PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA

Social issues relating to land-based automated vehicles in Australia

House of Representatives Standing Committee on Industry, Innovation, Science and Resources

August 2017
CANBERRA

ISBN 978-1-74366-677-7 (Printed Version)

ISBN 978-1-74366-678-4 (HTML Version)

List of Recommendations

Recommendation 1

1.30 The Committee recommends that the Commonwealth adopt as standard terminology the use of 'automated vehicles' and formally accept that the standard definition for the automation level of vehicles is that used by the Society of Automotive Engineers' (SAE) International Standard J3016. The Committee recommends that the use of 'driverless car/vehicle' and 'autonomous vehicle' be discontinued.

Recommendation 2

2.51 The Committee recommends that, noting the range of benefits automated vehicles are likely to bring and the need for public acceptance of the technology, the Commonwealth Government facilitate and encourage trials of automated vehicles in Australia, with a particular focus on trials that enable members of the public to experience automated vehicles on public roads.

Recommendation 3

2.52 The Committee recommends that the National Cyber Security Strategy specifically investigate automated vehicles (and associated transport systems) to address potential vulnerabilities relating to automation.

Recommendation 4

3.53 The Committee recommends that the Commonwealth Government further investigates the issue of data rights for consumers, vehicle manufacturers and third parties such as insurers and relevant government agencies.

Recommendation 5

5.25 The Committee recommends that the Commonwealth Government establish a working party with industry and academic stakeholders to identify industry needs regarding the development of automated vehicles and support services, and implement a strategy to ensure that Australia is best placed to exploit emerging opportunities.

Recommendation 6

6.30 The Committee recommends that the Commonwealth Government's preparation for autonomous vehicles includes consideration of how the needs of people with disability, older Australians and those in regional and rural areas can be met via automated vehicles.

Recommendation 7

7.26 The Committee recommends that the Commonwealth Government, in association with state and territory governments and local councils, consider funding of trials of automated vehicles with a public transport application, in both metropolitan areas and regional locations.

Recommendation 8

8.28 The Committee recommends that the Commonwealth Government, in consultation with state and territory governments, continues to coordinate their approach to automated vehicles, ensuring consistent regulations and policy settings.

Recommendation 9

8.32 The Committee recommends that the Commonwealth Government coordinates efforts to standardise road infrastructure in Australia, particularly as it relates to signs and road markings, and that the Commonwealth Government considers ways to ensure that the benefits of automated vehicles are available across Australia, including in regional Australia.

Recommendation 10

8.34 The Committee recommends that the Commonwealth Government consider the merits of establishing either a dedicated national body or a cross-agency taskforce, in conjunction with state and territory jurisdictions and working

with vehicle and software manufacturers, to coordinate Australia's preparation for the introduction of land-based automated vehicles. This body would have regard to topics including, but not limited to:

- Methods of public engagement to ensure that concerns about automated vehicles are addressed and benefits are explained
- The employment ramifications, both direct and indirect, of automated vehicles
- How to best ensure that people with disability and older Australians are able to benefit from automated vehicle technology
- How to best ensure that people in regional and rural Australia can access the benefits of automated vehicles
- The infrastructure needs, both physical and digital, of automated vehicles and the role of governments in ensuring that those standards are met, particularly in regional and rural areas of Australia
- The ownership, use and security frameworks applicable to the data generated by automated vehicles
- Legal liability and insurance implications of automated vehicles.

Terms of Reference

The Committee will inquire into the social issues relating to land-based driverless vehicles in Australia.

The inquiry will consider different types of transport (such as cars, trucks, buses and trains)-as well as different driverless options (such as directly controlled, remotely controlled and fully autonomous vehicles).

In particular, the Committee will inquire into and report on:

1 What social issues are relevant-such as:
   - general social acceptance levels
   - passenger and non-passenger safety
   - legal responsibility and insurance
   - potential impacts on employment and different industry sectors (such as the taxi industry)
   - access and equity issues (such as increasing individual mobility for the elderly and people with disabilities)
   - potential public transport applications
2 How each social issue is being handled- including the opportunities and challenges for each issue
3 Recommendations to progress action on the social issues identified

When undertaking this Inquiry the Committee should have regard to:

- non-social aspects relating to driverless vehicles - such as regulatory status, infrastructure, technological readiness, data management and cyber security issues
- the experience of other jurisdictions and nations
- how Australia might best position itself to contribute to global driverless vehicle initiatives
- the respective roles of the Australian government, the Australian Parliament, other jurisdictions and other stakeholders
- how issues identified from this inquiry might inform work on other emerging technologies.

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1. Introduction

Conduct of the inquiry

1.1 The Industry, Innovation, Science and Resources Standing Committee launched its inquiry into the social issues relating to land-based driverless vehicles on 1 December 2016. The Terms of Reference are available on page vii of this report.

1.2 The Committee's focus throughout the inquiry was on the social aspects of driverless vehicles in Australia. While technological developments and questions and regulatory approaches were considered within that context, the Committee's priority was to establish whether the social changes likely to be brought about by the introduction of highly automated vehicles in Australia are being adequately considered.

1.3 The Committee received 47 written submissions and held ten public hearings and four inspections between March and June 2017, in Canberra, Perth, Melbourne, Brisbane and Sydney. In total, the Committee heard from more than 30 witnesses. A list of submissions received is at Appendix A. The names of witnesses and a list of hearings are at Appendix B.

1.4 This report, transcripts of public hearings and submissions are available on the Committee's website: www.aph.gov.au/iisr.

Definitions and key terms

1.5 The Committee heard that there is considerable debate regarding the preferred terminology for driverless cars. While 'driverless vehicles' is the phrase most-readily understood and recognised, several witnesses and submitters argued that it is misleading and potentially off-putting to members of the public.

1.6 The National Transport Commission explained the rationale for using the term 'automated':

> We have used the term 'automated' rather than 'driverless' or 'autonomous' to recognise that it is a spectrum of automation and that there are different policy issues as we move along that spectrum. We are already on that journey today with today's cars.[1]

1.7 The Department of Infrastructure and Regional Development (DIRD) uses the term 'automated vehicle', meaning 'a vehicle that does not require a human driver for at least part of the driving task' and notes that this term captures a broader range of vehicles than the more specific descriptor 'driverless'.[2]

1.8 In contrast, the Australian Driverless Vehicle Initiative (ADVI), a peak advisory body comprised of a range of organisations across government, academia and industry, noted that:

> We use the term 'driverless' because we had a focus group and a number of discussions with our key people about what language the community would understand and relate to and, whilst our technological experts like 'automated', 'driverless' is the language that we use. We refer to everything as 'driverless' across the spectrum.[3]

1.9 This report uses the terms 'driverless', 'automated'' and 'autonomous' interchangeably, generally seeking to maintain consistency with the evidence being referred to.

Levels of automation

1.10 The standard definition for the automation level of vehicles is the one used in the Society of Automotive Engineers' (SAE) International Standard J3016. This definition has been adopted by authorities in Australia, Europe and the United States of America[4] and was consistently used by submitters and witnesses to this inquiry.

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[1] Mr Marcus Burke, Project Director, Compliance and Technology, National Transport Commission, *Committee Hansard*, 11 April 2017, p. 9.

[2] Department of Infrastructure and Regional Development, *Submission 26*, p. 7.

[3] Mrs Rita Excell, Executive Director, Australian Driverless Vehicle Initiative, *Committee Hansard*, 11 April 2017, p. 51.

[4] Department of Infrastructure and Regional Development, *Submission 26*, p. 7.

1.11 Under the SAE standard, there are five levels of automation. All vehicles will fall into one of these categories:

Table 1.1 SAE Standard Levels of Automation

SAE Level	Automation level	Description
0	None	Human driver responsible for all aspects of the driving task.
1	Driver assistance	In some circumstances the system is capable of either steering *or* acceleration/deceleration (including braking), with the expectation that the human driver performs all remaining aspects of the driving task.
2	Partial	In some circumstances the system is capable of *both* steering and acceleration/deceleration. The human driver must monitor the driving environment and respond as needed.
3	Conditional	Level 2, but when the system is operating in automated mode the human driver is not required to monitor the driving environment. The human driver must respond to requests from the driving system to intervene.
4	Highly	Level 3, but no human monitoring or intervention is required when the system is operating in automated mode.
5	Fully	Automated system in control all of the time, and in all road environments.

Source: Department of Infrastructure and Regional Development, Submission 26, p. 7.

1.12 As discussed above, the term 'driverless vehicles' therefore only strictly applies to vehicles meeting the characteristics of Levels 4 and 5 of the SAE Standard. Vehicles meeting the characteristics of Levels 1 and 2 are already commercially available in Australia and used on public roads; vehicles at higher levels are used only in controlled environments, including mining

sites or specific trials including the RAC Intellibus in Perth, which the Committee inspected, and the Darwin Waterfront bus.[5]

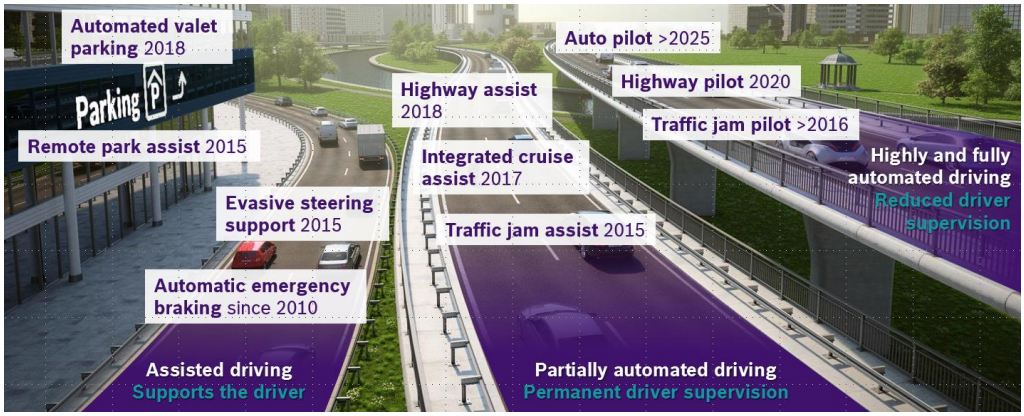
1.13 Submitters and witnesses to this inquiry expressed a range of views regarding when vehicles with high levels of automation can be expected to be commercially available for use on public roads.

1.14 Manufacturer Volvo, for instance, noted that public perceptions of driverless vehicles are probably based on inaccurate understandings of the current state of technology:

> Public confusion is exacerbated by regular media reporting which describes a utopian world in which drivers are transported from home to office in fully driverless, 'handsfree' vehicles. Based on future technology advances this scenario is certainly achievable in Australia, but realistically it is probably some decades away.[6]

1.15 Vehicle technology supplier Robert Bosch (Australia) provided the below image to illustrate the likely timeframe of technological development, showing increasing levels of assisted driving over the next few years and highly automated driving after 2020[7]:

Figure 1.1 Robert Bosch Technology Roadmap



[5] Department of Infrastructure and Regional Development, *Submission 26*, pp 8 – 9.

[6] Volvo Car Australia, *Submission 11*, p. [2].

[7] Robert Bosch Australia, *Submission 12*, p. 2.

1.16 The NTC noted its timeframe for regulatory reform – as endorsed by the Transport and Infrastructure Council[8] in November 2016 – is based on the following assumptions developed after consultation with industry:

- demand to trial different levels of driving automation on public roads is already occurring and is expected to increase significantly in the next two to three years.
- large-scale commercial deployment of increasingly automated vehicles that still require a human driver is expected by 2020.
- large-scale commercial deployment of automated vehicles that do not require a human driver (for some, or the entire journey) is expected after 2020.[9]

Models of car ownership

1.17 A point made by many of the witnesses and submitters to the Inquiry was that the introduction of driverless passenger vehicles can, and likely will, lead to a shift in the model of car ownership for most Australians. Opinions varied amongst the Committee's witnesses as to the extent of the likely change – ranging from those who believe there will be only minimal change through to those who argued that private car ownership will become a thing of the past. However, most witnesses agreed that there will be at least some impact on car ownership as driverless passenger vehicles become available.

1.18 Furthermore, most witnesses argued that many of the anticipated benefits of driverless vehicles will become most apparent if there is also a substantive change in the way that Australians own and use cars. DIRD's submission, for instance, noted that a model based on less ownership and more ride-sharing would have positive effects including 'improving mobility in Australia's densely populated urban areas and providing an incentive for travellers to move away from private car ownership and make better use of public transport'.[10]

1.19 Other witnesses noted that the early signs of this shift away from private ownership are already appearing: young Australians are choosing to get

[8] The Transport and Infrastructure Council is the council of the transport, infrastructure and planning ministers from the Commonwealth and state and territory governments.

[9] National Transport Commission, *Submission 28*, p. 3.

[10] Department of Infrastructure and Regional Development, *Submission 26*, p. 12.

their licence later than previously, and car ownership, particularly in inner-urban areas, has fallen.[11]

1.20 Professor Bradlow of the Australian Academy of Technology and Engineering, for instance, argued for a strongly interventionist approach to ensure that the anticipated benefits of autonomous vehicles transpire, suggesting that governments should choose 'to make individual ownership prohibitively expensive, because it is no longer necessary at that point'.[12]

1.21 DIRD's submission also pointed to a model wherein autonomous vehicles remain privately owned at about the same rate as vehicles currently are, wherein 'a number of perverse outcomes might occur'. These could include increased congestion (as vehicles drop passengers off and return to their residence, as well as by making longer commutes and reducing the attractiveness of public transport options) and possible negative environmental impacts.[13]

Structure of the report

1.22 Each chapter of this report addresses one of the Inquiry's terms of reference, with the final chapter focusing on the role of government in preparing for driverless vehicles.

1.23 Chapter 2 provides an overview of current public attitudes towards driverless vehicles, drawing on existing surveys and studies. The chapter discusses the major identified benefits of and concerns about driverless vehicles, and introduces the main theme of this report: that public engagement is of paramount importance. The concerns of the public will need to be addressed if the benefits of autonomous vehicles are to be realised in Australia. Similarly, stakeholders – including governments and manufacturers – will need to educate and emphasise the benefits which these vehicles can bring.

1.24 Chapter 3 focuses on the first of those benefits, and the one most anticipated by submitters and witnesses to this inquiry: the improved safety outcomes which driverless vehicles are likely to bring. Noting that human error is responsible for the overwhelming majority of road trauma, the capacity of

[11] Swinburne University of Technology, *Submission 39*, p. 6.

[12] Professor Hugh Bradlow, President, Australian Academy of Technology and Engineering, *Committee Hansard*, 11 April 2017, p. 1.

[13] Department of Infrastructure and Regional Development, *Submission 26*, p. 12.

driverless vehicles to significantly reduce the likelihood of accidents is a substantial benefit. The chapter considers safety for both passengers and non-passengers, as well as identifying some of the unresolved ethical concerns which driverless vehicles will bring.

1.25 Following on from safety, chapter 4 discusses one of the key concerns identified in the research to date: the lack of clarity around questions of legal liability and responsibility if an autonomous vehicle is involved in an accident. Recognising that a fully autonomous road system will see a significant change in terms of road safety, the chapter also addresses what changes can be expected in the insurance industry as a result.

1.26 Another key concern identified is the shift in employment that autonomous vehicles will bring. Chapter 5 discusses the main issues in relation to this question, including noting that the impact will be wider than the immediately affected sectors such as professional drivers. Chapter 5 concludes by noting some of the opportunities for Australia in new employment fields brought about by the introduction of autonomous vehicles, and the skills required to take those opportunities.

1.27 Chapter 6 is based on another one of the most important benefits expected of driverless vehicles: the increased access and mobility they will offer, particularly to people with disability or older Australians no longer able to drive. By opening up transport possibilities, autonomous vehicles may serve to significantly improve the lives of many Australians. As discussed in the chapter, however, it is important that this new technology does not serve to widen the divide between those who have the means to access driverless vehicles and those who do not.

1.28 Another aspect of travel likely to change substantially with the availability of autonomous vehicles is public transport systems. Chapter 7 addresses this topic, including the prospect that driverless technology will greatly expand access to public transport by leading to entirely new public transport applications. Concerns and possible issues with driverless public transport options are also discussed.

1.29 The final chapter outlines some of the roles governments will need to fill to enable the introduction of land-based driverless vehicles in Australia. These include ensuring consistency in regulations and standards across the country and working towards consistent and adequate infrastructure. It also includes leading public dialogue on the many social impacts Australia is likely to see as driverless vehicles become available. Public acceptance and engagement will be necessary to ensure that the anticipated benefits of

driverless vehicles will be seen in Australia, and governments have a central role to play in ensuring that this engagement occurs.

Recommendation 1

1.30 The Committee recommends that the Commonwealth adopt as standard terminology the use of 'automated vehicles' and formally accept that the standard definition for the automation level of vehicles is that used by the Society of Automotive Engineers' (SAE) International Standard J3016. The Committee recommends that the use of 'driverless car/vehicle' and 'autonomous vehicle' be discontinued.

2. Public acceptance and engagement

Introduction

2.1 This chapter examines some of the main factors affecting public acceptance of driverless vehicles. It first discusses the existing research on this question, with surveys and studies on attitudes towards driverless vehicles in Australia. The chapter then outlines the major benefits which driverless vehicles are expected to bring before focusing on some of the factors which have been identified as the key barriers to public acceptance. The chapter concludes by emphasising the importance of public engagement in building acceptance of driverless vehicles.

Surveys and studies on attitudes

2.2 Given the relatively new nature of driverless vehicle technology, only limited research has been conducted to date on the attitudes of Australians towards these technologies. The Department of Infrastructure and Regional Development (DIRD) pointed to a 2014 survey conducted by researchers from the University of Michigan of 500 Australians[1], which found that:

- A majority (61.0 per cent) of Australians were aware of 'self-driving' vehicles, with a similar number (61.9 per cent) having a positive general opinion.
- Sixty-seven per cent of Australian respondents expressed an interest in having automated vehicle technology and that 25 per cent stated they were willing to pay more than $3 000 for highly automated capability. Around 30

[1] Schoettle, B., & Sivak, M. (2014). 'A Survey of Public Opinion about Autonomous and Self-Driving Vehicles in the U.S., the U.K, and Australia'. University of Michigan. Ann Arbor: University of Michigan Transportation Research Institute.

per cent of respondents would be unwilling to pay anything extra for an automated vehicle.

