehicles. The review will cover civil and criminal liability frameworks as they apply in the context of automated vehicles, including product liability, seller's liability, the law of negligence, criminal sanctions, insurance, road traffic legislation and the Highway Code. We note that CCAV has already begun reform in some of these areas as part of the AEV Bill to facilitate testing and early stage deployment of automated vehicles. The Law Commission's review will build on that work to develop long term reforms needed to support the full-scale deployment of automated vehicles. The review will also consider what regulatory reforms may be necessary to support the use of automated vehicles as part of on-demand, technology-led, passenger transport provision and new models of public transport.

1.8 The Law Commission will consider where there may be gaps or uncertainty in the law, and what reforms may be necessary to ensure the regulatory framework is fit for purpose, including but not limited to, addressing the following issues:

(1) who is the 'driver' or responsible person, as appropriate;

(2) how to allocate civil and criminal responsibility where there is some shared control in a human-machine interface;

(3) the role of automated vehicles within public transport networks and emerging platforms for on-demand passenger transport, car sharing and new business models providing mobility as a service;

(4) whether there is a need for new criminal offences to deal with novel types of conduct and interference; and

(5) what is the impact on other road users and how can they be protected from risk.

1.9 In particular, the Law Commission may consider different models of accountability in the context of artificial intelligence. These will include consideration of the appropriate legal test for the standard of care, the application of rules of causation, the appropriateness of a fault-based model of liability compared with strict liability, and options for regulation including licensing. The Law Commission will also take into account changing business models in passenger transport impacting on ownership, use and ways in which automated vehicles may be used to provide MaaS. The Law Commission will also consider the extent to which its 2014 Taxi and Private Hire Services report and draft bill, which included a framework of national standards, could be adapted to regulate automated vehicles.

1.10 Where ethical considerations are relevant, for example, as part of assessing the safety case for automated vehicles and software programming, the Law Commission will highlight the regulatory choices to be made. The Law Commission will however avoid judging what may or may not be desirable ethical outcomes. It may on the other hand set out possible approaches in order to promote consistency and transparency. Further, the Law Commission will not cover consequential policy issues related to the advent of automation and its impact on future workforce planning for the UK.

1.11 Comparative analysis will be an important aspect of this review, both as regards foreign jurisdictions, and in respect of other modes of transport where automation is already widespread, including maritime and aviation law.

1.12 The Law Commission will have particular regard to the following non-exhaustive list of areas. While these will not be the focus of the review, they will have a significant impact on the delivery of the overall policy, namely:

(1) the International Road Traffic Conventions, and any guidance produced to support these Conventions;

(2) CCAV's Code of Practice for testing and any updates to it;

(3) vehicle roadworthiness and maintenance (including Construction and Use Regulations);

(4) driver licensing legislation; and

(5) enforcement.

1.13 The following areas will be integral to delivering effective policy in this area and will inform the Law Commission's review but are predominantly outside scope:

(1) data protection and privacy;

(2) theft and cyber security; and

(3) land use policy.

1.14 Close working relationships with departments leading on the above areas will be critical to successful delivery.

1.15 Subject to agreement, the review will include consideration of the regulatory frameworks of Scotland and Northern Ireland. The intention, if practicable, is to conduct this as a joint project with the Scottish Law Commission.

Appendix 2: Acknowledgements

2.1 We would like to thank the following organisations, groups and people who have provided their thoughts and materials for us to consider during the writing of this preliminary consultation paper.

PUBLIC SECTOR:

2.2 CCAV, Department for Transport, Department for Business for Business, Energy and Industrial Strategy, International Vehicle Standards, Driver and Vehicle Standards Agency (DVSA), Driver and Vehicle Licensing Agency (DVLA), Disabled Persons Transport Advisory Committee (DPTAC), Department for Infrastructure (Northern Ireland), Scotland Office, Transport Scotland, Welsh Government, Knowledge Transfer Network, Oxford CC, Transport Research Laboratory (TRL), Transport for London, Highways England, Chief Highways Engineers Meeting, Innovate UK, Crown Prosecution Service (CPS), Met Office, National Transport Commission (Australia), National Physical Laboratory, Meridian.

PRIVATE SECTOR:

2.3 Association of British Insurers (ABI), The Automated Driving Insurance Group (ADIG), AXA XL (formerly XL Caitlin), AXA Insurance, AGEAS Insurance, Thatcham Research Centre, Society of Motor Manufacturers & Traders (SMMT), British Vehicle Rental and Leasing Association (BVRLA), TRL-led GATEway project, AECOM-led CAPRI project, Royal Automobile Club (RAC), RAC Foundation, Brake the road safety charity, BikeSafe (police led motorcycle project), Road Haulage Association, Freight Transport Association, Turing Institute, UK Atomic Energy Authority (RACE), The Australian and New Zealand Driverless Initiative (ADVI), Law Society, Cameron McKenna Nabarro Olswang LLP, Pinsent Masons LLP, Burges Salmon LLP, BLM Law, Kennedys Law, Volvo, Tesla, BOSCH, Nvidia, Mobileye, Oxbotica, FiveAI, NuTonomy, DirectLine Insurance Group, Bristows LLP, Daimler AG, Parkopedia, Unite the Union, Licenced Private Hire Car Association, National Federation of the Blind, Visteon.

ACADEMICS AND LAWYERS:

2.4 Particular thanks to Prof. Bryant Walker Smith (University of South Carolina) for reviewing the entire draft publication. We would also wish to thank, Michael Cameron (New Zealand Law Foundation), Lucy McCormick (Barrister, Henderson Chambers), Dr Matthew Channon (Exeter University), Dr Kyriaki Noussia (Exeter University), Alex Glassbrook (Barrister, Temple Garden Chambers), Mathias N. Schubert (Attorney at Law, Germany), Kweku Aggrey-Orleans (Barrister, 12 King’s Bench Walk), Prof Richard Percival (University of Sheffield) Dr Chris Tennant (LSE), Prof Sally Kyd Cunningham (University of Leicester), Dr Mark Leiser (University of Leicester), Prof Neville Stanton (University of Southampton), Prof Gary Burnett (University of Nottingham), Prof Rebecca Williams (Oxford University), Prof Christopher Hodges (Univeristy of Oxford), Dr Michael O’Flynn (University of Glasgow), Prof Paul Newman (University of Oxford), Prof Bryan Reimer (MIT).

CONFERENCES:

2.5 The team has also participated in the following conferences: the Knowledge Transfer Network's Modelling and Simulations for CAVs competition (23 March 2018, London); The Dutch Ministry of Infrastructure and Water Management's Innovation in Transportation, facing the legal challenges ahead (9 February 2018, The Hague), CARTRE and SCOUT's Interactive Symposium on Research & Innovation for Connected and Automated Driving in Europe (19-20 April 2018, Vienna), The Future of Transportation World Conference (19-20 June 2018, Cologne), TaaS Technology Conference (9-10 July 2018, Coventry), Federated Logic Conference 2018 – Summit on Machine Learning meets Formal Methods (13 July 2018, Oxford), SAE International's Connect2Car Executive Leadership Forum (September 5-6 2018, San Jose CA); The Whitehall & Industry Group's Autonomous Vehicles Workshop (14 September 2018, Birmingham); 6th Annual Smart Mobility Summit (29-30 October 2018, Tel Aviv); and CAV Scotland 2018 (31 October-1 November, Edinburgh).

2.6 We are also particularly grateful to the UNECE's Global Forum for Road Traffic Safety (WP.1) for the opportunity to attend its 77th Session (18-21 September 2018, Geneva).

Appendix 3: Human Factors

3.1 "Human factors" is a discipline concerned with understanding the interaction between humans, machines and the environment in which they operate.[699] Human factors researchers tend to focus on how to improve productivity, safety and comfort when humans use machines.[700] The underlying principle is that "machines should be made for men; not men forcibly adapted to machines".[701]

3.2 This appendix supplements our discussion of human factors as they apply at all levels of automation in Chapter 3. This appendix is divided into three parts. First, we discuss concerns about SAE Level 3 systems from a human factors perspective. Secondly, we consider lessons which can be learned from human factors research on aviation. Thirdly, we outline the approach to automated vehicles in Germany and Australia.

CONCERNS ABOUT SAE LEVEL 3 SYSTEMS FROM A HUMAN FACTORS PERSPECTIVE

3.3 There are a number of safety concerns about SAE Level 3 systems.[702] These concerns can apply to other levels of automation (such as SAE Level 2 driver assistance, for example) but are particularly acute for Level 3 systems.[703] The fallback-ready user must be ready to take over the driving when requested to do so, or when there is an evident system failure. The fallback-ready user is not expected to monitor the driving environment. This poses two challenges. On the one hand, we must ensure the driver is sufficiently aware of their surroundings so they can take over the driving at short notice. On the other hand, we must not place too many restrictions on what can be done in a Level 3 system. Otherwise, we will defeat the productivity and efficiency gains of having a Level 3 system.

3.4 Below we examine seven particular concerns with SAE Level 3 systems from a human factors perspective. These concerns relate to:

(1) the handover between the automated driving system and the human;

(2) humans engaging in secondary activities, while the system is driving itself;

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699 For a more detailed definition, see the website of the International Ergonomics Association, https://www.iea.cc/whats/index.html. See also M Kyriakidis, J de Winter, N Stanton and others, "A human factors perspective on automated driving" (2017) 18 *Theoretical Issues in Ergonomics Science,* DOI: 10.1080/1463922X.2017.1293187.

700 D Meister, *The History of Human Factors and Ergonomics* (1st ed 1999) p 19.

701 M Viteles, editorial foreword to P Fitts (ed), *Human Engineering for an Effective Air-Navigation and Traffic-Control System National Research Council* (1951) p iv.

702 T Inagaki and T Sheridan, "A critique of the SAE conditional driving automation definition, and analyses of options for improvement" (2018) *Cognition, Technology & Work* 1 DOI: 10.1007/s10111-018-0471-5.

703 This is because SAE Level 3 systems perform the entirety of the driving task, yet depend on effective and timely human intervention in order to guarantee road safety.

(3) humans lacking trust in automated driving systems;

(4) automation complacency and automation bias;

(5) the impact of automation on human performance;

(6) mode confusion; and

(7) consumers misunderstanding the operational design domain.

3.5 Given the difficulties with SAE Level 3, Ford,[704] Waymo,[705] and Volvo[706] have stated that they intend to skip SAE Level 3, moving straight from Level 2 to Level 4. The Association of British Insurers state they would be reluctant to offer insurance to vehicles with SAE Level 3 systems and "demand that a vehicle should only be classified as an automated vehicle once it is at SAE Level 4".[707] By contrast, Audi, for example, is embracing the incremental approach to automation, taking advantage of legislative changes in Germany which enable the use of vehicles with Level 3 systems on public roads.[708]

Handover of the driving task

3.6 When a vehicle with a SAE Level 3 system can no longer drive itself, it will seek to handover control to the fallback-ready user. The handover needs to be as smooth as possible to optimise safety. If the human is asleep, or otherwise lacks awareness of their surroundings, this can create problems in the handover period.[709] Bespoke training on how and when to recover manual control makes the handover faster and smoother.[710]

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704 https://www.techemergence.com/self-driving-car-timeline-themselves-top-11-automakers/.

705 https://www.reuters.com/article/us-alphabet-autos-self-driving/google-ditched-autopilot-driving-feature-after-test-user-napped-behind-wheel-idUSKBN1D00MD.

706 https://www.m14intelligence.com/car-makers-skipping-sae-level-3-automation/ (last visited 18 September 2018).

707 Association of British Insurers and Thatcham Research, *Regulating Automated Driving: The UK Insurer View* (July 2017) p 8, https://www.abi.org.uk/globalassets/files/publications/public/motor/2017/07/regulating-automated-driving/.