- A majority of respondents expected better safety, cost of insurance, fuel consumption and environmental outcomes (but not shorter travel times or reduced congestion).
- A majority were 'moderately' or 'very' concerned about some aspects of automated driving technology, including:
  - system failures (including safety and security);
  - riding a vehicle with no driver controls;
  - automation of commercial vehicles and public transport;
  - legal liability;
  - automated vehicles getting 'confused';
  - unoccupied trips by automated vehicles;
  - interactions between automated vehicles and vulnerable road users; and
  - data privacy.
- A significant percentage would watch the road even when not required (43.4 per cent) or would not ride in an automated vehicle (21.2 per cent).[2]

2.3 In 2016, the Australian Driverless Vehicle Initiative (ADVI) conducted the first national survey on Australians' attitudes to driverless vehicles. That survey found that, while many Australians have heard of driverless vehicle technology, less than 10% reported having driven a car with any capacity to drive itself in some situations.[3] For most Australians, highly automated vehicles are an unfamiliar technology.

2.4 Professor Simone Pettigrew provided to the Committee an overview of as-yet unpublished research findings from a survey of approximately 1 500 Australians on their attitudes towards autonomous vehicles:

> Overall, favourability was quite high. It was 3.2 overall on a five-point scale. So it was definitely towards the positive end. Males were slightly more positive than females; younger people were slightly more positive than older people. But definitely not any kind of large segregation that we may have expected on demographic factors. About half of the respondents indicated that they would be willing to pay more for a vehicle that was autonomous. They

[2] Department of Infrastructure and Regional Development, *Submission 26*, p. 14.

[3] Australian Driverless Vehicle Initiative, *Submission 9*, p. 5.

> are probably underestimating the cost, though. The average willingness to pay was about $5,000 additional cost to a vehicle.[4]

2.5 It should be noted, however, that the majority of existing literature primarily deals with the opinions of Australians towards driverless vehicles in the absence of any direct, firsthand experience of them. As the submission from the Queensland University of Technology (QUT) argued:

> There are a growing number of peer-reviewed studies where the member of the public is asked about their acceptance and willingness to use automated cars. Although the questionnaires used in these studies are based on well-established psychology theories, these studies remain highly subjective. The major drawback of such studies is that participants viewed and responded to vignettes or scenarios involving automated vehicles, or descriptions of automated vehicles. Thus, these participants have never experience a real driving an automated car (level 3-4). It could be speculated that individuals still perceive driverless cars as "science fiction". They cannot form an accurate (non-biased) assessment of the true potential of such a disruptive technology without actually driving it.[5]

2.6 As multiple witnesses noted, while only limited numbers of Australians have had the opportunity to experience driverless vehicle technology, Australians tend to be early adopters of many new technologies.[6] This suggests that, as availability of, and familiarity with, automated vehicles grows, and as potential concerns are addressed, Australians may embrace the benefits of highly automated vehicles.

Expected benefits of driverless vehicles

2.7 Advocates of driverless vehicles identified a range of potential benefits. This section discusses the major benefits expected as a consequence of increasingly automated vehicle technology. Two of the major benefits identified, improved safety and increased access and mobility, are discussed separately in this report, in chapters three and six respectively.

Use of time

2.8 A key benefit identified is that, by removing the driving task, passengers in driverless vehicles will be able to spend their time more productively,

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[4] Professor Simone Pettigrew, Curtin University, *Committee Hansard*, 14 June 2017, p. 1.

[5] Queensland University of Technology, *Submission 19*, pp 7 – 8.

[6] See, for example, iMOVE CRC, *Submission 17*, p. 8.

enjoyably or usefully. ADVI's survey found that more than half (56 per cent) of respondents identified this as a potential benefit of driverless vehicles.[7] The survey conducted by the Royal Automobile Club of Western Australia (RAC WA) had a similar finding, with 'more productive and efficient use of travel time' as the third most identified benefit.[8]

2.9 The submission from the iMOVE CRC noted this potential benefit, highlighting that it could have positive impacts on health, employment and social lives:

> Removing the need to focus on the driving task frees up the time in the vehicle to be used more productively for work, relaxation, or even sleep. This would reduce the time cost of travel, reduce the pressure to live close to the location of the work, and more generally support decentralisation. It would also increase people's geographic range of work opportunities.
>
> Not requiring a licensed driver might also offer families more flexibility as they try to juggle competing demands for getting each member from A to B.[9]

2.10 The Swinburne Univeristy of Technology also commented on this factor, and noted that autonomous vehicles will likely result in lowered instances of driver stress.[10]

Congestion and use of urban space

2.11 The capacity of autonomous vehicles to decrease traffic congestion has been cited as one of their principal benefits.

2.12 Vehicle manufacturer Volvo outlined how this improvement might occur:

> In a fully self-driving environment autonomous cars will communicate with each other and the road network via the cloud. This will result in traffic flowing more smoothly, easing congestion on major roads and making these journeys more enjoyable and productive for the driver/occupants. Self-driving cars will be able to merge into traffic and plan ahead more efficiently than those with human drivers.
>
> Connected technology and better all-round awareness means that autonomous cars will reduce congestion on Australian roads, saving millions of wasted hours on the road. Autonomous cars will allow drivers to use their time in the

[7] Australian Driverless Vehicle Initiative, *Submission 9*, p. 6.

[8] RAC WA, *Submission 18*, p. [3].

[9] iMOVE CRC, *Submission 17*, p. 3.

[10] Swinburne University of Technology, *Submission 39*, p. 6.

> car as they choose – relaxing or working as desired. The car could become an extension of the office and allow commuters to arrive at work less stressed and better prepared.[11]

2.13 Professor Hugh Bradlow of the Australian Academy of Technology and Engineering also pointed to this advantage of driverless vehicles, arguing that the fully automated land vehicle system 'will yield massive convenience factors—for example, congestion will be a thing of the past. Every journey will have near-certain timing, so you will not have to allow for buffers'.[12]

2.14 Professor Bradlow also noted that road usage will change significantly with driverless vehicles:

> By the way, the autonomous vehicles will not leave four car lengths [between vehicles], because they have reactions of sometimes milliseconds as opposed to seconds like human beings. So one of the savings you get—and we have modelled this on the freeways—is that you can just pack the cars in really tightly, like a train, so you double the lane capacity of the roads.[13]

2.15 Improved urban planning and use of space has also been highlighted as a key expected benefit of autonomous vehicles. For instance, as Telstra's submission outlined:

> AVs do not need permanent parking spaces, are likely to be shared so there won't be as many, and can move away from the urban core when needed. This will drastically reduce the need for carparks and driveways, giving us scope to redevelop these areas for greater social amenity and economic benefit.[14]

2.16 The University of the Sunshine Coast submission made a similar point, noting that the likely reduction of designated parking spaces in urban environments could lead to better use of that land.[15] Mr Steven Harrison of the Council of Capital City Lord Mayors noted that this change will be seen in larger cities and is beginning to happen already:

> They are already beginning to see in the US changes in the use of homes and apartment construction where there is no car parking required or people are

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[11] Volvo Car Australia, *Submission 11*, p. [9].

[12] Professor Hugh Bradlow, President, Australian Academy of Technology and Engineering, *Committee Hansard*, 11 April 2017, p. 1.

[13] Professor Hugh Bradlow, President, Australian Academy of Technology and Engineering, *Committee Hansard*, 11 April 2017, p. 2.

[14] Telstra, *Submission 14*, p. 7.

[15] University of the Sunshine Coast, *Submission 37*, p. 12.

> converting their garages into bedrooms or Airbnbs. So those sorts of changes are already happening when people are thinking about design—'Do we really need to incorporate as much car parking as previously?'
>
> We have a couple of apartment projects in Adelaide, and they are very common in Melbourne, where the apartments go up but there might be three or four cars that are shared by the owners of the apartments. So the building actually owns the motor vehicles. You could see there would be a natural progression into autonomous vehicles. They would be autonomous and you would not own them but the building might own them. So we are starting to see those changes. We are experiencing that in Australia.[16]

2.17 DIRD also pointed to the potential benefit of improved liveability in cities, noting that it is dependent both on the dominant usage model of autonomous vehicles and active planning decisions:

> If automated vehicles do not generate increased travel, then potential improvements in congestion, sustainability and accessibility will serve to improve the liveability of Australian cities and communities. Some analysts envision a future where city structures are transformed and public spaces become cleaner and safer, leading to increased social connectedness and enhanced societal wellbeing.
>
> Reduced requirements for parking space could create surplus land for higher value urban redevelopment and community use. The realisation of these social and structural benefits will require proactive management through changes in land use planning policy and regulations.[17]

2.18 Some witnesses suggested that improved transport options will instead see increased urban sprawl as people take advantage of the convenience of autonomous transport to live further away from their workplaces than they currently do.[18]

Environment

2.19 Alongside the anticipated benefit of easing congestion is the likelihood that driverless vehicles will have a positive effect on the environment. While the

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[16] Mr Steven Harrison, Chief Adviser to the Lord Mayor and Chief Executive, City of Adelaide, Council of Capital City Lord Mayors, *Committee Hansard*, 14 June 2017, pp 8 – 9.

[17] Department of Infrastructure and Regional Development, *Submission 26*, p. 23.

[18] See, for instance, Department of Infrastructure and Regional Development, *Submission 26*, p. 23; Queensland University of Technology, *Submission 19*, pp 4 – 5; Swinburne University of Technology, Submission 39, p. 11; Council of Capital City Lord Mayors, *Submission 23*, p. 3.

main impact is likely to come from electric, rather than autonomous vehicles, the Committee nonetheless heard that autonomous vehicles should result in improved environmental performance.

2.20 As DIRD's submission noted, Australia's transport sector is responsible for 16 per cent of the country's total greenhouse gas emissions, with light vehicles making up 10 per cent of the total.[19]

2.21 Telstra pointed to the advantages through improved, and more consistent, driving as well as using information available to vehicles via network connections to improve fuel usage.[20]

2.22 Volvo made a similar point, noting that autonomous vehicles are likely to reduce the forms of driving which are most fuel intensive:

> Autonomous, connected cars will be able to drive more efficiently, reducing fuel consumption and harmful emissions. Better anticipation and communication with other cars will reduce stop/start traffic and heavy braking, and they will be able to form safe, tightly packed 'road trains' that reduce aerodynamic drag at speed.[21]

2.23 The latter point links to one of the anticipated benefits of truck platooning, likely to be one of the earliest functions of automated vehicles, as Telstra's submission explained:

> AVs in the Transport & Logistics sector can take advantage of techniques like truck platooning (where a truck travels close enough behind another to benefit from the wind break created by the leader, informed by C-ITS) or vehicle to infrastructure (V2I) communication which can provide green light priority for heavy vehicles to reduce carbon emissions from both fuel burn and reduced congestion… For example, Platooning vendor Peloton estimates a 7.5 per cent fuel reduction from platooning just two trucks.[22]

2.24 Volvo also noted that self-driving vehicles could have the further impact of making electric vehicle use more efficient, by automatically driving to and from a charging station as convenient, rather than requiring a human driver to do so.[23]

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[19] Department of Infrastructure and Regional Development, *Submission 26*, p. 19.

[20] Telstra, *Submission 14*, p. 7.

[21] Volvo Car Australia, *Submission 11*, p. [10].

[22] Telstra, *Submission 14*, p. 7.

[23] Volvo Car Australia, *Submission 11*, p. [10].

2.25 However, as with anticipated reductions in traffic congestion, the dominant use model for driverless vehicles will be a critical factor. Environmental benefits may be lessened if autonomous vehicles lead to a rise in vehicle usage because of the convenience they offer or because they frequently drive without passengers.[24]

Key barriers to public acceptance

2.26 This section discusses some of the key barriers to the public acceptance of driverless vehicles as identified by submitters and witnesses. Two of the major barriers, questions of legal liability and the impact driverless vehicles will have on employment, are discussed separately, in chapters four and five respectively.

Data security and privacy

2.27 A barrier to public acceptance of autonomous vehicles is the level of concern regarding data issues, particularly in terms of the privacy of personal information and the vulnerability of data to cybersecurity threats.

Privacy, data use and ownership

2.28 The submission from the iMove CRC team outlined the concerns regarding privacy and vulnerability to hacking:

> People are justifiably concerned about the collection of data and its subsequent use. We need to have a clear understanding of what data that is being collected in order to predetermine how it is used and ensure that people's fears are allayed. A global data governance model that considers all information sources would play an important role here for the 'global good', however there are considerable challenges in setting this up. [25]

2.29 The scale of the data which will be created by autonomous vehicles was explained by Professor Butler from the Queensland University of Technology:

> These vehicles are going to generate an enormous amount of data. I saw a quote from the CEO of Intel that suggested that, over an eight-hour period of driving, one of these vehicles will generate and consume 40 terabytes of data. So for every eight hours they will create 40 terabytes of data. That data is very

[24] See, for instance, Department of Infrastructure and Regional Development, *Submission 26*, p. 20.

[25] iMOVE CRC, *Submission 17*, pp 4 – 5.

> wide ranging, and the implications of it from a privacy perspective may depend on the particular model that we are talking about...
>
> There are issues there about who owns that data. The manufacturers may lay claim to that, and likely will lay claim to that sort of data. To that end, I saw an announcement by Ford that they are spending $200 million to convert an assembly factory in Michigan to a data-processing facility. So they are certainly planning on collecting a large amount of data.[26]

2.30 The Federal Chamber of Automotive Industries suggested that autonomous vehicle data could be broadly categorised into three types and noted that each of those will need to be considered in different ways:

- Traffic information;
- Vehicle owner/driver information (including location data); and
- Vehicle systems operation data.[27]

2.31 As Professor Butler indicated, there will likely be consequential use of that data too, as the companies who own it find ways to commercialise the information they collect about vehicle operators:

> The vehicles will record locations that you might like to frequently visit. If you like to go to a particular fast food restaurant… you might find then that, if the manufacturer is collecting that sort of data and passing it on to other fast food chains, there are implications of being deluged with advertising from rival food outlets.[28]

2.32 Furthermore, there are even more concerning aspects about access to that data:

> So these things are recording where you have been. There is a question there about who might access that information, such as whether, if you have a suspicious partner who is wondering where their partner is going to, that person can access the information. That might raise concerns about domestic violence, if that person is of a certain inclination.[29]

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[26] Professor Des Butler, Queensland University of Technology, *Committee Hansard*, 3 May 2017, p. 3.

[27] Federal Chamber of Automotive Industries, *Submission 24*, p. 10.

[28] Professor Des Butler, Queensland University of Technology, *Committee Hansard*, 3 May 2017, p. 4.

[29] Professor Des Butler, Queensland University of Technology, *Committee Hansard*, 3 May 2017, p. 4.

Cybersecurity

2.33 The Department of Industry, Innovation and Science (DIIS) described some of the effects of cybersecurity lapses as seen in the United States:

> In July 2015, Fiat Chrysler recalled 1.4 million vehicles in the US to address a software vulnerability in its systems, following a reported demonstration that allowed security researchers to remotely hack into and control a Jeep Cherokee's engine via its internet-connected entertainment system. The *New York Times* also reported that the same researchers demonstrated a way to control hundreds of thousands of vehicles remotely from the internet: they were able to track cars by their location, see how fast they were going, and control lights, windshield wipers, navigation and in some cases, brakes and steering.[30]

2.34 The iMOVE CRC submission also discussed the problem:

> … there is considerable concern about the perceived vulnerability of individual vehicles and the traffic system as a whole. There is potential for many undesirable scenarios if the systems of driverless vehicles are compromised. These concerns are magnified by the high level of connectivity between vehicles, and their integration with myriad other devices that could introduce malware or spyware.[31]

2.35 However, Mr David Pickett of Volvo Australia clarified that a key cybersecurity concern – that of a system being hacked to gain control of the vehicles reliant on it – will not be a problem, since there will be no capacity to control vehicles in this way:

> There is not that much communication allowed back into the car. For someone to get in and start controlling something is quite a different design to what the car is set up to do. It is not designed to take that sort of input. For majority of the steering and braking control, the car is controlling itself and what it sees. The only information it takes is that, maybe, the Sydney Harbour Bridge is closed because of an accident, so it would divert using the navigation system… The systems are not designed to allow that technology to access the car. You do not have access into the vehicle from outside.[32]

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[30] Department of Industry, Infrastructure and Science, *Submission 29*, pp 14 – 15.

[31] iMOVE CRC, *Submission 17*, pp 4 – 5.

[32] Mr David Pickett, Technical Manager, Volvo Car Australia, *Committee Hansard*, 4 May 2017, p. 5.

2.36 The Government's response to such concerns includes the $230 million National Cyber Security Strategy, which includes the Cyber Security Growth Centre:

> The part that [the Department of Industry, Innovation and Science] is responsible for is the Cyber Security Growth Centre, and they have developed a sector industry plan. Cyber security obviously covers lots of different issues around national security, but the growth centre is looking at the business opportunities and industry demand. So they are looking at technologies around privacy, trust and security, particularly in relation to things like cloud computing but also autonomous vehicles, robotics, the Internet of Things. This is to make the point that we have been making to the group during our discussions, which is that the government is working towards building the framework for all of the aspects—whether it is a satellite positioning, the regulatory structure, the cyber security—for what is going to be a 10-15 year implementation of autonomous vehicles. It involves looking at the skills, doing a lot of the structural stuff for the economy.[33]

2.37 As DIRD noted, Australia's place in the vehicle market means that its policies align with international standards and markets. As such:

> The Department is engaging with international bodies who are developing standards and guidance for automated vehicle cybersecurity, such as the World Forum for the Harmonisation of Vehicle Standards. Separately, collaborative work is underway with state and territory governments to develop a security management plan for connected and automated vehicles, focusing on the security of wireless communications between vehicles, and with roadside infrastructure.[34]

Enjoyment and cultural issues

2.38 As multiple witnesses noted during the Committee's hearings, for many Australians vehicle ownership and driving are not exclusively functional. Many people enjoy driving their car and consider it an important cultural marker. For that reason, the prospect of having only limited – or even zero – control over their vehicle is a prospect to be dreaded rather than positively anticipated.