708 https://www.m14intelligence.com/car-makers-skipping-sae-level-3-automation/ (last visited 18 September 2018).

709 M Kyriakidis, J de Winter, N Stanton and others, "A human factors perspective on automated driving" (2017) 18 *Theoretical Issues in Ergonomics Science,* DOI: 10.1080/1463922X.2017.1293187; T Sheridan, "Big Brother as Driver: New Demands and Problems for the Man at the Wheel" (1970) 12(1) *Human Factors* 95; A Eriksson, V Banks and N Stanton, "Transition to Manual: comparing simulator with on-12 road control transitions" (2017) 102C *Accident Analysis & Prevention* 227, DOI: 10.1016/j.aap.2017.03.011; Z Lu, R Happee, C Cabrall, M Kyriakidis and J de Winter, "Human factors of transitions in automated driving: a general framework and literature survey" (2016) 43 *Transport Research Part F* 183, DOI: 10.1016/j.trf.2016.10.007.

710 W Payre, J Cestac, N Dang, F Vienne and P Delhomme, "Impact of training and in-vehicle task performance on manual control recovery in an automated car" (2017) 46 *Transportation Research Part F Traffic Psychology and Behaviour* 216 DOI: 10.1016/j.trf.2017.02.001.

3.7 The time needed for a human to safely regain control of a vehicle depends on several factors, including:

(1) the length of time for which the automated driving system had been driving itself;[711]

(2) whether the human was expecting the handover;[712]

(3) whether the human could decide the timing of the handover;[713]

(4) whether the driver was distracted before the handover;[714] and

(5) the reaction time of the human.

3.8 Tiredness increases a person's reaction time. Research suggests that the effects of tiredness set in faster when a person is not required to actively drive the car.[715] Therefore, tiredness may pose a greater problem in automated vehicles compared to conventional vehicles.

3.9 Visual and audible warnings are more effective at reducing driver handover time compared with visual warnings only.[716] There are divided views on the extent to which sensory warnings, such as vibration, are useful.[717] Some researchers suggest installing

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711 V Dixit, S Chand and D Nair, "Autonomous Vehicles: Disengagements, Accidents and Reaction Times" (2016) 11(12) *Public Library of Science PLOS ONE,* DOI: 10.1371/journal.pone.0168054; K Funkhouser and F Drews, "Reaction Times When Switching From Autonomous to Manual Driving Control: A Pilot Investigation" (2016) 60(1) *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 1854, https://doi.org/10.1177/1541931213601423; C Gold, D Dambock, L Lorenz and K Bengler, "Take over! How long does it take to get the driver back into the loop?" (2013) *Proceedings of the Human Factors and Ergonomics Society 57th Annual Meeting* 1938*,* DOI: 10.1177/1541931213571433*.*

712 N Merat, H Jamson, F Lai, M Daly and O Carsten, "Transition to manual: driver behaviour when resuming control from a highly automated vehicle" (2014) 27 *Transport Research Part F* 274, doi.org/10.1016/j.trf.2014.09.005.

713 A Eriksson and N Stanton, "Driving Performance After Self-Regulated Control Transitions in Highly Automated Vehicles" (2017) 59(8) *Human Factors* 1233, DOI: 10.1177/0018720817728774.

714 K Zeeb, A Buchner and M Schrauf, "Is take-over time all matters? The impact of visual-cognitive load on driver take-over quality after conditionally automated driving" (2016) 92 *Accident Analysis and Prevention* 230, DOI: 10.1016/j.aap.2016.04.002.

715 Gesamtverband der Deutschen Versicherungswirtschaft eV (Association of German Insurers), "Tiredness and level 3 – automated driving" (2017) 70 *Unfallforschung der Vericherer* (German Insurers Accident Research), compact accident research. J Horne and L Reyner, "Vehicle Accidents Related to Sleep: A Review" (1999) 56(5) *Occupational and Environmental Medicine* 289, DOI: 10.1136/oem.56.5.289.

716 F Naujoks, C Mai and A Neukum, "The effect of urgency of take-over requests during highly automated driving under distraction condition" (2014) *Proceedings of the 5th international conference on applied human factors and ergonomics.* J Coughlin, B Reimer and B Mehler, "Monitoring, Managing and Motivating Driver Safety and Well-being" (2001) 10(3) *Automotive Pervasive Computing* 14, DOI: 10.1109/MPRV.2011.54, p 19.

717 A Telpaz, B Rhindress, I Zelman and O Tsimhoni, "Haptic seat for automated driving: preparing the driver to take control effectively" (2015) *Proceedings of the 7th International Conference on Automotive User Interfaces and Interactive Vehicular Applications,* DOI: 10.1145/2799250.2799267. Compare S Petermeijer, S Cieler and J de Winter, "Comparison spatially static and dynamic vibrotactile take-over requests in the driver seat" (2017) 99 *Accident Analysis and Prevention* 218, DOI: 10.1016/j.aap.2016.12.001.

technology in the car which monitors the driver's status (ie asleep or alert).[718] However, such technology has two drawbacks. First, some might be concerned about monitoring devices intruding on their privacy. Secondly, the absence of in-vehicle monitoring may lead consumers to believe that their input and attention is not necessary for the safe operation of the vehicle (when in fact it is).

3.10 There is also concern that the automated driving system might malfunction in a way which a human cannot detect. In such situations, the human would not realise that they need to resume control.[719]

Secondary activities

3.11 There is discussion about the extent to which secondary activities should be permitted in vehicles with SAE Level 3 systems. On the one hand, the human may become engrossed in secondary activities and therefore lack awareness of their surroundings. This could make it more difficult for the human to take back control safely when requested to do so.[720] On the other hand, controlled engagement in secondary activities may improve driver alertness and engagement, and enhance the driver's ability to regain control if required.[721] For example, secondary activities can help to ensure that the human does not drift into sleep.

3.12 In some of the early tests of increasing driving automation, users reported that they felt safer only engaging in standard secondary tasks, such as changing a radio station or putting on sunglasses.[722] However, it is likely that as levels of automation increase, and confidence in automated driving systems increases, appetite for secondary tasks will also increase. Indeed, one of the appeals of automated vehicles is that they will free up time for tasks chosen by the user.

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718 . P Fitts (ed), *Human Engineering for an Effective Air-Navigation and Traffic-Control System National Research Council* (1951) p 6.

719 B Seppelt and T Victor, "Potential Solutions to Human Factors Challenges in Road Vehicle Automation" in G Meyer and S Beiker (eds), *Road Vehicle Automation 3, Lecture Notes in Mobility* (1st ed 2016), DOI 10.1007/978-3-319-40503-2_11, pp 141-2.

720 House of Lords Science and Technology Select Committee, "Connected and Autonomous Vehicles: The future?" (2017) HL 115, para 131.

721 Gesamtverband der Deutschen Versicherungswirtschaft eV (Association of German Insurers), "Tiredness and level 3 – automated driving" (2017) 70 *Unfallforschung der Vericherer* (German Insurers Accident Research), compact accident research. B Seppelt, S Seaman, J Lee, L Angell, B Mehler and B Reimer, "Glass Half-full: Use of On-road Glance Metrics to Differentiate Crashes from Near-crashes in the 100-car Data" (2017) 107 *Accident Analysis and Prevention* 48, DOI: 10.1016/j.aap.2017.07.021.

722 H Abraham, B Reimer and B Mehler, "Advanced Driver Assistance Systems (ADAS): A Consideration of Driver Perceptions on Training, Usage & Implementation" (2017) *Proceedings of the 61st Annual Meeting of the Human Factors and Ergonomics Society* 1954, DOI: 10.1177/1541931213601967, p 1958.

3.13 Different approaches for regulating secondary activities have been suggested. For example:

(1) The UNECE suggests determining the principles which can define permissible secondary activities, which would be the same for all automated vehicles.[723]

(2) The Japanese National Police Agency distinguishes between activities which are considered unacceptable in the first place (such as drinking alcohol), activities which may be deemed to be accepted by the performance of the system (such as eating with both hands, watching television, whether on a built in or carry-in device) and others in between which are more difficult to classify (such as sleeping).[724]

(3) The UN's Global Forum for Road Traffic Safety Working Party 1 ("WP1") suggests that when the driver is not required to perform the driving task, the driver can engage in secondary activities provided that:

(a) Principle 1: these activities do not prevent the driver from responding to demands from the vehicle systems for taking over the driving task; and

(b) Principle 2: these activities are consistent with the prescribed use of the vehicle systems and their defined functions.[725]

(4) The international association for the automotive industry (OICA)[726] has suggested that a driver may be able to use "infotainment" systems via a "vehicle integrated communication display".

Lack of trust in driving automation technologies

3.14 Lack of trust in driving automation technologies, ranging from driver assistance to self-driving, is also problematic.[727] An operator, who does not trust the system, might be

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723 United Nations Economic Commission for Europe, *Discussion paper on possible driver's "other activities" while an automated driving system is engaged* (December 2017) ECE/TRANS/WP.1/2018/2 p 3.

724 Japanese National Police Agency, *Research report on the stepwise realization of automatic driving according to the direction of technology development* [translated title] (2018)

https://www.npa.go.jp/news/release/2018/20180410001jidouuntenkouhou.html (last visited 18 September 2018).

725 United Nations Economic Commission for Europe, *Discussion paper on possible driver's "other activities" while an automated driving system is engaged* (December 2018) ECE/TRANS/WP.1/2018/2; United Nations Economic Commission for Europe, *Report of the Global Forum for Road Traffic Safety on its seventy- fifth session* (2017) ECE/TRANS/WP.1/159, p 5.

726 Organisation International des Constructeurs d'Automobiles, http://www.oica.net/ (last visited 18 September 2018).

727 H Walker, N Stanton and P Salmon, "Trust in vehicle technology" (2016) 70(2) *International Journal of Vehicle Design* 157, DOI: 10.1504/IJVD.2016.074419.

inclined to disregard any information or warning message from that system.[728] Research shows that branding and advertising can be used to promote trust in a vehicle.[729]

3.15 If the safety features in the system are overly sensitive, the system will generate many false alarms.[730] This may not only cause a safety risk, but undermines the operator's trust in the system and may lead the operator to ignore genuine alarms. Conversely, if the safety features are insufficiently sensitive, genuine risks may be overlooked. Manufacturers and software programmers will have to strike the balance. Transparency in the human-machine interface (considered below) can be crucial in this area. If humans understand why the system is behaving in a certain way, then they may tolerate more false alarms in the interests of safety.[731]

Automation complacency and automation bias

3.16 Automation *complacency* occurs when a system generally functions well and the human therefore assumes that it is unnecessary to monitor the system frequently.[732] The longer the system functions without a problem, the more humans tend to rely on the system and this leads the human to check the system less and less frequently. Automation complacency has been a major factor in several aviation accidents since the 1980s,[733] and in 2016, automation complacency contributed to a car accident.[734]

3.17 Automation bias describes the phenomenon where automation influences a decision in an improper way, typically where too much reliance is placed on automation without verification by the operator. This bias is relatively benign – it can be beneficial when the system makes correct recommendations. However, where the system aiding human decision-making is wrong, this leads to additional errors of commission and omission

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728 R Parasuraman and V Riley, "Humans and Automation: Use, Misuse, Disuse, Abuse" (1997) 39(2) *Human Factors* 230, DOI: 10.1518/001872097778543886.

729 H Abraham, B Seppelt, B Reimer and B Mehler, "What's in a Name: Vehicle Technology Branding & Consumer Expectations for Automation" (2017) *Proceedings of the 9th International Conference on Automotive User Interfaces and Interactive Vehicle Applications* 226, DOI: 10.1145/3122986.3123018, p 231.

730 For example, if the Automated Emergency Braking system is triggered by a large metal object that is not a collision threat, causing the vehicle to stop unnecessarily.