2.39 For instance, Dr Hsu of the ARC Robotic Futures Team noted that 'a small but not insignificant body of research which finds that there is a cultural

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[33] Mr Darren Atkinson, Manager, Advanced Manufacturing Policy, Industry Growth, Department of Industry, Innovation and Science, *Committee Hansard*, 21 June 2017, pp 6 – 7.

[34] Department of Infrastructure and Regional Development, *Submission 26*, p. 26.

tendency in Australia today to equate private car ownership with personal autonomy.[35]

2.40 iMOVE CRC noted this point, highlighting that Australians' 'love affair' with their own vehicle is a strong cultural thread', which will 'need to be acknowledged in any plans for the introduction of new technologies'.[36]

2.41 The Australian Academy of Technology and Engineering's Professor Bradlow suggested that a useful way of combining the benefits of a fully automated vehicle system with people's desire to drive themselves could be found via analogy with the last great shift in land transport:

> The world made a very successful transition at the beginning of the 20th century from horses to cars. It took about 10 years, in fact. People still like to ride horses; they just do not do it on the Monash Freeway. The same thing will apply to cars. They can go out to Calder Park and race their cars or drive their cars there.[37]

Public engagement

2.42 As has been noted, a primary factor affecting the level of public acceptance of driverless vehicles is the unfamiliarity and lack of experience most people have with them. As a consequence, the general public's understanding of the currently available level of technology, and realistic expectations of how and when this will further develop, is often inaccurate.

2.43 One analogy the Committee heard compared the development of autonomous vehicles to that of lifts:

> … when lifts were invented: you needed an operator; then there was a point where you still had an operator but it was actually automated because people did not accept it or trust it; and eventually there were no lift drivers and now they are fully automated. It could have happened a lot earlier except for acceptance. It is really important that the government leads on outreach and social acceptance of driverless because with that acceptance and the real world experience of seeing these trials—and seeing is believing, if you like—then

[35] Dr Eric Hsu, Research Associate, ARC Robotics Futures Research Team, *Committee Hansard*, 24 May 2017, p. 9.

[36] iMOVE CRC, *Submission 17*, p. 8.

[37] Professor Hugh Bradlow, President, Australian Academy of Technology and Engineering, *Committee Hansard*, 11 April 2017, p. 2.

> people will want to be involved in it. That is when you get that acceleration of benefit.[38]

2.44 Telstra made a similar argument in its submission, noting that, 'to achieve the required level of social acceptance, reliability needs to be demonstrated through pilots and public participation'.[39]

2.45 As Dr Wenham of the Australian Academy of Technology and Engineering argued, it is vital for there to be public engagement on the social issues around driverless vehicles, noting that with new technologies, social licence is key:

> Pick your technology; the issue is rarely with the technological aspects—that will be resolved with research that is going on in markets and that sort of work—it is around social acceptance and social licence. If the conversation is not structured properly with the community and people do not understand the issues around this and are not able to feel that they can have a say in how these technologies are deployed, you will have the sort of problems that you had with other technologies. We should not underestimate that social licence.[40]

2.46 Inevitably, as both the technology itself and its spread improve, the attitudes of Australians towards driverless vehicles will change. The Committee notes that the National Transport Commission released its *Guidelines for Trials of Automated Vehicles in Australia* in May 2017, and expects that as trials of vehicles with autonomous capabilities expand, some of these concerns will be alleviated and benefits will be recognised. However, as with all emerging technologies, the Committee notes that increased use may also identify further problems to be resolved. Similarly, additional benefits may also emerge as the adoption of highly automated vehicles become available.

Committee view

2.47 Having heard about some of the primary concerns and barriers to public acceptance of driverless vehicles, the Committee emphasises that all stakeholders involving in introducing these vehicles need to engage with community concerns and ensure that these are taken seriously. Driverless

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[38] Mr Alex Foulds, Executive Director, Surface Transport Policy Division, Department of Infrastructure and Regional Development, *Committee Hansard*, 21 June 2017, p. 6.

[39] Telstra, *Submission 14*, p. 8.

[40] Dr Matt Wenham, Executive Manager, Policy and Projects, Australian Academy of Technology and Engineering, *Committee Hansard*, 11 April 2017, p. 6.

vehicles have the capacity to bring about substantial social benefits – including those discussed in this report – but without adequate public engagement, those may never be fully realised in Australia.

2.48 As part of that public engagement, the Committee is of the view that the Commonwealth Government should continue to ensure that addressing concerns in regards to data privacy and cybersecurity forms a part of Government's preparations of driverless vehicles.

2.49 Overall, the Committee found that the main issue affecting public acceptance of driverless vehicles is the lack of familiarity most Australians have with vehicles containing high levels of automation. Given the substantial safety benefits, improved access and mobility options, better use of time and improved environmental and planning outcomes likely to result from the availability of driverless vehicles, the Committee considers it to be of primary importance that there is genuine engagement with Australians' concerns about and inexperience with driverless vehicles.

2.50 For that reason, the Committee considers that the Commonwealth Government should facilitate and encourage public trials of driverless vehicles to increase public understanding and develop further dialogue on any future social issues.

Recommendation 2

2.51 The Committee recommends that, noting the range of benefits automated vehicles are likely to bring and the need for public acceptance of the technology, the Commonwealth Government facilitate and encourage trials of automated vehicles in Australia, with a particular focus on trials that enable members of the public to experience automated vehicles on public roads.

Recommendation 3

2.52 The Committee recommends that the National Cyber Security Strategy specifically investigate automated vehicles (and associated transport systems) to address potential vulnerabilities relating to automation.

3. Safety

3.1 Of the potential benefits of driverless vehicles, the one most consistently anticipated by witnesses and submitters to this inquiry is that of improved safety features and therefore improved safety outcomes. The Committee heard that this stands as the most likely and most important benefit of automated and driverless vehicles. Noting that over 1 200 Australians die[1] and over 37 000 are injured[2] as a result of accidents on Australian roads each year, the Committee considers these safety benefits to be of paramount importance in any discussion of the social impacts of driverless vehicles.

3.2 This chapter outlines the major benefits to road safety likely to emerge as a result of increasing automation of vehicles, as well as the further consequences of those. It also canvasses some of the concerns raised in this context, including the ethical questions arising from accidents and other incidents involving automated vehicles, as well as the issues raised during period in which there is a mixed fleet on public roads.

Safety benefits

3.3 The Committee heard from a wide range of submitters and witnesses to this inquiry that the safety benefits of increasingly automated vehicles will be the technology's most significant outcome.

3.4 As the Department of Infrastructure and Regional Development (DIRD) submission noted:

> Road crashes in Australia kill about 1,300 people per year. The cost of road crashes to society has been estimated to be $27 billion annually, or 1.8 per cent

[1] Department of Infrastructure and Regional Development, *Submission 26*, p. 16.

[2] Australasian College of Road Safety, *Submission 31*, p. 4.

> of GDP (based on a willingness-to-pay methodology of valuing human life) (Transport and Infrastructure Council, 2016a) (BITRE, 2014b, p.28). International evidence indicates that human error may be a factor in more than 90 per cent of crashes, and that road user distraction or inattention is a contributory factor in around 10-30 per cent of road accidents (Singh, 2015), (TRL, TNO and Rapp Trans, 2015, pp. 54-55). This does not necessarily mean the driver is the cause of the crash; however, it does indicate that human error may be the predominant factor in most road accidents.
>
> If automated technology reduces or eliminates human errors, as is generally expected, then benefits for road safety may be substantial.[3]

3.5 Mr Christensen of the iMOVE Cooperative Research Centre, when asked about the potential benefits of autonomous vehicles, argued that:

> The largest benefit altogether will be in safety and the avoidance of accidents and road trauma and the costs that are associated with that. It is a massive burden on the economy and the prospect for autonomous vehicles to substantially reduce the rate of accidents and trauma, therefore, stands to benefit the economy in a dramatic way.[4]

3.6 The Australasian College of Road Safety (ACRS) argued that, not only are the direct effects of road trauma serious, they represent only one element of the consequences:

> With 25 people dying and 700 being seriously injured each week in Australia, the ripple effect of each road trauma event to our families, to the workplace and communities is enormous. It is reasonable to assume the cost to the national economy over the next decade to be in the order of at least $350bn.
>
> The subsequent impact on Australia's health system and communities is too often overlooked, as is the impact on national productivity.[5]

3.7 The Road Trauma Australia 2016 Statistical Summary, published by DIRD in July 2017, notes that the annual reduction in Australia's death toll over the past decade has been reversed in the last three years, with annual increases across all states and territories.[6]

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[3] Department of Infrastructure and Regional Development, *Submission 26*, p. 16.

[4] Mr Ian Christensen, Chief Executive Officer, iMOVE Cooperative Research Centre, *Committee Hansard*, 11 April, p. 60.

[5] Australasian College of Road Safety, *Submission 31*, p. 5.

[6] Bureau of Infrastructure, Transport and Regional Economics, 2017, *Road trauma Australia 2016 statistical summary*, BITRE, Canberra ACT,

3.8 A significant proportion of the serious road trauma on Australian roads occurs in regional and remote areas.[7] The National Farmers' Federation argued that autonomous vehicles should improve safety 'by removing the risks of driver error and driver fatigue during long and tedious travel on country roads'.[8]

3.9 Mr Lauchlan McIntosh of ACRS pointed to Australia's fall in road safety results, noting that a focus on improving Australia's performance has not been enough of a priority:

> In our road safety performance we have fallen from about ninth to about 19th. We used to be at the top of the game. We were in the top 10. We are now in the best 20. That is not good enough. Why is that so? We have really let ourselves slip. We need to do this not just by ourselves. We need to do this with other countries. We need to sign into the US and we need to sign in to Europe and be part of that. ANCAP is doing that with our merger with the Europe ANCAP testing, but it needs to happen in all these other areas.[9]

3.10 Austroads also noted the significant levels of road trauma in Australia and the potential for autonomous vehicles to reduce those levels, while also highlighting that even vehicles that do not meet the definitions of autonomous should contribute to this:

> Perhaps the most significant societal benefit that could be achieved with technologies that automate the driving task is the potential to significantly reduce road trauma. As you have already heard today, road crashes lead to about 1,300 fatalities per annum and over 30,000 serious injuries each year. It has already been highlighted by others that studies have estimated that over 90 per cent of road fatalities have human error as a causative factor. The potential for automation to reduce this figure is significant; however, it is not just driverless vehicles that can address this issue. Vehicles with self-driving capabilities that are not necessarily driverless also have significant potential to mitigate human error with the driving task and thus improve road safety significantly. Austroads would like, therefore, to suggest that any

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https://bitre.gov.au/publications/ongoing/road_deaths_australia_annual_summaries.aspx (accessed 3 August 2017).

[7] See, for instance, Mr Bernard Carlon, Executive Director, Centre for Maritime Safety and Centre for Road Safety, Transport for NSW, *Committee Hansard*, 4 May 2017, p. 22.

[8] National Farmers' Federation, *Submission 22*, p. 2.

[9] Mr Lauchlan McIntosh, President, Australian College of Road Safety, *Committee Hansard*, 24 May 2017, p. 5.

> recommendations from this inquiry relating to road safety be not limited to just vehicles that are driverless.[10]

3.11 Pointing to existing technology, manufacturer Volvo noted that the incorporation of SAE level 1 or 2 into some vehicles has already demonstrated improved safety performance:

> Research conducted in the US highlights the value of cars equipped with safety features that would be standard in fully autonomous cars. The Insurance Institute for Highway Safety's (IIHS) 2016 survey found that that cars equipped with front crash prevention technology are much less likely to rear-end other vehicles.
>
> In the first study of the feature's effectiveness using U.S. police-reported crash data, IIHS also found that cars with automatic braking reduce rear-end crashes by about 40 percent on average, while forward collision warning alone cuts them by 23 percent. The autobrake systems also greatly reduce injury crashes. The rate of rear-end crashes with injuries decreases by 42 percent with forward collision warning with autobrake.
>
> IIHS concluded that If all vehicles had been equipped with autobrake that worked as well as the systems studied, there would have been at least 700,000 fewer police-reported rear-end crashes in 2013. That number represents 13 percent of police-reported crashes overall. Front crash prevention would be a standard safety feature incorporated into fully autonomous cars.[11]

3.12 Similarly, representatives of the New South Wales Government told the Committee that these existing technologies are having an impact on road safety:

> So already in the market, with registered vehicles operating on our roads in New South Wales, we have the benefits of those technologies which, when we look at the research that is being done, are already contributing significant reductions. When we see that rear-end crashes and when we see head-on crashes—crashes into objects on the road constitute more than 60 per cent of the fatalities that we have, and a significant amount of the 12,000 serious injuries where people are admitted to hospital in New South Wales each year. We can see that those technologies are already having a benefit when comparing those vehicles against vehicles without the technology. So right now we already have the benefits coming through, which are all clearly

[10] Mr Nicholas Koukoulas, Chief Executive Officer, Austroads, *Committee Hansard*, 11 April, p. 16.

[11] Volvo Australia, *Submission 11*, [p. 6].

> technologies that have been developed against the vision of having driverless vehicles in the future.[12]

3.13 As Mr James Goodwin of ANCAP argued, the increasing automation of vehicles will have a significant and important effect in improving road safety: 'with more than 90 per cent of crashes involving human error, automation is really the key in reducing road trauma, and the future of vehicle safety lies with these active and autonomous safety features'.[13]

3.14 As such, from 2018, ANCAP's assessment of new vehicles will take into account automated driving technologies: as of that year, only vehicles with some level of autonomous technology included as standard can be rated as a five-star ANCAP vehicle.[14]

Non-passenger safety

3.15 While the safety of vehicle passengers has been the main focus of this chapter, the Committee also heard that increasingly automated vehicles will have implications for the safety of non-passengers. However, while there was general agreement that autonomous vehicles would lead to improved safety for passengers, some witnesses expressed concern that non-passenger safety has not been adequately considered in the debate on driverless vehicles to date. In particular, the Committee heard concerns about the safety and rights of vulnerable road users – generally defined as pedestrians and cyclists – and the extent to which those may be affected by the increasing levels of automation in vehicles.

3.16 As Ms Katie Minogue of Maurice Blackburn Lawyers argued:

> … it is really important that consideration is given to vulnerable road users in the regulation and governing of those programming decisions. It is crucial that manufactures of that technology are not automatically assigned the decision-making power. And it is really important that it is a conversation in which

[12] Mr Bernard Carlon, Executive Director, Centre for Maritime Safety and Centre for Road Safety, Transport for NSW, *Committee Hansard*, 4 May 2017, p. 19.

[13] Mr James Goodwin, Chief Executive Officer, Australasian New Car Assessment Program, *Committee Hansard*, 24 May 2017, p. 1.

[14] Mr James Goodwin, Chief Executive Officer, Australasian New Car Assessment Program, *Committee Hansard*, 24 May 2017, p. 3.

> society also participates in and that vulnerable road users have a voice in also.[15]

3.17 The Amy Gillett Foundation, advocates for road safety for cyclists, noted research suggesting that all road users will need to familiar with autonomous vehicle technology, to understand the capabilities of the vehicles:

> We also draw your attention to recent work from the respected Dutch safety research institute, SWOV. This highlights the need to anticipate behavioural adaptations by vulnerable road users to an increase in automated vehicles. Pedestrians and cyclists are likely to appreciate messages from the vehicles that they have been detected and what action the vehicle is going to take. The form of these messages needs to be determined.[16]

3.18 The submission from the University of the Sunshine Coast highlighted that, since human drivers are often unable to adequately respond to vulnerable road users, work remains to be done on how a vehicle should be programmed to do so:

> In a recent study of road user behaviour at intersections, Salmon et al (2014) found that human drivers are not prepared for the variability in behaviour displayed by cyclists, motorcyclists and pedestrians. How AV designers can develop systems that a. understand this level of variability, and b. are able to cope with it in complex road scenarios, remains unclear.[17]

3.19 Ms Cecilia Warren of the Insurance Australia Group (IAG) noted that recent evidence has shown that, while there has been an increase in the safety features available in vehicles, vulnerable road users remain part of the equation:

> We have to remember as well that roads are not just used by vehicles but also used by pedestrians, bicyclists, vulnerable road users and others. Even in a fully autonomous scenario, it is still not just autonomous vehicles that are using these roads. As we head towards full autonomy, we are still looking at interactions of the human with the machine, to put it in those terms.[18]

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[15] Ms Katie Minogue, Associate, Road and Work Injuries, Maurice Blackburn Lawyers, *Committee Hansard*, 11 April 2017, p. 47.

[16] Amy Gillett Foundation, *Submission 42*, p. 3.

[17] University of the Sunshine Coast, *Submission 37*, pp 9 – 10.

[18] Ms Cecilia Warren, Director, Mobility Research and Development, IAG, *Committee Hansard*, 4 May 2017, p. 12.

3.20 The NTC's submission stated that the safety assurance system being developed will 'look to assess the safety of the vehicle for both passengers – in a shared mobility or private ownership setting – and vulnerable road users'.[19]

3.21 DIRD highlighted that all road users – passengers and others – should expect to see improvements to safety as a result of highly automated vehicles on the road:

> If automated technology reduces or eliminates human errors, as is generally expected, then benefits for road safety may be substantial. The expected safety benefits of automated vehicles extend to other vulnerable road users, such as pedestrians and cyclists, since vehicles with higher levels of automation (i.e. SAE Levels 4 and 5) will be able to detect their presence and take evasive action automatically (Somers and Weeratunga, 2015).[20]

3.22 However, DIRD also noted that expected safety benefits are at this stage only expected – in the absence of significant trials on public roads, actual consequences have not yet been seen:

> Importantly, the expectation of near zero fatalities with highly automated vehicles may not be realistic, including for the duration of a mixed fleet... More trials and real-world experiences are required to understand the safety impacts of higher levels of automated driving.[21]

Safety concerns

3.23 While proponents of driverless vehicles argue that increased road safety is one of the primary benefits of increasingly automated vehicles, multiple studies have demonstrated that uncertainty around the safety of these vehicles is a key concern for many people. This ambiguity is increased by media reports of accidents involving automated vehicles, which highlight the new and unknown nature of the technologies.

3.24 Research by the Australian Driverless Vehicle Initiative found that 80 per cent of people surveyed expressed concern about 'the ability of the car to

[19] National Transport Commission, *Submission 28*, p. 9.

[20] Department of Infrastructure and Regional Development, *Submission 26*, p. 16.

[21] Department of Infrastructure and Regional Development, *Submission 26*, p. 16.

perform safely in all conditions' as one of their key concerns regarding autonomous vehicles.[22]

3.25 Mr James Goodwin of ANCAP noted that new technologies, even those which improve safety, have often taken some time to gain widespread public acceptance, and for that reason it is important for vehicle manufacturers and other stakeholders to engage with community concerns:

> People did not like air bags in the old days, and they did not like seat belts even before that. We have to learn from those experiences and know that this is the newest form of technology that we need to bring the consumers along for the ride. We have to make sure they have the confidence in it. We feel that the level 1 features we are currently evaluating and assessing are the building blocks to a full driverless future. We need to get that right now and we need to make sure that the systems work and that consumers have the confidence to use them and know how they do work to make sure that they know what is in their car and how it works.[23]

The Australian context

3.26 The Committee heard that, while safety principles are largely universal, Australia faces unique challenges in ensuring passenger safety in autonomous vehicles. In particular, kangaroos present uncertainties unlike many other animals that may be expected near roads. Witnesses noted that this problem, which has received some media attention[24], will need to be solved before passengers will feel safe in autonomous vehicles on Australian roads.

3.27 Mr David Pickett of Volvo Australia discussed the difficulties which kangaroos present for autonomous vehicle software:

> We have done a research project here in Australia for kangaroos, which has proven to be very interesting. The cars at present do not take what you would call a drastic measure. They will brake. At the same time, though, we have technologies in the car so that, if we do brake hard for something, the emergency brake warning lights come on on the car. It will start flashing the hazard lights, and the high-mounted brake light will flash to warn the other

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[22] Australian Driverless Vehicle Initiative, *Submission 9*, p. 7.

[23] Mr James Goodwin, Chief Executive Officer, Australasian New Car Assessment Program, *Committee Hansard*, 24 May 2017, p. 2.

[24] See, for example, 'Driverless cars: Kangaroos throwing off animal detection software', *ABC News*, 24 June 2017, http://www.abc.net.au/news/2017-06-24/driverless-cars-in-australia-face-challenge-of-roo-problem/8574816 (accessed 29 June 2017).

> drivers earlier. The decision about what we do for kangaroos has not been made. At this point in time, everyone is concentrating on reducing the speed. If we can knock off 20 kilometres an hour or 10 kilometres an hour, it might be the difference between driving home with a busted headlight or walking.[25]

The regulatory approach

3.28 The Department of Infrastructure and Regional Development outlined the approach to safety being taken by the COAG Transport and Infrastructure Council to develop a national performance-based safety assurance regime:

> In November 2016, the COAG Transport and Infrastructure Council agreed that a national performance-based assurance regime should be developed to ensure the safe operation of automated vehicles, in line with international practices (NTC, 2016b). Such a safety assurance regime will give consideration to issues such as an automated vehicle's ability to obey speed zones and traffic controls, interact safely with other road users and perform safely in all likely road and environmental conditions (NTC, 2016b).[26]

3.29 Mr Marcus Burke of the NTC expanded on this approach, noting that it places the burden of demonstrating safety assurance on the vehicle manufacturers:

> I think this goes to the approach we are looking to develop in terms of both guidelines and broader safety assurance. We are trying to learn from rail and aviation and moving away from the prescriptive approach that we in the road sector have had towards more of a safety management approach. What we are envisioning that would look like—again, initially for trials and then potentially for broader deployment—is the operator of these vehicles coming to government and demonstrating that they have identified all the key risks based on the scope of operations that they are looking to operate in and they have systems and processes in place to mitigate, eliminate or manage those risks. That will be dependent on the scope of operations. […] So we are looking to try and take an approach which does not prescribe particular technologies or a mix of technologies, or assume a particular business model; it is about putting it back on industry to demonstrate how they have managed the risks. We believe that is the right approach both for trials and then for broader regulation to ensure that we are not putting in regulation that is going

[25] Mr David Pickett, Technical Manager, Volvo Car Australia, *Committee Hansard*, 4 May 2017, p. 3.

[26] Department of Infrastructure and Regional Development, *Submission 26*, p. 17.

> to become outdated very quickly and that does not assume a particular technology that will finish up not being used.[27]

Safety ethics

3.30 Driverless vehicles will pose ethical questions in ways that vehicles with human drivers do not. The fundamental question is how autonomous vehicle algorithms will be designed to protect the safety of passengers and non-passengers. As the Committee heard, resolution of these questions is central in encouraging public acceptance of driverless vehicles on public roads.

3.31 The well-known philosophy exercise 'The Trolley Problem' lies at the heart of this question. The Trolley Problem, in its basic form, revolves around a scenario wherein a vehicle can either stay on course and injure a number of people or divert, harming a smaller number of people, inviting people to consider under which conditions they would divert the trolley. As applied to driverless vehicles, the question becomes: in a scenario where people will be harmed regardless of what the vehicle does, what action should the algorithm controlling the vehicle take?

3.32 This situation, as the submission from the iMOVE CRC noted, 'is not a new dilemma, but it is one that is being highlighted frequently in the media and which requires some attention in order for the general public to feel sufficiently safe that they are willing 'grant' the technology a 'social licence' to operate'.[28]

3.33 The submission from the Queensland University of Technology similarly noted that this issue, and how it is handled and resolved, will affect how people think about autonomous vehicles:

> Part of the disquiet around automated vehicles is an emotional reaction to the inability to understand their decision-making or predict their behaviour. Ignorance of the perceptual and decision-making systems of automated vehicles risks them being judged as negligent or reckless agents or even a public menace. For example, what issues arise for acceptance in terms of regulation and consequences for socially unacceptable behaviour (e.g. driving too quickly in a car park and frightening humans, even if the vehicle is rated as safe moving at those speeds)? We are still at an early stage of developing

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[27] Mr Marcus Burke, Project Director, Compliance and Technology, National Transport Commission, *Committee Hansard*, 11 April 2017, p. 14.

[28] iMOVE CRC, *Submission 17*, p. 7.

> our understandings of public perceptions of and interactions with automated vehicles. Consumer engagement in the development of programming decisions about vehicle responses in a crash or emergency will be an important aspect of ensuring consumer confidence in this new technology.[29]

3.34 The ARC Robotic Futures Research Team also made the point that these ethically difficult decisions will need to be made on the basis of transparency and public debate: 'It cannot be a hidden process; it needs to be out in the open and publicly debated'.[30]

3.35 As DIRD noted, the United States Department of Transportation draft Automated Vehicle Policy from 2016, 'suggests that manufacturers address ethical issues consciously and transparently with input from various stakeholders'.[31]

Mixed fleet

3.36 One issue raised by witnesses and submitters was concern that insufficient attention has been paid to date on the reality that, even once highly automated vehicles are commercially available and legal on public roads, such vehicles will be in a minority. Australian roads will feature, for many years to come, a mixed fleet, consisting of vehicles of markedly different levels of automation and safety features. As multiple experts emphasised, this will have repercussions on how road safety is managed.

3.37 Mr James Goodwin of ANCAP noted the extent of this problem:

> We have an average vehicle age at the moment of 10 years, and older cars are overrepresented in fatality crashes. With one in five cars on the road more than 15 years old, it is going to be a long time until we get this technology rolled out across the fleet. What we are saying is that we really need to protect everyone on the road. Hopefully cars will start avoiding crashes in the first place, but there will still be some crashes in the future. We are going to have to understand how all those different vehicles will mix on the roads.[32]

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[29] Queensland University of Technology, *Submission 19*, p. 7.

[30] Dr Eric Hsu, Research Associate, ARC Robotics Futures Research Team, *Committee Hansard*, 24 May 2017, p. 13.

[31] Department of Infrastructure and Regional Development, *Submission 26*, p. 31.

[32] Mr James Goodwin, Chief Executive Officer, Australasian New Car Assessment Program, *Committee Hansard*, 24 May 2017, p. 2.

3.38 Mr Ashley Wells of the Federal Chamber of Automotive Industries also pointed to the average age of passenger vehicles in the Australian fleet, and noted that this fact in conjunction with the density of vehicle ownership in Australia means that, even once highly automated passenger vehicles become commercially available, there will be a long period where driverless vehicles share the roads with fully driver-operated ones.[33]

Access to data in the event of an accident

3.39 As noted in chapter 2 of this report, the use of data created by driverless vehicles is a key point requiring clarification to encourage public acceptance. The question of data ownership and access becomes of particular importance when an autonomous vehicle is involved in an accident which causes harm to passengers, other people or to property.

3.40 This data would be able to serve multiple purposes. It would be able to provide an accurate and precise reconstruction of the circumstances of, and reasons for, the accident, thus clarifying liability issues. It would also provide manufacturers with the capacity to improve the model's safety performance by assessing any shortcomings which the accident revealed.

3.41 Ms Cecilia Warren of the IAG summarised the main reasons why this question is important:

> At the moment, as insurers, when a collision occurs there is a lot of reliance on human testimony. Experts are used to understand or potentially reconstruct a collision. What the promise of future vehicles provides is that there will be data that will help to describe what happened, why it happened, where it happened and who was involved. There are a couple of things that are really important with that. Firstly, ensuring that similar incidents do not occur again is a really key piece around ensuring that we learn. We know from other industries, such as aviation et cetera, that there will be things that go wrong that we cannot predict. The key to that is a continual learning piece. Secondly, there will be a need to determine, when something going wrong, who needs to recompense and where liability needs to fall. Finally, there are concerns around both ethics and privacy for the consumer. Is it the consumer's data? Is it the manufacturer's data? Is it the government's data? All those questions are

[33] Mr Ashley Wells, Policy Director, Federal Chamber of Automotive Industries, *Committee Hansard*, 31 May 2017, p. 4.

currently being grappled with by the National Transport Commission, and beyond that as well.[34]

3.42 Ms Katie Minogue of Maurice Blackburn Lawyers argued that public acceptance of driverless technology will require that people understand what data is collected by vehicles and what access they will have to that data in the event of an accident:

> … consumers need protection and guarantees in terms of how their data is handled and kept, that there be standards on the use of that data and that in the event of an accident they not be denied access to relevant event or crash data that is going to help determine liability in an accident. Certainly consumers are going to need certainty and appropriate support and care if they are involved in an accident that involves an automated vehicle. It is really important that people have confidence in that in terms of their acceptance and uptake of the technology.[35]

3.43 The National Transport Commission (NTC)'s work program for autonomous vehicles indicates that in 2018 it will undertake a project on 'regulatory access to C-ITS and automated vehicle data', with an aim to:

> Develop options to manage government access to automated vehicle data that balances road safety and network efficiency outcomes and efficient enforcement of traffic laws with sufficient privacy protections for automated vehicle users.[36]

Consequences

3.44 As noted above, many witnesses highlighted the positive impacts expected to emerge as a result of the improved safety features of highly automated and autonomous vehicles. However, as with other aspects of driverless vehicles, there will likely be further and broader consequences of this improved level of road safety.

3.45 For instance, witnesses noted that considerable policing resources are currently devoted to road safety issues. As vehicles become increasing

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[34] Ms Cecilia Warren, Director, Mobility Research and Development, IAG, *Committee Hansard*, 4 May 2017, p. 10.

[35] Ms Katie Minogue, Associate, Road and Work Injuries, Maurice Blackburn Lawyers, *Committee Hansard*, 11 April 2017, p. 46.

[36] National Transport Commission, Automated vehicles in Australia, Roadmap of reform – Current projects, https://www.ntc.gov.au/roads/technology/automated-vehicles-in-australia/ (accessed 25 July 2017).

automated, there will be a corresponding decrease in the need for this work. In the longer term, this would affect the employment patterns of the police force.[37]

3.46 Further, the current road trauma levels are a substantial component in the work of health care professionals, particularly in emergency departments of hospitals. If, as many have argued, increasingly automated – and eventually driverless – vehicles lead to a significant decrease in the number, and severity, of road accidents in Australia, then the work of those in the healthcare sector would correspondingly shift.[38]

3.47 Another sector likely to change as a consequence of increasing automation of vehicles is vehicle repair – mechanics, panelbeaters and similar occupations – where a decrease in the number of road accidents would lead to a reduction in the need for people to carry out those repairs.

Committee view

3.48 Given the wide range of witnesses arguing that autonomous, or even highly automated, vehicles could lead to a substantial reduction in the number of deaths and injuries on Australian roads, the Committee is of the view that this important social goal should make the introduction of these vehicles a priority for Australia.

3.49 The Committee notes that public engagement remains a key component of the move to autonomous vehicles, and emphasises the importance of stakeholders, including Commonwealth and state and territory governments along with vehicle and software manufacturers, conducting open public dialogue regarding safety concerns with driverless vehicles.

3.50 The Committee is of the view that the approach to driverless vehicle ethical questions suggested in the United States' policy should apply broadly, and that manufacturers should be transparent in how their vehicles will behave in ethically difficult situations. Such an approach will help to ensure that Australians are comfortable with the automation of these ethical difficulties.

3.51 The Committee considers that an adequate regulatory framework for the ownership of and access to vehicle data is one of the key issues affecting

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[37] Professor Hugh Bradlow, President, Australian Academy of Technology and Engineering, *Committee Hansard*, 11 April 2017, p. 5.

[38] See, for instance, Department of Infrastructure and Regional Development, *Submission 26*, p. 29, and University of the Sunshine Coast, *Submission 37*, p. 12.

public acceptance of driverless vehicles. As the next chapter will discuss, uncertainty around legal liability in the case of an autonomous vehicle accident remains one of the major concerns people hold about the technology, and clarity around the data generated during such an event is an important component of resolving the issue.

3.52 While these issues remain distant contingencies at the present time, and dependent on the changes to road safety expected by many experts, the Committee believes it is important that these consequential impacts of increasingly automated vehicles are discussed and understood as part of the broader discussion of the topic. The introduction of driverless vehicles, when it happens, will have substantial and yet to be understood impacts on many aspects of life. These changes should be discussed as part of broad public engagement on the topic of driverless vehicles, as recommended in chapter eight of this report.

Recommendation 4

3.53 The Committee recommends that the Commonwealth Government further investigates the issue of data rights for consumers, vehicle manufacturers and third parties such as insurers and relevant government agencies.

4. Legal responsibility and insurance

4.1 Related to the question of safety is concern about the legal questions which arise from changed understandings of driving and control of the vehicle. One of the key concerns expressed by Australians surveyed on their thoughts about driverless vehicles is the uncertainty regarding legal responsibility and insurance in case of an accident. This chapter discusses some of the issues and concerns regarding legal and insurance questions, as well as some of the attempts to address those questions.

4.2 The Australian Driverless Vehicle Initiative (ADVI) 2016 survey of Australians' opinions about autonomous vehicles found that the most common concern was 'being legally and financially responsible if the car is involved in an accident or makes mistakes', with 92% of respondents identifying this as a concern.[1]

4.3 The University of Michigan study mentioned above also identified this area as a barrier to people's acceptance of driverless vehicles, as did a 2016 survey by the Royal Automobile Club of Western Australia.[2] iMOVE CRC described current regulation as 'inadequate in the event of a driverless vehicle crash'.[3]

Where does responsibility lie in case of an accident?

4.4 The central question revolves around where legal responsibility lies should a vehicle operating with at least some automation be involved in an accident. Currently, even the most advanced vehicles have an identifiable driver who

[1] Australian Driverless Vehicles Initiative, *Submission 9*, p. 7.

[2] Department of Infrastructure and Regional Development, *Submission 26*, p. 17.

[3] iMOVE CRC, *Submission 17*, p. 7.

is responsible for control of the vehicle. However, ambiguity arises when the vehicle is not being – and in higher-level vehicles, *cannot* be – controlled by a person within it.

4.5 Thus, the question arises: who is responsible for that vehicle in the case of an accident? The owner, the car's manufacturer or someone else?

4.6 The National Transport Commission (NTC), as part of its work in identifying regulatory barriers to more automated vehicles, noted that:

> … in November 2016 Australian transport ministers agreed to reaffirm the existing policy position that human driver remains in full legal control of a vehicle that is partially or conditionally automated, unless or until a new position is developed and agreed. This provided immediate clarity on Australia's interpretation level 3 vehicles while allowing the possibility to update this position in line with technology developments.[4]

4.7 In late 2017, the NTC will begin work to develop 'legislative reform options to clarify the application of current driver and driving laws to automated vehicles, and to establish legal obligations for automated driving system entities'.[5] The NTC, in November 2017, will present to the Transport and Infrastructure Council draft guidelines on the definition of 'control' in automated vehicles.[6]

4.8 Manufacturer Toyota emphasised that Australian standards underpinning the control of vehicles should be aligned with international ones:

> The challenge for legislators will be to ensure that the legislated definitions cater for the different levels of automation in addition to conventional vehicles (i.e. 'mixed fleets'), and that the clarification in ambiguity on the automated vehicle front does not have any unintended consequences when it comes to defining 'control' and 'proper control' for the non-automated fleet.
>
> The definition of 'control' and 'proper control' used in legislation should be based on globally harmonised regulations. WP.29 has a proposal for the definitions of automated driving and the general principles for developing a UN-Regulation, and therefore is a comprehensive framework on which to base

[4] National Transport Commission, *Submission 28*, p. 9.

[5] National Transport Commission, *Submission 28*, p. 9.

[6] National Transport Commission, *Current projects/Clarifying control of automated vehicles*, https://www.ntc.gov.au/current-projects/clarifying-control-of-automated-vehicles/ (accessed 3 August 2017).