731 C Merenda, H Kim, J Gabbard, G Burnett, G and D Large "Did You See Me? Assessing Perceptual vs Real Driving Gains Across Multi-Modal Pedestrian Alert Systems" (2017) *Proceedings of the 9th International Conference on Automotive User Interfaces and Interactive Vehicular Applications* 40 DOI: 10.1145/3122986.3123013.

732 C Billings, J Lauber, H Funkhouser, G Lyman and E Huff, *NASA Aviation Safety Reporting System* (1976) Technical Memorandum, TM-X-3445, Quarterly Report Number 76-1; R Parasuraman and D Manzey, "Complacency and Bias in Human Use of Automation: An Attentional Integration" (2010) 53(3) *Human Factors* 381, DOI: 10.1177/0018720810376055; R Parasuraman and C Wickens, "Humans: Still Vital After All These Years" (2008) 50(3) *Human Factors* 511, DOI: 10.1518/001872008X312198, p 515.

733 R Parasuraman and D Manzey, "Complacency and Bias in Human Use of Automation: An Attentional Integration" (2010) 53(3) *Human Factors* 381, DOI: 10.1177/0018720810376055.

734 National Transportation Safety Board, *Collision Between a Car Operating with Automated Vehicle Control Systems and a Tractor-Semitrailer Truck Near Williston, Florida* (May 2016), Accident Report NYST/HAR-17/02 PB2017-102600.

by human operators.[735] This has been seen in the aviation space, but also in the diagnostic and even military arenas. Both individuals with significant experience, and new users of automated technology, are susceptible to automation bias.[736]

3.18 Bias and complacency are both induced by "over-trust" in the proper functioning of a system.[737]

The impact of automation on human performance

3.19 Research shows that automation reduces human ability to perform the same tasks.[738] The greater the level of automation and the greater the human dependence on automation, the greater the problems when the system fails and the human is required to resume manual control.[739]

3.20 The impact of automation on human ability has been studied extensively in the context of aviation. Pilots' manual performance is determined by their recent flying experience, not their general flying experience and training.[740] Further, pilots who habitually allow their thoughts to drift away from the flying task are more likely to have deteriorated cognitive skills.[741] There is concern that, as automation in cars increases, the same patterns will occur amongst car users. Research on cars shows that if humans are only required to intervene intermittently, they are more likely to lose concentration.[742]

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735 This is due to the operator's loss of situational awareness and could lead to an accident, see R Parasuraman and D Manzey, "Complacency and Bias in Human Use of Automation: An Attentional Integration" (2010) 53(3) Human Factors 381, DOI: 10.1177/0018720810376055.

736 R Parasuraman and V Riley, "Humans and Automation: Use, Misuse, Disuse, Abuse" (1997) 39(2) Human Factors 230, DOI: 10.1518/001872097778543886.

737 R Parasuraman and D Manzey, "Complacency and Bias in Human Use of Automation: An Attentional Integration" (2010) 53(3) Human Factors 381, DOI: 10.1177/0018720810376055.

738 K Volz, E Yang, R Dudley, E Lynch, M Dropps and M Dorneich, "An Evaluation of Skill Degradation in Information Automation" (2016) 60(1) *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 191, DOI: 10.1177/1541931213601043; B Seppelt and T Victor, "Potential Solutions to Human Factors Challenges in Road Vehicle Automation" in G Meyer and S Beiker (eds), *Road Vehicle Automation 3, Lecture Notes in Mobility* (1st ed 2016) p 135, DOI 10.1007/978-3-319-40503.

739 L Onnasch, C Wickens, L Huiyang and D Manzey, "Human Performance Consequences of Stages and Levels of Automation: An Integrated Meta-Analysis" (2014) 56(3) *Human Factors* 476, DOI: 10.1177/0018720813501549, p 477: "as applied to trees in the forest, 'the higher they are, the farther they fall'." A Sebok and C Wickens, "Implementing Lumberjacks and Black Swans into Model-Based Tools to Support Human–Automation Interaction" (2017) 59(2) *Human Factors* 189 DOI: 10.1177/0018720816665201. See also, the Yerkes-Dodson law. This law states that as mental stimulation increases, task performance also increases, up to a point after which performance decreases again. R Yerkes and J Dodson, "The Relation of Strength of Stimulus to Rapidity of Habit-Formation" (1908) 18 *Journal of Comparative Neurology and Psychology* 459.

740 M Ebbatson, D Harris, J Huddlestone and R Sears, "The relationship between manual handling performance and recent flying experience in air transport pilots" (2010) 53(2) *Ergonomics* 268 DOI:10.1080/00140130903342349.

741 S Casner, "Thoughts in Flight: Automation Use and Pilots' Task-Related and Task-Unrelated Thought" (2014) 56(3) *Human Factors* 433 DOI: 10.1177/0018720813501550.

742 B Seppelt and T Victor, "Potential Solutions to Human Factors Challenges in Road Vehicle Automation" in G Meyer and S Beiker (eds), Road Vehicle Automation 3, Lecture Notes in Mobility (1st ed 2016) p 135, DOI: 10.1007/978-3-319-40503. See further the US National Safety Council, *Understanding the distracted brain –*

3.21 At present, drivers tend to over-estimate how good they are at driving.[743] There is a risk that, as automation increases, drivers will continue to believe that they are highly capable at driving, when in fact their driving skills have faded.

Mode confusion

3.22 Mode awareness describes the human operator's understanding of the way in which the system in their vehicle is working, for example, whether it is in automated, or manual mode, and which level of automation the system is operating at. Where the user is not driving, they may lose awareness about how the system is operating.[744] With a lack of mode awareness, a system can behave in ways not anticipated by the user.

3.23 There are evident risks associated with a lack of mode awareness of an automated vehicle. A mistaken belief that an automated driving system is controlling a vehicle could have dangerous consequences for occupants. The time it takes to detect and correct mode confusion could be the difference between a serious traffic accident and a last-minute evasive manoeuvre.

3.24 Mode confusion has caused several aviation accidents.[745] A lack of mode awareness has also been observed in studies in which test subjects drive conditionally automated vehicles.[746] In a recent study, mode confusion was frequently observed, typically with test subjects believing that automation was engaged when it was not.[747]

3.25 Mode awareness can be improved by having a carefully designed human-machine interface.[748] The human machine interface (HMI) describes how users and machines understand each other. The dashboard on a car and infotainment systems are examples of human machine interfaces. A well-designed HMI would facilitate a safe handover and alert the human when there is a need for human intervention. It would

why driving while using hands-free cell phones is risky behaviour (April 2012) https://www.nsc.org/Portals/0/Documents/DistractedDrivingDocuments/Cognitive-Distraction-White-Paper.pdf. This study found that drivers using hands-free mobile phones tended to look at, but not 'see', up to 50% of the information in their driving environment.

743 A Sundström, "Self-assessment of driving skill – A review from a measurement perspective" (2008) 11(1) *Transportation Research Part F: Traffic Psychology and Behaviour* 1. Research shows that most drivers perceive themselves to be "above average" in terms of skill, which is logically impossible.

744 B Seppelt and T Victor, "Potential Solutions to Human Factors Challenges in Road Vehicle Automation" in G Meyer and S Beiker (eds), Road Vehicle Automation 3, Lecture Notes in Mobility (1st ed 2016) p 142.

745 For further reading on mode awareness in aviation see: P Salmon, G Walker and N Stanton, "Pilot error versus sociotechnical systems failure: a distributed situation awareness analysis of Air France 447" (2016) 17(1) *Theoretical Issues in Ergonomics Science* 64, DOI: 10.1080/1463922X.2015.1106618.

746 SAE Level 3.

747 V Banks, A Eriksson, J O'Donoghue and N Stanton, "Is partially automated driving a bad idea? Observations from an on-road study" (2018) 68 *Applied Ergonomics* 138, DOI: 10.1016/j.apergo.2017.11.010, p 141.

748 V Banks, A Eriksson, J O'Donoghue and N Stanton, "Is partially automated driving a bad idea? Observations from an on-road study" (2018) 68 *Applied Ergonomics* 138, DOI: 10.1016/j.apergo.2017.11.010; N Stanton, A Dunoyer and A Leatherland, "Detection of new in-path targets by drivers using Stop & Go Adaptive Cruise Control" (2011) 42(4) *Applied Ergonomics* 592, DOI: 10.1016/j.apergo.2010.08.016.

also make the human aware about the mode in which the vehicle is operating. This means the human knows what they can expect from the automated system.[749]

Consumers misunderstanding the operational design domain

3.26 It is important to explain the operational design domain in a way that consumers can easily understand.[750] Some evidence suggests consumers are confused about operational design domains – including drivers engaging an automated driving system in conditions outside the operational design domain. For example, suppose a system is only designed for motorways. If the human user is unaware of this, they may activate the system on normal roads.

3.27 There is a risk that marketing will lead consumers to believe that a car is capable of doing more than it actually can.[751] The US National Highway Traffic Safety Administration has expressed concerns that drivers operating these vehicles should have a good understanding of the capabilities and limitations of the systems which are put in an owners' manual.[752]

3.28 It may be necessary to provide training to consumers about how to use automated vehicles.[753] Research shows that the most effective method of training people to use automated vehicles is test drives with an instructor.[754] At present, this is not typically offered by manufacturers and retailers. There are some exceptions. For example, Tesla offers a supervised test drive, as a matter of course, at the point of sale.[755]

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749 A Eriksson, S Petermeijer, M Zimmerman, J De Winter, K Bengler and N Stanton, "Rolling out the red (and green) carpet: supporting driver decision making in automation to manual transitions" (2017) *IEEE Transactions on Human-Machine Systems*. It was found that a well-designed Human-Machine Interface promoted correct braking and lane change manoeuvres. See also J Coughlin, B Reimer and B Mehler, "Monitoring, Managing and Motivating Driver Safety and Well-being" (2001) 10(3) *Automotive Pervasive Computing* 14, DOI: 10.1109/MPRV.2011.54, p 16.

750 B Seppelt, B Reimer, L Angell and S Seaman, "Considering the Human Across Levels of Automation: Implications for Reliance" (2017) *Proceedings of the Ninth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design* 228, DOI: 10.17077/drivingassessment.1640, p 234.

751 H Abraham, B Seppelt, B Reimer and B Mehler, "What's in a Name: Vehicle Technology Branding & Consumer Expectations for Automation" (2017) Proceedings of the 9th International Conference on Automotive User Interfaces and Interactive Vehicle Applications 226, DOI: 10.1145/3122986.3123018.

752 US Department of Transportation, NHTSA, Investigation PE16-007 on Automatic Vehicle Control Systems (19 January 2017), see https://static.nhtsa.gov/odi/inv/2016/INCLA-PE16007-7876.PDF.

753 R Parasuraman and D Manzey, "Complacency and Bias in Human Use of Automation: An Attentional Integration" (2010) 53(3) *Human Factors* 381, DOI: 10.1177/0018720810376055. M Young and N Stanton, "What's skill got to do with it? Vehicle automation and driver mental workload" (2007) 50(8) *Ergonomics* 1324 DOI: 10.1080/00140130701318855.

754 H Abraham, B Reimer and B Mehler, "Advanced Driver Assistance Systems (ADAS): A Consideration of Driver Perceptions on Training, Usage & Implementation" (2017) Proceedings of the 61st Annual Meeting of the Human Factors and Ergonomics Society 1954, DOI: 10.1177/1541931213601967.

755 https://www.tesla.com/en_GB/drive.

LESSONS LEARNED FROM AVIATION

3.29 Two lessons can be learned from the experience of automation in aviation.[756] First, as levels of automation increase, there is a need to educate operators so they understand their new role.[757] Secondly, when a task is automated, humans become worse at performing that task due to lack of practice.