> local legislation as it takes into account levels of automation, system performance requirements and specific use cases for the vehicles.[7]

4.9 Car manufacturer Volvo noted its position on legal responsibility in its submission, and called on other manufacturers to adopt a similar one:

> Volvo's public position on liability is very clear. Volvo will accept full liability for damages or injuries whenever one of its cars is in full autonomous mode. Volvo is confident that the redundant and back-up systems contained in our Autopilot and Pilot Assist technologies will bring a Volvo car to a safe stop. This accords with Volvo's 20-20 vison that no one will be killed or seriously injured in a Volvo car by 2020.
>
> Volvo believes the Australian government should mandate that all manufacturers who sell fully driverless cars in Australia must accept liability for cars involved in accidents that were in full autonomous mode at the time of the accident.[8]

4.10 As Maurice Blackburn Lawyers pointed out, there are serious problems with the idea of holding individual operators responsible for the harm caused by an autonomous vehicle:

> A strict liability system would essentially be created, as the operators are powerless to avoid the product malfunction. It would also mean that the manufacturer is not responsible for making vehicles safer, or being made responsible for their negligence. More broadly, it embraces the wrong societal incentives and may disincentivise riders from using autonomous vehicles.[9]

4.11 However, the submission further argued, it is important that this system does not create too great a burden on manufacturers and thus discourage innovation.[10]

4.12 Academics from the Queensland University of Technology (QUT) noted that considerations of the legal liability issues will also have address the question of autonomous vehicle data:

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[7] Toyota Australia, *Submission 3*, p. 6.

[8] Volvo Car Australia, Submission 11, p. [7].

[9] Maurice Blackburn Lawyers, *Submission 25*, p. 7.

[10] Maurice Blackburn Lawyers, *Submission 25*, p. 7.

> This confusion [regarding responsibility] is likely to be exacerbated if there is also confusion over whether the data recorded by the vehicle can be readily accessed by consumers and/or insurance companies in the event of a crash.[11]

4.13 ADVI also noted that, even where there appears to be some clarity, the actual legal and other implications remain untested:

> While some vehicle manufacturers have publicly stated their preparedness to accept full liability for a crash involving one of their vehicles when in driverless mode, the legal basis for this warranty remains unclear, as well as mechanisms for assessing and determining an outcome for property and personal injury claims.[12]

Partial automation

4.14 While there are unresolved questions regarding responsibility in the case of a fully autonomous vehicle, the ambiguity increases with vehicles in which neither an identifiable human driver with full control of the vehicle nor a completely driverless vehicle system exists. In such cases, the driver could argue that the vehicle's autonomous systems should have taken over and averted the accident, while the vehicle manufacturer could equally argue that the driver, absent a completely autonomous system, must bear responsibility for the control of the vehicle.

4.15 The submission from Maurice Blackburn Lawyers pointed out the dilemma when a partially automated vehicle causes an accident:

> Where the 'operator' of a partially automated vehicle is required to actively monitor and be ready to intervene where required, liability will prima facie fall on the operator should an accident be caused by their failure to intervene when they are prompted by the automated vehicle. They may also be liable for negligent decisions in relation to engaging the autonomous system, for example if the instruction manual stipulated that autonomous mode should not be used in certain weather or traffic conditions and they did so anyway, or if they chose to ignore the system commands and caused an accident. On the other hand, the operator may be able to prove defectiveness or negligence on the manufacturer's part by showing that their failure to respond to the car's request to intervene was due to the manufacturer not including sufficient

[11] Queensland University of Technology, *Submission 19*, p. 10.

[12] Australian Driverless Vehicles Initiative, *Submission 9*, p. 10.

> driver vigilance controls or because the human-machine interface was poorly designed.[13]

4.16 Maurice Blackburn also noted that further ambiguity exists in such cases in determining the level of negligence for which the vehicle was responsible:

> The standard to which this technology will be held is unclear. For example, in determining issues of negligence, should an automated vehicle be measured by reference to how an ordinary human would act in a given scenario or how a road user programmed to resolutely follow the road rules would have acted?[14]

4.17 As noted above, Volvo has publicly stated that it will be liable in cases where a fully automated Volvo vehicle is responsible for an accident. Asked by the Committee about cases of partially automated vehicles, they responded:

> I think it stays as it is now. Realistically, if the driver is at fault, the driver is at fault. It runs through insurance. If there is a manufacturing defect with the vehicle, there are policies in place for that. If there is a safety recall, insurance companies would then chase the manufacturer. If the car has not been maintained properly, is it the owner's lack of maintenance of the vehicle or has the person who has maintained it done something negligent during the manufacture? From where we see it, the only change will be in that handover phase when we go to a fully autonomous car; that will then be the issue. Even in that space as well, if the customer or the owner of the vehicle has not maintained it—if the tyres are bald and the car has an accident—there is still a certain responsibility that the driver must maintain the car in accordance with normal use. If it runs out of petrol because the car has not been refuelled and has an accident that way, that is not a manufacturing defect. Although we say we take responsibility, we are not going to take responsibility if it is something you have done negligently or deliberately.[15]

4.18 Dr Damith Herath, in a similar vein, noted that the question will change as technology adapts, but also as people get used to the technology and to the idea of changing understanding of vehicle control:

> So I think it will evolve in a progressive manner. At this stage probably the best-case scenario we can anticipate is for the human to have the final judgement, for a number of different reasons. One is that we still do not have

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[13] Maurice Blackburn Lawyers, *Submission 25*, pp 6 – 7.

[14] Maurice Blackburn Lawyers, *Submission 25*, p. 7.

[15] Mr David Pickett, Technical Manager, Volvo Car Australia, *Committee Hansard*, 4 May 2017, p. 6.

> the full technological capacity for the car to make the judgements that rational humans make. In that instance we want to ensure that the human feels in control. Some of the early studies suggest that having the ability to have the final say in the decision-making process makes it more comfortable for the transition to happen. But as the technology progresses and humans adapt to that, we could ease into giving autonomy to the cars to make the final decision.[16]

The insurance industry in a driverless world

4.19 If, as is anticipated, the availability of driverless vehicles results in a substantial reduction in the number of traffic accidents, the vehicle insurance industry will necessarily be changed significantly. This will be multiplied if, as is often argued, the model of car ownership is replaced by more ride-share based options. Approaches to insurance will shift radically if most Australians not only no longer drive a car, but do not own one either.

4.20 During the period of the mixed fleet – a range of vehicles sharing Australian roads – ADVI argued that there will be 'ongoing need for personal insurance, including compulsory third party (CTP) personal injury insurance, property damage insurance and product liability insurance'.[17]

4.21 However, ADVI noted that 'what an insurance industry looks like and how it evolves will inevitably change in line with driverless technology'.[18]

4.22 The submission from the Swinburne University of Technology also addressed this question, noting that international studies have suggested that increasingly automated vehicles – particularly passenger vehicles – will alter the insurance industry in a substantial way:

> If automation will make crashes far less likely, then why buy vehicle insurance? Some studies have speculated that premiums could be reduced by 75%, especially if drivers are no longer required to get coverage, and liability is shifted from drivers to product liability, manufacturers and technology companies. Under this scenario, insurers might move away from covering private customers from risk tied to 'human error' to covering manufacturers and mobility providers against technical failure.
>
> A Rand Corporation report also predicts that drivers might end up covering themselves with health insurance instead of vehicle insurance. According to a

[16] Dr Damith Herath, University of Canberra, *Committee Hansard*, 14 June 2017, p. 5.

[17] Australian Driverless Vehicles Initiative, *Submission 9*, p. 10.

[18] Australian Driverless Vehicles Initiative, *Submission 9*, p. 10.

> similar report by KPMG, the insurance industry could contract by as much as 60% by 2040 as accident damage payouts and premiums fall.[19]

4.23 The Insurance Australia Group (IAG) argued that, while the models of car ownership and insurance coverage may change as a result of the introduction of autonomous vehicles, insurance will still be a necessary part of the landscape:

> We believe it is of critical importance, particularly because we cannot say with certainty that there will be no death or injury on the road with autonomous vehicles. We hope that there will be a safety aspect and we actually anticipate and believe there will be a safety benefit. We do not know exactly the full extent of that. And we do not know what will happen in terms of new risks that might emerge—as you previously mentioned—around cybersecurity risk or if there was a mass of systemic failure of the broader system on the road. Certainly, compulsory third-party insurance is a key one going forward. It has challenges, obviously, because it is regulated at a state-based level. So it is different in every state.[20]

4.24 The Insurance Commission of Western Australia argued that the shift in responsibility for accidents from human drivers to autonomous systems should result in a corresponding shift from Compulsory Third Party insurance to insurance coverage of vehicle and software manufacturers:

> Manufacturers and suppliers should have insurance that is appropriate and sufficiently broad to cover a number of risk areas, including public liability, product liability and cyber risk. People injured in the event that automated vehicle technology fails should be easily able to claim on that insurance. This cover should extend to all people injured in any crash including passengers, cyclists and pedestrians.[21]

4.25 Professor Robert Sparrow and Dr Mark Howard of Monash University made the same point, arguing that 'eventually insurance to protect against the cost of motor vehicle accidents will be primarily purchased by manufacturers rather than individual owners, thus radically reshaping the current motor vehicle insurance industry'.[22]

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[19] Swinburne University of Technology, *Submission 39*, p. 10.

[20] Ms Cecilia Warren, Director, Mobility Research and Development, IAG, *Committee Hansard*, 4 May 2017, p. 11.

[21] Insurance Commission of Western Australia, *Submission 36*, p. 4.

[22] Professor Robert Sparrow and Dr Mark Howard, *Submission 20*, p. 4.

4.26 DIRD noted that, as part of the insurance industry's response to the changing environment of vehicle use, ownership and safety, some firms have been involved in trials of driverless vehicles or begun releasing new insurance types in light of technological advance.[23]

Committee view

4.27 The Committee recognises that the availability of driverless vehicles, especially of passenger vehicles, may necessitate a substantial shift in the way vehicles are insured and in the current understanding of legal liability. This topic should be discussed as part of the engagement with the public, as is recommended in chapter eight of this report.

4.28 The Committee notes the ongoing work of the National Transport Commission in identifying regulatory and other barriers, including key issues such as the definition of 'control', to the introduction of automated vehicles in Australia, and considers this work to be a priority. The Committee is pleased to see that the NTC currently has a range of projects relating to automated vehicles and looks forward to seeing the results of those.

[23] Department of Infrastructure and Regional Development, *Submission 26*, p. 25.

5. Employment

5.1 The Committee heard that the introduction of fully driverless vehicles will have a significant impact on employment. Witnesses disagreed as to the extent, but most expect that there will be at least some job losses and changes in employment patterns.

5.2 At the same time, autonomous vehicles – both in the technological development and in the changes to society and the economy they are likely to bring – also offer new employment opportunities, and this chapter explores some of those and how Australia might be placed to take advantage in these new areas.

Job losses

5.3 While substantial impacts on the workforce are contingent on highly automated vehicles replacing human drivers – a prospect unlikely to eventuate in the short term – the Committee recognises that there will be negative impacts on the workforce as a whole and on the individual people who comprise it. For that reason, the Committee is of the view that both governments and industry should begin the process of preparing for the automation-led transition of the Australian workforce as soon as possible in order to minimise any potential negative effects.

5.4 The Australian Academy of Technology and Engineering (ATSE) noted that the impact on employment from automation in its broadest sense is a major issue facing the global economy in the short and medium term:

> The World Economic Forum estimates that a confluence of technological, socioeconomic and demographic drivers will displace 5.1 million jobs across 15 major economies by 2020. Modelling by CEDA [Committee for Economic Development of Australia] suggests that in Australia, almost five million jobs

> face a high probability of being replaced in the next decade or two while a further 18.4 per cent of the workforce has a medium probability of having their roles eliminated.
>
> Clearly, only a small proportion of these job shifts or losses will be directly as a result of driverless vehicles, but they will certainly be part of the total.[1]

5.5 The ARC Robotic Futures Research Team also noted that the employment impacts of driverless vehicles are part of the broader move towards automation of labour, and that the skills required by those employed in a driverless capacity are not the same as those required by drivers:

> In the domain of land-based transportation, the advent of driverless vehicles is likely to change the labour skills required in the trucking sector. Rather than entirely unmanned vehicles, research on automation indicates that the role of the driver is likely to change from vehicle control, to monitoring (Lipson and Kurman, 2016). The precise combination of skills required will likely change at different stages of the journey. For instance, highway driving with minimal variations might involve a high degree of automation, whereas city driving would require more human control for making deliveries and pick-ups.
>
> Nevertheless, many predict that the consequences for the current transportation labour force are likely to be negative, given that the economic rationale for driverless trucks to reduce labour costs and increase safety (e.g. Validakis, 2013). Predictions are for fewer workers with one operative potentially overseeing multiple vehicles.[2]

5.6 Further, while recognising that some new jobs will be created as a consequence of autonomous vehicles, the USC argued that, 'it appears likely that overall advanced AVs will result in an overall decrease in employment opportunities'.[3]

Professional drivers

5.7 The Department of Infrastructure and Regional Development (DIRD) noted that since professional driving roles are the most likely to be affected by increasingly automated vehicles, a substantial number of Australians will face uncertain employment futures:

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[1] Australian Academy of Technology and Engineering, *Submission 38*, pp 2 – 3.

[2] ARC Robotic Futures Research Team, *Submission 7*, p. 3.

[3] University of the Sunshine Coast, *Submission 37*, p. 12.

> … a range of current roles could experience varying degrees of disruption. For example, a number of professional driving roles could be automated to some extent in the future, including taxi, freight and public transport drivers. Around 247,000 Australians were employed driving trucks, buses and taxis in 2015.[4]

5.8 The Australian Driverless Vehicle Initiative (ADVI) acknowledged that the introduction of autonomous vehicles will fundamentally change the employment model for professional drivers, particularly taxi drivers:

> With trials of driverless taxis in Australia expected before the end of the decade, it is likely that drivers will still have a role to play, and while that may be different to current tasks, there will still be a need to provide full customer care when it is required - particularly for people living with a disability, the elderly, and others needing a higher level of support during their point to point journey.[5]

5.9 The Department of Industry, Innovation and Science (DIIS) suggested that there are several 'mitigating factors' which may reduce the risk of any sharp decline in employment for professional drivers. The first of these is, as mentioned above, the likely timeframe of any such change:

> Key predictions suggest that that any shift toward automation will take decades rather than years. A more gradual shift toward automation would increase the opportunity for labour to be absorbed by other growth industries. This kind of structural change is a continual process - around a million people have changed jobs in Australia every year over the past five years.[6]

5.10 DIIS also noted that the changing demographics of the professional driving sector will ease the transition. The workforce has seen:

> … a steady increase in the age profile over the last 30 years. In 2016, persons aged 45 and over represented over half of all workers in these occupations. Rather than significantly displacing the current workforce, automation of driving occupations may reduce the number of new entrants and allow older drivers to see out their careers to retirement.[7]

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[4] Department of Infrastructure and Regional Development, *Submission 26*, p. 29.

[5] Australian Driverless Vehicle Initiative, *Submission 9*, p. 11.

[6] Department of Industry, Innovation and Science, *Submission 29*, p. 6.

[7] Department of Industry, Innovation and Science, *Submission 29*, pp 6 – 7.

5.11 The Bus Industry Confederation (BIC) also pointed to the ageing demographics of the industry to note that employment effects may be manageable:

> The introduction of driverless buses in the Mass Transit Trunk Services segment if accepted by the community will cause a reduction in the existing driver work force. The transition to new driverless technology will need to be managed in a way that provides for an ageing workforce to be naturally retired from the workforce or retrained to take on new roles that will emerge. Drivers may become attendants on the bus for example.[8]

5.12 However, the BIC noted that retraining and redeploying older workers – particularly into a smaller total workforce in the sector – is likely to pose challenges for both the individuals involved and employers.[9]

Consequential changes

5.13 Beyond the directly affected industries, the Committee heard that autonomous vehicles will have a consequential impact on many other sectors.

5.14 The first of those is the broader vehicle industry, which extends well beyond professional drivers and associated roles. Motor Trades Association Queensland in its submission highlighted that approximately 90, 000 people are employed in the motor trades sector in Queensland alone. The advent of autonomous vehicles is expected to create:

> … significant changes in the employment profiles resulting in jobs phased out in some trades and new opportunities created in others. In regional areas employment will be less likely to be impacted by technological change as the internal combustion engine will continue to be the motor vehicle of choice.[10]

5.15 If, as many anticipate, increasingly automated vehicles reduce the number and severity of collisions and other accidents, industries based on the effects of these will see a corresponding change:

> … occupations that deal directly with the cause and effect of accidents such as insurers, crash repairers, road rule enforcement officers (including some police

[8] Bus Industry Confederation, *Submission 27*, p. 7.

[9] Bus Industry Confederation, *Submission 27*, p. 7.

[10] MTA Queensland, *Submission 13*, p. [4].

> officers and council parking infringement officers), accident and emergency workers and crash investigation workers.[11]

5.16 Similarly, the submission from the University of the Sunshine Coast (USC) noted that the effects of the changes will not be confined to professional drivers:

> … traffic police are likely to have very different roles in the future road system, and the courts may expect a reduction in caseload relating to road-related offences, potentially affecting employment for groups such as lawyers and registrars. There will also be implications for the health sector such as hospital workers and allied health professionals if the proposed reduction in road crashes eventuates.[12]

5.17 DIRD also noted that there would be further employment impacts if – as has been suggested – the rise in autonomous passenger vehicles significantly alters the current model of car ownership:

> Businesses involved in the supply of vehicles to market (manufacturers, car dealerships) could also be affected if the overall size of the vehicle market decreases due to greater use of shared mobility at the expense of private vehicle ownership.[13]

New job opportunities

5.18 Autonomous vehicles also bring the likelihood of new jobs, through increased demand in some existing sectors as well as through the evolution of entirely new industries and business models.

5.19 DIRD outlined some of the possible employment growth sectors in its submission, highlighting that opportunities may exist that are currently unthought of:

> … automation will create new business and job opportunities that could offset possible losses. There could be new roles in supplying, maintaining and operating automated vehicles, or other roles that use automated vehicles as a platform to deliver new kinds of services to the market. As with other

[11] Department of Infrastructure and Regional Development, *Submission 26*, p. 29.

[12] University of the Sunshine Coast, *Submission 37*, p. 12.

[13] Department of Infrastructure and Regional Development, *Submission 26*, p. 29.

> disruptive technologies, it difficult to anticipate the opportunities that may arise with automated vehicles.[14]

5.20 DIIS identified new job creation possibilities for Australian industry across a range of sectors, including:

- Manufacturing;
- Mining;
- Agriculture; and
- Integration with global value chains.[15]

What skills will be required?

5.21 As DIRD noted:

> … past experience in other sectors that have undergone technological transformation indicates that new roles tend to require higher skills and education, particularly in science, technology, engineering and mathematics (STEM), and are higher paid positions (Hajkowicz, et al., 2016). This can create a barrier to retrain or reskill displaced employees so they can transition to new roles. Government education policies continue to focus on equipping students for the future workforce by increasing participation in STEM education and improving digital literacy.[16]

5.22 Professor Bradlow of the Australian Academy of Technology and Engineering made a similar point, noting that there will need to be planning and preparation to mitigate the likely negative impact on employment:

> I personally believe we will see a significant disruption in employment, and we have to plan for that, because, while people have as an article of faith that there will be new jobs, that is true, but we do not know what they are. More or less, the experience of the last wave of digital disruption over the last 30 to 40 years is that the people who lose the old jobs do not get the new jobs, so we do have to plan for a significant disruption to the employment environment.[17]

5.23 Likewise, Dr Bissell of the ARC Robotic Futures Research Team emphasised that the shift in the nature of the jobs created will be a substantial one:

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[14] Department of Infrastructure and Regional Development, *Submission 26*, p. 30.

[15] Department of Industry, Innovation and Science, *Submission 29*, pp 7 – 10.

[16] Department of Infrastructure and Regional Development, *Submission 26*, p. 30.

[17] Professor Hugh Bradlow, President, Australian Academy of Technology and Engineering, *Committee Hansard*, 11 April 2017, p. 5.

> I think that the key thing that we probably want to emphasise here is that the skill set of those new jobs is going to be significantly different from the skill set of the jobs that we are talking about in terms of unemployment. What is particularly significant are the skills required for these new jobs. Much of the literature presently talks about the need for digital skills, which are a fairly broad and nebulous set of capacities, but they are something that obviously is going to be important at each level of education and from an early age as well.[18]

Committee view

5.24 The role of governments in planning for the change in employment brought about by the introduction of fully autonomous vehicles will be discussed further in chapter 8, however the Committee recognises that witnesses and submitters to this inquiry were near unanimous in agreeing that there will be considerable changes to the workforce. As mentioned above, there are job creation opportunities worth considering in the Australian context. The Committee is of the view that the Government should give further consideration to potential national employment benefits from autonomous vehicles.

Recommendation 5

5.25 The Committee recommends that the Commonwealth Government establish a working party with industry and academic stakeholders to identify industry needs regarding the development of automated vehicles and support services, and implement a strategy to ensure that Australia is best placed to exploit emerging opportunities.

[18] Dr David Bissell, Chief Investigator, ARC Robotic Futures Research Team, *Committee Hansard*, 24 May 2017, p. 9.

6. Access and equity

6.1 Second to increased safety, the most frequently discussed benefit of increasingly automated technology is how driverless vehicles will improve access and mobility for many people currently unable to operate a car. Advocates argue that both the lives of those individuals and the broader Australian society and economy will be improved by the increased opportunities afforded by driverless vehicles.

6.2 This chapter outlines some of those benefits, as well as identifying some concerns with the assumptions of increased access through driverless vehicles. The Committee considers it of the utmost importance that the benefits of driverless vehicles should be available to those Australians who need them the most.

6.3 As multiple witnesses noted, Australia is a signatory to the Convention on the Rights of Persons with Disabilities (CRPD), which includes obligations relevant to mobility: 'States Parties shall take effective measures to ensure personal mobility with the greatest possible independence for persons with disabilities'.[1]

[1] Convention on the Rights of Persons with Disabilities, United Nations Human Rights Office of the High Commissioner, Article 20 (http://www.ohchr.org/EN/HRBodies/CRPD/Pages/ConventionRightsPersonsWithDisabilities.aspx#20). See, for instance, Griffith Law Reform Research Team, *Submission 46*, pp 3 – 4; Queensland University of Technology, *Submission 19*, p. 4.

Mobility benefits

People with disability

6.4 The 2016 survey conducted by the Australian Driverless Vehicle Initiative (ADVI) found that the greatest perceived benefit – identified by 82% of respondents – of autonomous vehicles would be 'mobility for the impaired'.[2]

6.5 As ADVI notes, while driverless vehicles may improve the lives of all Australians, the effect will be particularly marked for people with disability:

> The introduction of driverless vehicles offer a previously unobtainable level of freedom that could see them relying far less on carers, family and public transport. Driverless vehicles offer a user the opportunity to travel further to work, explore locations not serviced by public transport and better enjoy their transport experience.[3]

6.6 Research led by Professor Simone Pettigrew of Curtin University found that 'By far, the greatest benefit that people could see from autonomous vehicles was the increased independence of people who currently cannot drive'.[4]

6.7 Dr Bissell of the ARC Robotic Futures Research Team also noted the importance of autonomous vehicles in improving mobility, arguing that mobility is central to:

> … enabling people to thrive in everyday life—how mobility relates to access to services, how mobility relates to access to employment, how mobility relates to access for leisure. Mobility is not just about getting from A to B; it is about opening up and enabling people's capacities in all kinds of ways.[5]

6.8 The Department of Infrastructure and Regional Development (DIRD) also pointed to this benefit in its submission, noting the number of Australians which it could affect:

> Automated vehicles have the potential to provide mobility to groups such as people with a disability, older people and children who currently have difficulties accessing transport services in our community (IGA, 2016, p. 7).

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[2] Australian Driverless Vehicle Initiative, *Submission 9*, p. 6.

[3] Australian Driverless Vehicle Initiative, *Submission 9*, p. 12.

[4] Professor Simone Pettigrew, Curtin University, *Committee Hansard*, 14 June 2017, p. 1.

[5] Dr David Bissell, Chief Investigator, ARC Robotic Futures Research Team, *Committee Hansard*, 24 May 2017, p. 12.

> They may also provide an opportunity for governments to service public transport needs in regional areas more effectively and efficiently.
>
> In 2015, almost one in five Australians reported living with disability (18.3 per cent or 4.3 million people). More than half of people with a disability aged 15 to 64 years participated in the labour force (53.4 per cent), which is considerably fewer than those without disability (83.2 per cent) (ABS, 2016b). Highly automated vehicles could improve these outcomes simply by providing more convenient access to transport services for people with a disability (IGA, 2016, p. 7).[6]

6.9 Similarly, the Griffith Law Reform Research Team noted a 2009 report which found that 29 per cent of respondents with disability identified transport as a barrier to their day to day life. The identified problems included 'inability to independently drive, heavy costs for modifications, and poor public transportation services'.[7]

6.10 Further, a 2015 survey of drivers with disability found that 90 per cent of respondents identified driving as their preferred mode of transport:

> This need for transportation goes beyond a simple 'getting from a to b', but is intrinsically tied to an individual's ability to receive medical treatment, find work, and enjoy freedom and independence that is often inadvertently denied and restricted because of an individual's disability.[8]

6.11 While these are important benefits, the submission from the Queensland University of Technology notes that 'the realization of these benefits assumes a very high level of autonomy that does not require human intervention'.[9]

6.12 The submission from the University of the Sunshine Coast made a similar point, noting that:

> When reliable level 5 automation becomes available, this will potentially increase transport options for individuals who are currently unable to apply for a driver's licence, which could have other benefits for these individuals and society in general (such as increased employment opportunities).[10]

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[6] Department of Infrastructure and Regional Development, *Submission 26*, pp 20 – 21.

[7] Griffith Law Reform Research Team, *Submission 46*, p. 9.

[8] Griffith Law Reform Research Team, *Submission 46*, p. 10.

[9] Queensland University of Technology, *Submission 19*, p. 3.

[10] University of the Sunshine Coast, *Submission 37*, p. 11.

Older Australians

6.13 ADVI also highlighted the benefit for older Australians who have lost the ability or will to drive: 'Australia's ageing population also stands to benefit from new vehicle technology, which provides an effective transport solution and opportunity to maintain a full and independent life rather than the isolation that can come from losing independent mobility'.[11]

6.14 Similarly, DIRD noted that older Australians – around half of who have a disability – may be able to use autonomous vehicles to improve their quality of life:

> Highly automated vehicles will enable older people to continue to visit the doctor, do their shopping and participate in the community (Siorokos, 2016). As with current restricted driving licences, people with a disability or medical conditions could qualify for a licence to operate an automated vehicle subject to passing whatever threshold is necessary for a vehicle with that level of automation (Tranter, 2016). Austroads is currently investigating how licencing requirements may need to be adjusted for automated vehicle technology.[12]

6.15 Drawing on DIRD statistics, the Griffith Law Reform Research Team noted that approximately 4 000 Australians lost their driving licence in 2016 due to age restrictions and, as Australia's population continues to age, an increasing number of people will lose their capacity to drive each year.[13] The submission further outlined some of the benefits of increased mobility via autonomous vehicles:

> By giving the elderly greater access to this advanced form of transport, this will reduce the issues of isolation, give them greater access to the community, and it will be safer for road users. Autonomous vehicles have been recognised as a mechanism that could achieve both independence and inclusion that the current situation does not achieve for the elderly.[14]

6.16 The submission from Maurice Blackburn Lawyers also pointed to the lifestyle improvements which autonomous vehicles could offer older Australians, and further noted the safety consideration:

> Elderly drivers are overrepresented in vehicle accident statistics, largely because reflexes can deteriorate with age. For those members of our

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[11] Australian Driverless Vehicle Initiative, *Submission 9*, p. 12.

[12] Department of Infrastructure and Regional Development, *Submission 26*, p. 21.

[13] Griffith Law Reform Research Team, *Submission 46*, p. 7.

[14] Griffith Law Reform Research Team, *Submission 46*, pp 7 – 8.

> community with reduced mobility, the introduction of automated vehicles may increase their access to a safer method of transport. This has a further advantage of partially alleviating pressure on our community support networks.[15]

6.17 The National Farmers' Federation highlighted the benefits which driverless vehicles will be able to bring to people in regional, rural and remote Australia:

> Elderly, ill or disabled people living on isolated properties are not able to receive the same at home care provided to Australians living in townships. Driverless vehicles could assist in enabling services such as the Commonwealth Home Support Programme to access properties further away from towns by enabling care providers to travel more safely and efficiently by, for example, doing administrative tasks while driving to farms and stations outside of the current radius of care provision. Driverless vehicles could also help facilitate the arduous drive to and from town for Australians living in rural and remote locations, thus enabling them to access health care in town with less reliance on their support network to get to medical appointments.[16]

Concerns about access and equity

6.18 While the benefits discussed above are frequently highlighted by autonomous vehicle advocates, the Committee also notes some of the concerns raised in relation to access and equity. A significant barrier to these anticipated benefits – particularly in the short term – will be the likely cost of driverless vehicles. As with most new technologies, the initial cost of fully automated passenger vehicles is likely to be higher than for existing driver-operated equivalents.

6.19 As the QUT submission notes, 'However, in order to achieve these benefits it will be important to ensure that automated transportation options are affordable and accessible'.[17]

6.20 Similarly, the ARC Robotic Futures Research Team's Dr Bissell, arguing that mobility has a central place in people's capacity to access services, employment and leisure, also emphasised that autonomous vehicles may

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[15] Maurice Blackburn Lawyers, *Submission 25*, p. 9.

[16] National Farmers' Federation, *Submission 22*, p. 2.

[17] Queensland University of Technology, *Submission 19*, p. 4.

serve to widen social inequalities if access to them is limited for those who need them.[18]

6.21 Concerns about affordability and accessibility are amplified for Australians in regional, rural and remote areas, as academics from QUT noted:

> In Australia, access and equity issues will be also a significant problem for rural and remote communities. Not only is the road infrastructure unlikely to be ready for passenger vehicles in remote environments but the acceptance, affordability, and maintenance of such technology in remote areas may be difficult to implement. Planning for the introduction of automated vehicles and incentives to encourage their use as part of strategies to reduce road congestion should be inclusive of the needs of persons with disabilities, the elderly, and those living in rural and remote areas.[19]

6.22 The ARC Robotic Futures Research Team pointed to similar concerns, noting that the increasing prevalence of autonomous vehicles may result in a widening of the digital divide, whereby older drivers – along with less wealthy ones – are unable to access the benefits of these vehicles:

> In Australia an unprecedented number of older drivers will be on the highways in the next few decades and these older drivers are not liable to forego automobile-dependence (Nakanishi and Black 2015). A chief risk here is the creation of a 'two-tier society'—that is, through class or age—between conventional road vehicles and those that are networking with the infrastructure, autonomous from human control and connected to each other (McCarthy 2016). Moreover, as driverless systems mature infrastructural investments will no doubt target affordances that are irrelevant or deleterious to solely human driven vehicles, such as vehicle-to-vehicle (e.g., platooning) or vehicle-to-infrastructure (e.g., wireless enabled traffic lights) communication systems (Lipson and Kurman 2016: 128). These will further alienate those unable or unwilling to utilize driverless systems.[20]

6.23 The Motor Trades Association Queensland made a similar point, emphasising that the Australians who would stand to benefit the most from driverless vehicle technology may be amongst those to have the least engagement with it:

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[18] Dr David Bissell, Chief Investigator, ARC Robotic Futures Research Team, *Committee Hansard*, 24 May 2017, p. 12.

[19] Queensland University of Technology, *Submission 19*, p. 4.

[20] ARC Robotic Futures Research Team, *Submission 7*, p. 5.

> The main down-side to general social acceptance is what may be termed as 'techno fear' for the upper 'baby-boomer' age bracket. In this circumstance, there is a reverse relationship where the people to benefit the most from autonomous vehicles will be older generations but it will be the younger cohorts who will assimilate the technology at the most rapid rate and apply it for professional or private advantage.
>
> It appears that a challenge for government, community organisations and industries over the longer term will be the implementation of programs to assist older generations to digest the new technological knowledge and adjust to the benefits of emerging transport choices which include accessing or owning autonomous vehicles.[21]

6.24 The MTA Queensland also noted the likely geographic divide that could accompany those of age and class:

> There is a need to address the social equity of the introduction of autonomous vehicle technology. Economies of scale and business models are likely to favour the urban uptake of this technology and if the social utility of the introduction of autonomous vehicles is to be equitable, support programmes for rural and regional areas need to be considered.[22]

6.25 Similarly, Mr Stuart Ballingal from Austroads argued that the social benefits of autonomous vehicles should not be the sole preserve of those in urban areas:

> … we often read and hear about the coming automated taxis or ride-share services, that will be able to take you point to point, and how they will have great benefits for those who do not otherwise have access to mobility because they cannot get a drivers licence or whatever the case may be. That is fine in a dense urban area, but we cannot overlook what rural areas require. If they do not have the population to commercially support that service or they do not have the infrastructure to support that vehicle technology, then they are going to miss out on the societal benefits from those new mobility services. That is a key point I would like to raise with the committee: do not focus just on dense urban areas, because it could be at the expense of societal benefit to rural areas.[23]

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[21] MTA Queensland, *Submission 13*, p. [2].

[22] MTA Queensland, *Submission 13*, p. [2].

[23] Mr Stuart Ballingall, Program Director, Connected and Autonomous Vehicles, Austroads, *Committee Hansard*, 11 April 2017, p. 20.

6.26 While increasingly automated vehicles have been posited by many advocates as improving accessibility and mobility options for people with disability, Deaf Australia noted that in some instances the reverse is true, and accessibility for people with disability is actually being lowered:

> Yet, many new developments on vehicles (both commercial and private) have consistently relied on sounds and/ or audible alerts which prevents deaf people taking advantage of a range of features available to non-deaf people. This can lead to preventing them from potential in obtaining meaningful employment.
>
> We believe this lack of universal design where sounds are not accompanied by visual systems has intentionally or unintentionally caused various barriers where products, services, environments are not accessible for deaf and hard of hearing people who require specialised modifications. This further marginalises deaf and hard of hearing people.[24]

6.27 For that reason, Deaf Australia recommended that all vehicles which use an audible warning and/or operation system should also include visual systems.[25]

Committee view

6.28 The Committee notes that a wide range of witnesses and submitters have identified increased mobility – and therefore improved quality of life – as a likely benefit of driverless vehicles. The Committee recognises this as an important social benefit.

6.29 The Committee believes that great social benefit can come from driverless vehicles, and that it is of critical importance that the identified benefits of improved mobility and access for people with disability and older Australians are realised. The Committee further emphasises that many of these benefits will be felt most strongly in regional and rural areas and therefore notes that the infrastructure to enable this must be of a sufficient standard in those areas.

[24] Deaf Australia, *Submission 30*, pp 1 – 2.

[25] Deaf Australia, *Submission 30*, p. 3.

Recommendation 6

6.30 The Committee recommends that the Commonwealth Government's preparation for autonomous vehicles includes consideration of how the needs of people with disability, older Australians and those in regional and rural areas can be met via automated vehicles.

7. Public transport applications

7.1 Driverless vehicles have the capacity to revolutionise how Australians think about and access public transport. This chapter will discuss the major potential benefits which autonomous vehicles could have for public transport services, especially in regional Australia, along with some of the concerns the Committee heard.