3.30 While there are several parallels between automated aviation and automated vehicles, there are also some significant practical differences between the fields. For example, whereas most pilots are professionals, most car drivers are not. This potentially increases the difficulty for users of automated vehicles who may not have adequate relevant knowledge or skills for using automation.[758] A further example is the different types of manoeuvres required by aeroplanes and cars. Cars need to perform evasive manoeuvres more frequently, and under greater time pressure, than aeroplanes do.[759] This means that, for cars, there is less room for error.

3.31 In aviation, one of the models for promoting safety is the "systems approach". The systems approach involves looking at the human as part of an overall system, including the vehicle and the surrounding environment.[760] This approach can be applied to automated vehicles. To guarantee the safety of an automated vehicle, it is not enough to consider the safety of each part separately. Rather, it is necessary to consider the safety of the system as a whole.[761]

3.32 The issue of distracted driving is a good example of how the systems approach can be applied to automated vehicles. Increased use of driver assistance technology means

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756 There is extensive human factors research on automation in aviation. See for example the Federal Aviation Authority, Performance-based operations Aviation Rulemaking Committee Steering Group and Commercial Aviation Safety Team joint report, *Operational Use of Path Flight Management Systems* (2013) p 118: "appropriate human factors expertise is integrated into the flight deck design process in partnership with other disciplines, with the goal of contributing to a human-centred design... Early in the design process, designers should document their assumptions on how the equipment should be used in operation."

757 N Sarter, D Woods, and C Billings, "Automation surprises" in G Salvendy (ed), *Handbook of Human Factors and Ergonomics* (2nd 1997) p 1926.

758 T Inagaki and T Sheridan, "A critique of the SAE conditional driving automation definition, and analyses of options for improvement" (2018) *Cognition, Technology & Work* 1 DOI: 10.1007/s10111-018-0471-5, p 8.

759 See for examples, A Llamazares, V Iran, E Molinos, M Ocana and S Vijayakumar, "Dynamic Obstacle Avoidance Using Bayesian Occupancy Filter and Approximate Inference" (2013) 13(3) *Sensors* 2929, DOI: 10.3390/s130302929. Stakeholders have told us that the primary "instructions" to automated vehicles are to not hit anything, and not to leave the road. By contrast, when aeroplanes enter a defined region around another aircraft, this is known as a "separation incident" and is subject to an investigation.

760 J Rasmussen, "Risk Management in a Dynamic Society: A Modelling Problem" (1997) 27(2) *Safety Science* 183, DOI: 10.1016/S0925-7535(97)00052-0, p 184.

761 M Viteles, editorial foreword to P Fitts (ed*), Human Engineering for an Effective Air-Navigation and Traffic-Control System National Research Council* (1951) p v; J Rasmussen, "Risk Management in a Dynamic Society: A Modelling Problem" (1997) 27(2) Safety Science 183, DOI: 10.1016/S0925-7535(97)00052-0, pp 184 and 206; W Haddon and A Kelley, "Reducing Highway Losses: A Logical Framework for Categorizing Highway Safety Phenomena and Activity" (1971) *American Bar Association, Section of Insurance, Negligence and Compensation Law Proceedings*. 54, p 59; B Reimer, L Angell, D Strayer, L Tijerina and B Mehler, "Evaluating Demands Associated with the Use of Voice-Based In-Vehicle Interfaces" (2016) *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 2083, DOI: 10.1177/1541931213601472.

there is a greater risk that drivers lose concentration and become distracted.[762] A systems approach can help to identify the causes of distraction when driving, such as road signs, mobile phone design or an accident on the other side of the road.[763] Rather than pinning the blame on the driver, the focus is on how all the potential sources of distraction can be managed.[764]

AN INTERNATIONAL PERSPECTIVE

Germany

3.33 In June 2017 the German parliament approved amendments to the German Road Traffic Act (Strassenverkehrsgesetz, "StVG"), which allows for the use of highly and fully automated vehicles.[765]

3.34 § 1a of the StVG defines what motor vehicles have driving functions which qualify as "highly" or "fully automated". Amongst the requirements are that the vehicles are equipped with technology that:

(5) after activation, can control the dynamic driving task. Driving functions are characterised by the fact that, in order to cope with the driving task (including longitudinal and transverse guidance), they can perform the driving task after activation by the driver;

(6) during "highly" or "fully automated" driving, can comply with traffic regulations which are applicable to the driving task;

(7) can be overridden or deactivated by the driver at any time;

(8) can identify when there is a need to hand back control to the driver;

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762 H Abraham, B Reimer and B Mehler, "Advanced Driver Assistance Systems (ADAS): A Consideration of Driver Perceptions on Training, Usage & Implementation" (2017) *Proceedings of the 61st Annual Meeting of the Human Factors and Ergonomics Society 1954*, DOI: 10.1177/1541931213601967, p 1956; K Parnell, N Stanton and K Plant, "Exploring the mechanisms of distraction from in-vehicle technology: The development of the PARRC model" (2016) 87 *Safety Science* 25, DOI: 10.1016/j.ssci.2016.03.014; M Regan, J Lee and K Young, "Defining driver distraction" (2009) in M Regan, J Lee and K Young (eds), *Driver Distraction: Theory, Effects and Mitigation* (1st ed 2008) p 31.

763 K Parnell, N Stanton and K Plant, "Creating the environment for driver distraction: a thematic analysis of sociotechnical factors" (2018) 68 *Applied Ergonomics* 213, DOI: 10.1016/j.apergo.2017.11.014, p 214; K Young and P Salmon, "Sharing the responsibility for driver distraction across road transport systems: A systems approach to the management of distracted driving" (2015) 74 *Accident Analysis and Prevention* 350, DOI: 10.1016/j.aap.2014.03.017, p 351.

764 K Parnell, N Stanton and K Plant, "Creating the environment for driver distraction: a thematic analysis of sociotechnical factors" (2018) 68 Applied Ergonomics 213, DOI: 10.1016/j.apergo.2017.11.014, p 219; K Young and P Salmon, "Sharing the responsibility for driver distraction across road transport systems: A systems approach to the management of distracted driving" (2015) 74 Accident Analysis and Prevention 350, DOI: 10.1016/j.aap.2014.03.017, p 358.

765 As reported in the Federal Law Gazette of 20 June 2017, Part I No. 38, p. 1648. We also discuss the German approach in Chapter 3 above, at para 3.91.

(9) is able to, and appropriately (visually, acoustically, tactilely or otherwise perceptibly), warn the driver about the requirement for manual vehicle control, and provide a sufficient time buffer before it hands over control; and

(10) is able to notify of use that is contrary to the system description.

3.35 Vehicles with SAE Level 3 systems would be permitted in Germany if they fulfil these requirements.

3.36 The legislation places an obligation on the manufacturer to ensure that the vehicle's operational design domain is defined and clear to the driver.[766] However, responsibility for setting the boundaries of use of the system is in the manufacturer's hands.

3.37 § 1b of the StVG describes the responsibilities of the driver of an automated vehicle.[767] They are permitted to divert their attention from traffic whilst using the automated system in the intended manner,[768] as defined by the manufacturer. However, the operator/driver must always remain "wahrnehmungsbereit" or ready to perceive. This means that they must be able to take over the driving task when prompted by the system in a timely manner,[769] or when the operator realises because of "obvious circumstances" that the conditions for the use of the system are no longer met.

3.38 This prompts the question: what will qualify as an "obvious circumstance"? When the amendments were being considered in the German Bundesrat,[770] it was suggested it would include an important road sign or inclement weather, such as snow. It is not clear whether the actions of the vehicle might also be "obvious", such as where the vehicle begins to veer between lanes or cross white lines. Presumably this might be determined on a case-by-case basis, taking into account the particulars of the situation. One such factor, for example, might be whether the driver complied with the requirements and conditions of use as set out in the manufacturer's "system description".

3.39 The StVG does not appear to alter the liability of the driver, vehicle keeper, nor the manufacturers of vehicles. The StVG § 7, which describes the liability of the vehicle keeper, remains unaltered by the amendments. In the event of an accident the vehicle keeper (or in practice, the vehicle keeper's insurer[771]) remains liable for death, injury and property damage caused by the vehicle and no direct liability is placed upon the manufacturer. However, the StVG has always provided for the situation where the driver, if proven not to have fulfilled their duties, is liable for the resultant damage alongside the registered keeper. The manufacturer can also be held liable for damage, which occurred as a result of a proven defect (eg something not complying with the

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766 Strassenverkehrsgesetz (StVG), § 1a (2) 2.

767 StVG, § 1b.

768 StVG, § 1b (1).

769 StVG, § 1b (2) 1.

770 The Bundesrat is the upper house of the German parliament. Their response and concerns regarding the introduction of the amendments are available at: http://dipbt.bundestag.de/doc/btd/18/117/1811776.pdf.

771 Motor vehicle insurance is compulsory for vehicle owners who live in Germany, see the "Pflichtversicherungsgesetz" (PflVG) – Law on compulsory insurance for motor vehicle owners.

system description required by § 1a) within European and German product liability regimes.

3.40 § 12 of the StVG has however been specifically amended, such that there are special provisions for damage caused by automated vehicles. For ordinary vehicles, liability for injury and death is usually limited at 5 million euros. For automated vehicles, this figure is 10 million euros. Similarly, for property damage caused by an ordinary vehicle, liability is limited at 1 million euros. For automated vehicles, this figure is 2 million euros.

3.41 The provisions on automated vehicles in the StVG will be reviewed in late 2019.[772]

Australia

3.42 The National Transport Council (NTC) in Australia published its policy paper for standardised national automated vehicle laws in May 2018. On the 18 May 2018, transport ministers from the states and territories of Australia approved the recommendations and agreed to implement them in a uniform way.

3.43 The NTC recommendations permit conditional, highly and fully automated vehicles to be used on Australian roads, provided they comply with the NTC safety assurance system. There are two stages in the NTC safety assurance system. First, the manufacturers self-certify that the vehicle can manage safety and comply with road traffic laws.[773] Then, manufacturers must submit their automated system to a centralised body for approval. Vehicles with SAE Level 3 systems would be permissible on Australian roads provided they comply with the NTC safety assurance system.[774]

3.44 The NTC recommend that when the automated driving system (ADS) is engaged at conditional, high and full automation, it should be considered "in control".[775] If a human engages the ADS to perform the driving task it was designed to undertake, they would not expect to be held responsible for contraventions of road traffic laws while the ADS was engaged.[776] However, the NTC are clear that the automated driving systems should not be regarded as legal entities. Rather, when the automated driving system is engaged and being used in the manner for which it was designed and certified, the automated driving system entity is responsible for compliance with dynamic driving task obligations.[777]

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772 StVG, § 1c.

773 National Transport Commission of Australia, *Changing driving laws to support automated vehicles - Policy paper* (May 2018) s 3.3.

774 In November 2017 the Transport and Infrastructure Council of the National Transport Commission of Australia agreed that a national safety assurance system for automated vehicles would be based on mandatory self-certification. https://www.ntc.gov.au/roads/technology/automated-vehicles-in-australia/.

775 National Transport Commission of Australia, Changing driving laws to support automated vehicles - Policy paper (May 2018) s 4.2.3.

776 National Transport Commission of Australia, Changing driving laws to support automated vehicles - Policy paper (May 2018) s 4.2.3.

777 National Transport Commission of Australia, Changing driving laws to support automated vehicles - Policy paper (May 2018) s 4.2.3.

3.45 The fallback-ready user must be ready to drive when the system requests them to.[778] Secondary activities, other than those permitted in conventional cars, are only allowed if the in-vehicle system can override them. The NTC concluded that further consideration would need to be given as to whether these same obligations should be placed upon people who could potentially take over the driving task. They noted that this may be difficult to enforce if there are multiple passengers.

[778] National Transport Commission of Australia, Changing driving laws to support automated vehicles - Policy paper (May 2018) s 6.2.2.