7.2 As the Department of Infrastructure and Regional Development (DIRD) noted:

> Automated vehicles have significant potential to improve public transport services and deliver increased social benefits, particularly for people who do not live close to major public transport hubs or routes with regular services, including in regional areas.[1]

7.3 DIRD identified some possible public transport application of driverless vehicles in its submission:

- improved first and last mile connections to existing services, particularly if automated vehicles are deployed as a low-cost, on-demand service;
- new mobility options in areas not linked by public transport and in areas of low patronage; and
- potential reductions in the need for investment in new services and infrastructure (if automated vehicles create large efficiency benefits).[2]

7.4 As the Bus Industry Confederation (BIC) noted, the economics of bus operation would favour automation, since the driver's wages account for

[1] Department of Infrastructure and Regional Development, *Submission 26*, p. 22.

[2] Department of Infrastructure and Regional Development, *Submission 26*, p. 22.

approximately half the costs of running an urban route bus service.[3] Removing this component could therefore turn currently unviable services into financially sustainable ones.

7.5 The submission from Swinburne University of Technology highlighted some of the reasons why autonomous public transport could be amongst the first passenger-focused examples of driverless technology:

> Full automation of buses, for example, could be much easier to achieve than for private vehicles. When the situations in which autonomous vehicles must operate on shared road space are limited, this would greatly increase their feasibility. Fixed route buses with high ridership are perfect examples of this possibility. They run on pre-set paths in a narrow range of situations and in some cases they have their own exclusive lanes. Unlike vehicles that could go anywhere, fixed route buses don't need a map of absolutely everywhere.[4]

7.6 Similarly, Telstra pointed out that, without having to factor in the cost of a driver, 'there is no imperative for public transport to be based around the use of large vehicles like buses and trams. This provides a completely new set of possibilities for public transport that is highly configurable'.[5]

7.7 Amongst the most important potential impacts of autonomous vehicles could be the increased public transport options for Australians in regional areas. DIRD discussed this option in its submission:

> Automated transport also has the potential to fill gaps in public transport services in some regional areas, with significant social benefits for residents, including increased access to employment opportunities. For example, on-demand public transport services using small automated vehicles with low operating costs could significantly improve service coverage in satellite towns around Australia's major cities. This type of automated transport could be cost competitive with regional rail links or bus services, or could fill last-mile service gaps.[6]

RAC Intellibus Trial – Perth

7.8 As part of its inquiry, the Committee undertook an inspection of the RAC Intellibus trial in Perth. This, launched in August 2016, was the first automated vehicle trial in Australia and had three aims:

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[3] Bus Industry Confederation, *Submission 27*, p. 6.

[4] Swinburne University of Technology, *Submission 39*, p. 8.

[5] Telstra, *Submission 14*, p. 6.

[6] Department of Infrastructure and Regional Development, *Submission 26*, p. 24.

- increase the understanding about the potential impacts and opportunities from the advent of AV technology;
- give Western Australians the chance to see AV technology and use and experience it; and
- further help WA prepare a roadmap for changes to support and safely transition to AV technology.[7]

7.9 One of the key findings of the Intellibus trial reiterates a key theme of this inquiry – that more exposure to autonomous vehicles leads to a better understanding and higher levels of acceptance. In the case of the Intellibus, RAC found:

> We survey every person who goes on the shuttle bus both before and after they travel, and we know that 93 per cent of them feel better or more positive about level 4 vehicles once they have been on the Intellibus and 98 per cent of all of our survey respondents say they can see it being a viable mode of transport in the future. It is really difficult to get 98 per cent of people to agree on anything, and usually we are in the 30s and 40s—and that is if we get a response. Our response rate has been fantastic. The community is absolutely aware of it. They are definitely engaged. The critical thing will be making sure they are a part of the story for how we roll out these vehicles in the future.[8]

Rail

7.10 While much of the focus of this inquiry was on road-based vehicles, the Committee also heard that rail systems will offer some of the first options for completely automated transport in Australia. Freight trains will be one of the earliest applications of fully autonomous vehicles, but the public transport options will also exist. DIRD's submission notes that automation in the rail industry is 'a mature technology', with over 50 driverless metro lines across 37 cities worldwide.[9]

7.11 The key benefits of rail-based driverless public transport are largely the same as for road-based vehicles, including improved capacity, lower running costs (in part due to reduced staffing costs) and increased safety.[10]

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[7] RAC WA, *Submission 18*, p. [2].

[8] Ms Anne Still, General Manager, Public Policy, Royal Automobile Club of Western Australia, *Committee Hansard*, 3 April 2017, p. 8.

[9] Department of Infrastructure and Regional Development, *Submission 26*, p. 45.

[10] Department of Infrastructure and Regional Development, *Submission 26*, p. 48; Office of the National Rail Safety Regulator, *Submission 6*, p. 1.

As DIRD's submission notes, the successful use of driverless train systems across the world suggests that public acceptance of fully autonomous trains is at a higher level than for road-based vehicles.[11]

7.12 In Australia, the first example of a driverless rail system is currently under construction: the Sydney Metro Northwest project. The New South Wales Government's submission highlighted that Sydney's Metro rail system will be 'a highly controlled, closed system where access is restricted to the automated vehicles, which do not have to interact with other types of trains, road vehicles or pedestrians'.[12]

7.13 Dr Herath of the University of Canberra pointed to rail as an obvious first step in the automation of public transport in Australia:

> That is a key area we should look into right now. In terms of improving efficiency, that is one of the first steps you would want to look into. That is where some of these partnerships could happen, because they have immediate benefits, both economic and social, and efficiency-wise. That is the sort of thing you would want to look into as a first stage of transition rather than looking at the automation of other transport like cars and commuter buses.[13]

7.14 The Office of the National Rail Safety Regulator (ONRSR) is responsible for accrediting rail safety operators in Australia. For an operator to gain that accreditation, they 'must be able to demonstrate competence and capacity in managing risks to safety'. Risks must be assessed and mitigated 'so far as reasonably practicable'.[14]

7.15 As the NTC's submission notes, the ONRSR's accreditation model means that 'there are unlikely to be regulatory barriers to introducing more automated trains in Australia'.[15]

Concerns

7.16 One concern regarding public transport in the context of driverless vehicles is that the rise in autonomous passenger vehicles may act as a disincentive for people to use public transport. As DIRD's submission noted:

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[11] Department of Infrastructure and Regional Development, *Submission 26*, pp 45 – 47.

[12] New South Wales Government, *Submission 35*, p. 17.

[13] Dr Damith Herath, University of Canberra, *Committee Hansard*, 14 June 2017, pp 2 – 3.

[14] Office of the National Rail Safety Regulator, *Submission 6*, p. 1.

[15] National Transport Commission, *Submission 28*, p. 25.

> … it is also possible that automated vehicles could compete for trips with existing public transport services, especially because of increased convenience, comfort and privacy. Early modelling (based on data from the Netherlands) suggests that the costs of using shared automated vehicles could be significantly lower than owning a traditional vehicle, and that these costs could be commensurate with public transport fares. If this scenario were to eventuate, it could affect the economics of public transport networks and future investment, and increase congestion on the road network.[16]

7.17 An issue raised by some witnesses was that the functions of existing drivers and other employees on public or mass transport systems are not exclusively related to the control of the vehicle. Drivers and conductors serve other roles, including ticketing, social supervision and passenger assistance. While a driver may no longer be necessary on the vehicle, there will still need to be a staff member to carry out the other roles.

7.18 The Bus Industry Confederation (BIC), for instance, argued that the public may not willingly accept entirely driverless buses:

> The BIC would note however that the concept of a driverless bus, in particular large buses, may be technologically possible but the reality of mass transit and school bus services operating in this way are much less certain for a variety of operational and personal safety and societal issues. The unknown element from a bus perspective is if it is going to be accepted by users concerned about safety and security. Measures to gain the trust of the community in relation to safety and security will be very important, but ultimately they may not be successful. This issues has the potential to block the use of driverless buses and may limit the technology to personal conveyances and may even restrict them.[17]

7.19 The BIC pointed to overseas experience to support this argument, noting that a 'driver' of a bus seems to be preferred by many passengers:

> One factor that has been recognised after actual trials of driverless buses on guided busways in France is that passengers do have concerns of trust and safety when a driver is not aboard. In this example, drivers were returned to the bus to ease concern, despite the fact that the vehicle remained self-driven. The physical presence of the driver was an important psychological factor,

[16] Department of Infrastructure and Regional Development, *Submission 26*, p. 22.

[17] Bus Industry Confederation, *Submission 27*, p. 3.

> even if it was only for "override" capabilities if required. Trusting future technology will be a major challenge for many individuals.[18]

7.20 The Australian Driverless Vehicle Initiative (ADVI) provided further research support for this point, based on its 2016 survey of Australians' attitudes towards autonomous vehicles. That survey found that only 43 per cent of respondents were comfortable with the idea of travelling on public transport – such as a bus or taxi – without a driver. Only slightly more (46 per cent of respondents) were comfortable with the suggestion of share cars – travelling in a small vehicle with strangers.[19]

7.21 If the suggestion that a non-driving staff member on board the vehicle will still be required is correct, then the benefits, other than improved safety, of driverless vehicles to mass public transport may be limited. Many of the expected benefits – particularly for regional areas – described above are based on the premise that driverless public transport options will be flexible and more economical than those requiring human drivers.

7.22 A related point was made by the Motor Trades Association Queensland, noting that the impact of autonomous vehicles on the public transport sector need to be understood in the context of Australia's overwhelmingly private transport-focused pattern:

> Public transport systems/modes may emerge that provide solutions not available previously, but to date public transport has not been the transport mode of choice and it seems on average less than 10 per cent of Australia's workforce utilises public transport to travel to work. Private motor vehicles have been the transport of choice resulting in urban transport congestion, environmental degradation and generating social cost for communities and cities.[20]

Committee view

7.23 As with other aspects of driverless vehicles, it is likely that attitudes towards driverless public transport will change once more people experience the technology. The Committee therefore is of the view that trials of autonomous vehicles in Australia should focus on vehicles with public

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[18] Bus Industry Confederation, *Submission 27*, p. 6.

[19] Australian Driverless Vehicle Initiative, *Submission 9*, p. 8.

[20] MTA Queensland, *Submission 13*, p. [5].

transport applications. The existing trials of buses in Perth and Darwin could provide models for other trials.

7.24 While the Intellibus itself – like the Darwin Waterfront driverless bus trial that began in February 2017 – is only a small vehicle, and therefore not comparable to large commuter buses, the Committee nonetheless recognises that these trials serve important roles in increasing people's familiarity with driverless vehicle technology. Further, they point to a potential future application of public transport, in which small autonomous vehicles provide more focused and localised services than has traditionally been the role of public transport. The emergence of driverless vehicle technology will bring about a change in the role of public transport without necessarily replicating existing public transport structures.

7.25 The Committee is of the view that improving public transport options, particularly in regional and rural Australia, will offer a substantial public benefit.

Recommendation 7

7.26 The Committee recommends that the Commonwealth Government, in association with state and territory governments and local councils, consider funding of trials of automated vehicles with a public transport application, in both metropolitan areas and regional locations.

8. The role of governments

8.1 This chapter discusses the role of governments in Australia in preparing for the social issues surrounding driverless vehicles, aside from those discussed in previous chapters. The focus of this chapter is on the importance of consistency Australia-wide: evidence received by the Committee broadly agreed that the successful introduction of autonomous vehicles into Australia relies on a consistent approach.

Consistent approach

8.2 As noted throughout this report, one of the key points made by a wide range of submitters and witnesses to this inquiry was that Australia needs to adopt a nationally consistent approach to driverless vehicles. This applies to infrastructure standards and to regulatory approaches.

8.3 Toyota Australia, for instance, made this point, noting that Australia's relatively small population size makes it more important that manufacturers see the entire country as one market with nationally consistent infrastructure, rules and guidelines:

> … in order to get the best outcomes from driverless vehicles and the related technologies, we see the need for a consistent approach across Australia, across all the states and territories. Again, it is very positive. The publication of the national trial guidelines, which I think are expected out in May this year, will create a good foundation. This single national guideline, we hope, will then create, as organisations wish to undertake trials throughout Australia, some consistency in the application of the approach.[1]

[1] Mr Andrew Willis, Manager, Government Affairs, Toyota Australia, *Committee Hansard*, 11 April 2017, p. 39.

8.4 In November 2015, the National Transport Commission (NTC) was given a central role in coordinating Australia's regulatory approach to autonomous vehicles, as the NTC's Chief Operating Officer Dr Geoff Allan explained to the Committee:

> When the Transport and Infrastructure Council, which is a COAG committee of transport ministers from around Australia, met in late 2015, they stated that they wanted Australia to work towards harmonised standards and regulations in relation to automated vehicles to ensure that Australia was well positioned to adopt new technologies. That is a nationally consistent approach, so we position ourselves well in the international market. To achieve that, ministers asked the NTC to prepare for more autonomous vehicles by identifying regulatory and operational barriers… When we reported back to ministers in November 2016 ministers endorsed a plan to remove some of those barriers to allow for the uptake of automated vehicles.[2]

8.5 The NTC's Mr Marcus Burke further emphasised that the Australian approach to the regulation of autonomous vehicles is a national one, and is based on concerns raised by industry:

> We are aiming to develop an approach which is national. We do not want to have a situation where vehicles cannot cross state borders due to different regulations in different parts of the country, and that is something we have heard very clearly from industry. We want to support innovation and support the safe deployment of this new technology in order to in particular reduce the current death toll and rate of serious injuries on our roads. We heard very clearly from industry on the need for consistency both nationally and with emerging international standards, given that Australia is a relatively small market for vehicles.[3]

Infrastructure needs and readiness

8.6 This section discusses the infrastructure needs of autonomous vehicles and the different levels of infrastructure these vehicles require to existing driver-controlled vehicles.

8.7 The Department of Infrastructure and Regional Development (DIRD) highlighted that, currently, the infrastructure needs of autonomous vehicles are unclear:

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[2] Dr Geoff Allan, Chief Operating Officer, National Transport Commission, *Committee Hansard*, 11 April 2017, p. 8.

[3] Mr Marcus Burke, Project Director, Compliance and Technology, National Transport Commission, *Committee Hansard*, 11 April 2017, p. 9.

> Automated vehicles may also require the deployment of new kinds of digital infrastructure (e.g. communications infrastructure, accurate satellite positioning) or may require aspects of physical infrastructure to be designed and maintained to a particular standard (e.g. road signage, line markings, road geometry). At the current time, given the early stage of automated vehicle development and trials, there is significant uncertainty about what the exact future requirements might be.
>
> An additional challenge is that not all developers of automated vehicles will use the same enabling technologies, meaning that it is possible that different vehicles could have different technical requirements. There are also different approaches to the design and maintenance of physical infrastructure across Australia, which in the past has presented a barrier to the deployment of technologies such as automatic speed zone recognition.[4]

8.8 The Royal Automobile Club of Western Australia (RAC WA) made a similar point, noting that planning to date has not sufficiently recognised that traffic patterns are likely to change with the introduction of autonomous vehicles:

> … much of the longer-term planning for road infrastructure requirements is informed by transport models which do not take account of the implications of AVs on travel demand and behaviours. This situation is unlikely to be unique to WA, and further research is needed to better understand these implications.[5]

8.9 Mr Alex Foulds of DIRD also noted that infrastructure is a major investment for governments (at all levels) – not just in terms of money but of timeframes of infrastructure projects:

> I think it is important that the investment also is guided by real-world experience. For example, if you build a road, it takes four years to build—it is with you for 60 years, maybe more. If you build a car and design a car from scratch, it takes two to three years—and it is with you for maybe eight to 10, on the whole. Software—overnight. They are the clock speeds that sit around the way things are developed. So you do not want to commit to a 60-year long piece of—potentially stranded—infrastructure until you know that that is actually what you need, and that it is fit for growth, and that it can accept change.[6]

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[4] Department of Infrastructure and Regional Development, *Submission 26*, p. 28.

[5] RAC WA, *Submission 18*, p. [9].

[6] Mr Alex Foulds, Executive Director, Surface Transport Policy Division, Department of Infrastructure and Regional Development, *Committee Hansard*, 21 June 2017, p. 3.

Consistency

8.10 One of the strongest points made by witnesses and submitters to this inquiry was the importance of consistent road infrastructure across Australia. For autonomous vehicles to operate successfully across the country, infrastructure – in particular, road markings and signs – will need to be consistent nationwide.

8.11 Mr Ashley Wells of the Federal Chamber of Automotive Industries reflected on this, noting that Australia's federal system may pose some problems for automated vehicle sensors:

> There are apparently global standards for road signs. Australia has taken a slightly different path, and we do have differences across the states and territories relating to those as well. The federal highway system is somewhat different, but when you get into individual states there can be some differences. So the in-car cameras, and the technology that is going into those, are obviously not sophisticated enough to pick up the nuances that come with the various state and territory changes.[7]

8.12 Austroads, the association of road transport agencies across Australia (and New Zealand) emphasised that consistency of approach is central to the work of road agencies:

> As has been highlighted in our submission and in the submissions from other stakeholders at these hearings, it is extremely important that the regulatory and operational frameworks to support the deployment of automated vehicles are nationally consistent. In an effort to achieve this Austroads works very closely with the Commonwealth Department of Infrastructure and Regional Development, the NTC and its road agency members in each of the jurisdictions.[8]

8.13 Austroads also has an industry reference group whose role is to ensure that industry is engaged in the process of preparing road infrastructure for the arrival of autonomous vehicles.[9]

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[7] Mr Ashley Wells, Policy Director, Federal Chamber of Automotive Industries, *Committee Hansard*, 31 May 2017, p. 2.

[8] Mr Nick Koukoulas, Chief Executive Officer, Austroads, *Committee Hansard*, 11 April 2017, p. 16.

[9] Mr Nick Koukoulas, Chief Executive Officer, Austroads, *Committee Hansard*, 11 April 2017, p. 16.

Road quality

8.14 The Committee heard that a significant issue with Australia's readiness for autonomous vehicles was that the quality of roads in Australia is variable. This may cause substantial problems – particularly in regional areas – for the functioning of driverless vehicles.

8.15 As DIRD noted, infrastructure in regional Australia is not consistently at the level required to support autonomous vehicles:

> A significant challenge to the deployment of automated vehicles in regional areas is the provision of supporting infrastructure. Depending on how technology develops, this could include requirements for both physical infrastructure (e.g. sealed roads, signage, road markings) and digital infrastructure (e.g. mapping data or communications infrastructure). Improving infrastructure in regional Australia would require a concerted effort by all levels of government.[10]

8.16 Austroads highlighted the scale of the issue – Australia has approximately 900, 000 kilometres of roads, approximately 85 per cent are the responsibility of local councils.[11] Over half of Australia's road kilometres are unsealed dirt roads, which will present significant issues for automated vehicles in their current form.[12]

8.17 Austroads was also able to point to the specific areas of concern raised by the vehicle manufacturers:

> With regard to physical infrastructure, with the consultations that we did, particularly with car companies and tech companies, the barriers that they are seeing at the moment—some of them are having issues with lines, where they might be non-existent, inconsistent or deteriorated. They are certainly having issues with inconsistency with road signs, and speed signs in particular. One issue that has been highlighted during our consultations is dynamic electronics signs, LED signs, in that they do not necessarily work at the same frequency rate as the signs in Europe. We have car companies that have actually withheld safety applications, because of the infrastructure that we have. The other issue that has come through, particularly from our international colleagues doing trials, is the condition of the pavement itself. The technology is just at a point where it may not be able to handle where

[10] Department of Infrastructure and Regional Development, *Submission 26*, p. 24.

[11] Mr Nick Koukoulas, Chief Executive Officer, Austroads, *Committee Hansard*, 11 April 2017, p. 16.

[12] Mr Stuart Ballingall, Program Director, Connected and Autonomous Vehicles, Austroads, *Committee Hansard*, 11 April 2017, p. 20.

> there is significant deterioration of the pavement—potholes et cetera. So, we cannot forget the basics. It is not only those attributes that you think that the sensors are reading but also the condition of the road that is affecting how these vehicles operate.[13]

8.18 Roadworks and other changes to existing road environments remains one of the major problems for autonomous vehicles to solve, as Mr Ballingal of Austroads further explained:

> … in the consultations we did with car companies and supporting tech services, that was highlighted as a key issue. There are basically two ways that a vehicle could identify that it is entering a roadworks area. One is by receiving data—so there could be a map service coming from a cloud service—that is where the permitting comes in; permitting a site to be a work zone. The second is the sensors on the vehicle detecting that it is entering a work zone. That is a real issue at the moment because we do have inconsistencies with our roadwork sites. That is going to be a key area with Austroads moving forward, to try to raise the consistency in the standards in those sites.[14]

Digital infrastructure

8.19 While road quality can affect all forms of vehicles, the Committee heard that satellite and internet infrastructure is necessary for autonomous vehicles, and that particularly in regional areas, may require further improvement to support their operation.[15]

8.20 In its evidence to the Committee, Austroads noted the importance of this form of infrastructure, in particular ensuring the vehicles have up-to-date information about changes to roads:

> With digital infrastructure, data is going to be critical. For the most part, the market will support that. We have mapping data providers that have better data on our roads than road agencies do, but there will be some attributes for which a road operator will still be the authoritative source. It is still within a jurisdiction where the decision is made to close a road, close a lane, give a permit to do roadworks or change a speed zone, and so, somehow, the road

[13] Mr Stuart Ballingall, Program Director, Connected and Autonomous Vehicles, Austroads, *Committee Hansard*, 11 April 2017, p. 17.

[14] Mr Stuart Ballingall, Program Director, Connected and Autonomous Vehicles, Austroads, *Committee Hansard*, 11 April 2017, pp 18 – 19.

[15] See, for instance, Mr Mark Harvey-Sutton, Manager, Rural Affairs, and Ms Maxie Hanft, Policy Officer, National Farmers' Federation, *Committee Hansard*, 14 June 2017, pp 10 – 12.

> agencies have to feed into that supply chain. That is part of the digital infrastructure.[16]

8.21 Austroads also emphasised that the digital infrastructure requirements will be dependent on the type of vehicle and its use:

> It is not like every vehicle is going to need a cellular connection 100 per cent of the time everywhere. It will depend on how the manufacturers develop that vehicle to operate. We call it an operational design domain, so it is within the boundaries of what it is designed to do. But certainly, moving forward, it is something that as a country we need to give appropriate consideration to. Compared with other developed countries, our geographic coverage of cellular communications is relatively low. It is high by population; it is not high by geography. It could be that if we want to support more automated-use cases, such as truck platooning on rural highways, we will need to give consideration to communications coverage.
>
> The other digital infrastructure that I would highlight is around positioning services, particularly satellite positioning services. On that one, we are working very closely with not just the Commonwealth Department of Infrastructure and Regional Development but also Geoscience Australia.[17]

8.22 One resolution to concerns raised regarding digital infrastructure is currently being tested by Geoscience Australia. The Satellite Based Augmentation System, which is a program to overlay information:

> An augmentation system is an overlay that works with GPS to improve the accuracy from the standard five to 10 metres that you will get from GPS down to submetre levels of accuracy.
>
> This is relevant because the North Americans, the Japanese and the Europeans—some of the largest car manufacturers—already have augmentation systems in place. The positioning component of the multisensor units that are in vehicles that are being designed now are coming from SBASs, but in Australia we do not have one. We were funded, through MYEFO last year, to undertake a two-year testing program of a satellite based augmentation system across Australia, and then our New Zealand friends subsequently joined in the testing as well, by contributing another $2 million.

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[16] Mr Stuart Ballingall, Program Director, Connected and Autonomous Vehicles, Austroads, *Committee Hansard*, 11 April 2017, p. 17.

[17] Mr Stuart Ballingall, Program Director, Connected and Autonomous Vehicles, Austroads, *Committee Hansard*, 11 April 2017, p. 17.

> We are coordinating that testing through the Cooperative Research Centre for Spatial Information, and right now we are in the process of assessing—we had something like 60 proposals for different testing examples that could be undertaken with the SBAS. We are trying to now cut them down and get groups together to fit within the allocated research budget. Two of those are relevant to this discussion. One of them is around autonomous cars and the other one is around intelligent transport systems in heavy vehicles, both with state government leadership but also industry participation. We think that is going to take us in the right direction as far as transport goes.
>
> The important part about an SBAS is that it is not reliant on a telecommunications network in any shape or form. The corrections actually come from space. So a person sitting out the back of rural Australia, in the Simpson Desert, gets exactly the same access to signals as a person sitting in one of the larger metro areas—in fact, probably improved access than someone who is sitting in an urban canyon for some reason, because of visibility of the satellite itself.[18]

Employment preparation

8.23 As discussed in chapter 5, the shift to fully driverless vehicles, particularly as part of the larger move towards automation of many tasks, will cause significant changes in the current employment model. In order to minimise the negative effects of that change, all levels of government, alongside industry, will need to prepare.

8.24 Mr Harrison of the Council of Capital City Lord Mayors made the point that the transition is not far off and will happen quickly:

> When you go back to the early days with settlers, there were whipmakers, groomsmen that would look after horses and things like that. Those jobs all disappeared, but with the new technology came new jobs. But there was a long transition. It was 26-odd years before we started seeing a lot of vehicles on the road. That is going to happen much more quickly this time. From a social perspective, for those people who may lose their jobs due to autonomous vehicles there will be new jobs that will come but it is incumbent upon the three levels of government to work with the universities and our TAFEs to identify those new jobs and make sure that we are reskilling people

[18] Mr Gary Johnston, Branch Head, Geodesy and Seismic Monitoring Branch, Geoscience Australia, *Committee Hansard*, 21 June 2017, pp 4 – 5.

> to take on those new jobs and that people do not fall through the gaps with these changes that are inevitably going to come.[19]

8.25 Some witnesses identified that Australia has traditionally had problems retaining trained and skilled young workers in the science, engineering and information technology fields, but that Australian universities have recently had a strong focus on autonomous technologies, including vehicles.[20]

8.26 The Department of Industry, Innovation and Science noted the importance of planning for this workforce change, and highlighted the Commonwealth Government's National Innovation and Science and Agenda to encourage increased levels of STEM literacy amongst Australians:

> Part of the government's role in facilitating a move to new and growing industries is enabling workers to develop the right skills for the jobs of the future.
>
> Australia's workforce will need to be equipped with the right skills and training – from basic digital literacy to complex science, technology, engineering and mathematics (STEM) expertise – to be able to undertake the jobs created around autonomous vehicle development and use. For example, a very large quantity of data will be generated by connected and autonomous vehicles. Different skillsets will be required to build and maintain the systems, servers and processors to protect this asset, as well as manage, analyse, and make sense of the data.[21]

Committee view

8.27 The Committee recognises the importance of a nationally consistent approach to the preparation for and introduction and regulation of driverless vehicles in Australia and was pleased to hear that a consistent approach is currently being taken, with cooperation between the Commonwealth and state and territory governments via the Transport and Infrastructure Council and with a coordinated approach being led by the Department of Infrastructure and Regional Development, the National Transport Commission and Austroads.

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[19] Mr Steven Harrison, Chief Adviser to the Lord Mayor and Chief Executive, City of Adelaide, Council of Capital City Lord Mayors, *Committee Hansard*, 14 June 2017, p. 9.

[20] See, for example, Mr Carl Liersch, Department Manager, Engineering and Business Development, Chassis Systems Control, Robert Bosch (Australia) Pty Ltd, *Committee Hansard*, 11 April 2017, pp 29 – 30; Dr Damith Herath, University of Canberra, *Committee Hansard*, 14 June 2017, p. 2.

[21] Department of Industry, Innovation and Science, *Submission 29*, pp 12 – 13.

Recommendation 8

8.28 The Committee recommends that the Commonwealth Government, in consultation with state and territory governments, continues to coordinate their approach to automated vehicles, ensuring consistent regulations and policy settings.

8.29 Noting that the successful deployment of autonomous vehicles in Australia will require further standardisation of road infrastructure, the Committee is of the view that the Commonwealth Government, through the Department of Infrastructure and Regional Development, should coordinate a project to standardise road infrastructure in Australia.

8.30 The Committee also notes that the quality of roads in Australia is variable and the issue of road quality, particularly in regional Australia, must be considered in preparing for increasingly autonomous vehicles.

8.31 Similarly, the Committee recognises the important work being conducted by Geoscience Australia on digital infrastructure required for autonomous vehicles and encourages that work's continuation.

Recommendation 9

8.32 The Committee recommends that the Commonwealth Government coordinates efforts to standardise road infrastructure in Australia, particularly as it relates to signs and road markings, and that the Commonwealth Government considers ways to ensure that the benefits of automated vehicles are available across Australia, including in regional Australia.

8.33 Notwithstanding the work being undertaken already to prepare the way for driverless land-based vehicles in Australia, the Committee's inquiry has highlighted that there will be many and wide-ranging social impacts once driverless vehicles become available in Australia, and it is important that those are adequately prepared for.

Recommendation 10

8.34 The Committee recommends that the Commonwealth Government consider the merits of establishing either a dedicated national body or a cross-agency taskforce, in conjunction with state and territory jurisdictions and working with vehicle and software manufacturers, to coordinate Australia's preparation for the introduction of land-based

automated vehicles. This body would have regard to topics including, but not limited to:

- **Methods of public engagement to ensure that concerns about automated vehicles are addressed and benefits are explained**
- **The employment ramifications, both direct and indirect, of automated vehicles**
- **How to best ensure that people with disability and older Australians are able to benefit from automated vehicle technology**
- **How to best ensure that people in regional and rural Australia can access the benefits of automated vehicles**
- **The infrastructure needs, both physical and digital, of automated vehicles and the role of governments in ensuring that those standards are met, particularly in regional and rural areas of Australia**
- **The ownership, use and security frameworks applicable to the data generated by automated vehicles**
- **Legal liability and insurance implications of automated vehicles.**

Ms Michelle Landry MP
Chair

30 August 2017

A. Submissions

1 Mr Edward Nelson

2 REAPP Technology Pty Ltd

3 Toyota Motor Corporation Australia

4 Geoscience Australia

5 Professor Matthew Rimmer

- 5.1 Supplementary to submission 5

6 Office of the National Rail Safety Regulatory

- 6.1 Supplementary to submission 6

7 ARC Robotic Futures Research Team

8 Austroads

9 Australian Driverless Vehicle Initiative

10 Australian Industry Group

11 Volvo Car Australia

12 Robert Bosch (Australia) Pty Ltd

13 MTA Queensland

14 Telstra

- 14.1 Supplementary to submission 14

15 Australian Automobile Association

16 Australasian New Car Assessment Program (ANCAP)

- 16.1 Supplementary to submission 16

17 iMOVE CRC

18 Royal Automobile Club of WA (RAC WA)

19 Queensland University of Technology

20 Professor Robert Sparrow and Dr Mark Howard

21 Department of Agriculture and Water Resources

22 National Farmers' Federation

23 Council of Capital City Lord Mayors

24 Federal Chamber of Automotive Industries

25 Maurice Blackburn Lawyers

26 Department of Infrastructure and Regional Development

27 Bus Industry Confederation

28 National Transport Commission

29 Department of Industry, Innovation and Science

30 Deaf Australia Inc

31 Australasian College of Road Safety

32 IAG

33 Hon Luke Donnellan MP

34 Hon Stephen Mullighan MP

35 NSW Government

36 Insurance Commission of Western Australia

37 Centre for Human Factors and Sociotechnical Systems at the University of the Sunshine Coast

38 Australian Academy of Technology and Engineering

39 Associate Professor Hussein Dia, Swinburne University of Technology

40 Dr Adrian McCallum, University of the Sunshine Coast

41 John Yeaman AM

42 Amy Gillett Foundation

43 Australian Trucking Association

44 Infrastructure Victoria

45 Squire Patton Boggs

46 Griffith Law Reform Research Team

47 John Saint-Smith

B. Public Hearings

Wednesday, 1 March 2017, Canberra

Department of Infrastructure and Regional Development

- Mr Alex Foulds, Executive Director, Surface Transport Policy Division
- Ms Philippa Power, Executive Director, Policy and Research Division
- Ms Donna Wieland, General Manager, Strategic Policy, Surface Transport Policy Division

Wednesday, 22 March 2017, Canberra

Department of Industry, Innovation and Science

- Dr Christopher Locke, Head of Division, Portfolio Policy and Innovation Strategy
- Ms Francesca Astolfi, Acting General Manager, Strategic Policy and Digital Economy
- Mr Darren Atkinson, Manager, Advanced Manufacturing Policy

Monday, 3 April 2017, Perth

Royal Automobile Club, WA

- Mr Patrick Walker, Executive General Manager, Advocacy and Members
- Ms Anne Still, General Manager, Public Policy

Tuesday, 11 April 2017, Melbourne

Academy of Technology and Engineering

- Prof Hugh Bradlow, President

- Dr Matt Wenham, Executive Manager, Policy and Projects

National Transport Commission

- Dr Geoff Allan, Chief Operating Officer
- Mr Marcus Burke, Project Director, Compliance and Technology

Austroads

- Mr Nicholas Koukoulas, Chief Executive Officer
- Mr Stuart Ballingall, Program Director, Connected and Automated Vehicles

Robert Bosch (Australia) Pty Ltd

- Mr Mark Jackman, Regional President, Chassis Systems Control
- Mr Carl Liersch, Department Manager, Engineering and Business Development, Chassis Systems Control

Office of the National Rail Safety Regulator

- Ms Susan McCarrey, Chief Executive
- Mr Peter Doggett, Executive Director, National Operations

Toyota Motor Corporation Australia

- Mr Dickson Leow, Manager, Homologation Department
- Mr Andrew Willis, Manager, Government Affairs

Maurice Blackburn Lawyers

- Ms Katherine Minogue, Associate, Road and Work Injuries

Australia and New Zealand Driverless Vehicle Initiative

- Mrs Rita Excell, Executive Director

iMOVE Cooperative Research Centre

- Mr Ian Christensen, Bid Leader and Chief Executive Officer, Nominee

Wednesday, 3 May 2017, Brisbane

Prof Matthew Rimmer

Motor Trades Australia Queensland

- Dr Brett Dale, Chief Executive Officer

Swarm Farm Robotics

- The Hon. Campbell Newman, Chairman
- Mr Andrew Bate, Managing Director and Chief Executive Officer

Queensland University of Technology

- Prof Belinda Bennett, Professor of Health, Law and New Technologies, Faculty of Law
- Prof Andry Rakotonirainy Deputy Diredctor, CARRS-Q, Centre for Accident Research, Road Safety
- Prof Des Butler, Professor of Law, Faculty of Law

University of the Sunshine Coast

- Dr Vanessa Beanland, Australian Research Council Discovery, Early Career Researcher and Research Fellow
- Dr Gemma Read, Research Fellow, Centre for Human Factors and Sociotechnical Systems

Thursday, 4 May 2017, Sydney

Volvo

- Mr Greg Bosnich, Director, Public Relations and Corporate
- Mr David Pickett, Technical Manager

Insurance Australia Group

- Associate Prof Vinayak Dixit, Academic Director, IAG Research Centre, Customer Labs
- Ms Cecilia Warren, Director, Mobility Research and Development

Telstra

- Dr Dean Economou, Chief Technology Officer, Products
- Mr Brian Miller, General Manager, Network and Technology Regulation
- Mr James Shaw, Director, Government Relations

Department of Transport NSW

- Mr Bernard Carlon, Executive Director, Centre for Maritime and Centre for Road Safety
- Mr Anthony Wing, Executive Director, Transport Policy
- Mr Evan Walker, Director, Smart Innovation Centre

Wednesday, 24 May 2017, Canberra

Australasian New Car Assessment Program (ANCAP)

- Mr James Goodwin, Chief Executive Officer
- Mr Mark Terrell, Chief Technical Officer

Australasian College of Road Safety

- Mr John Lauchlan McIntosh AM, President

ARC Robotic Futures Research Team

- Dr David Bissell, Chief Investigator
- Dr Eric Hsu, Research Associate

University of Wollongong

- Dr Thomas Birtchnell, Senior Lecturer

Wednesday, 31 May 2017, Canberra

Bus Industry Confederation

- Mr Michael Apps, Executive Director

Federal Chamber of Automotive Industries

- Mr Ashley Wells, Policy Director

Wednesday, 14 June 2017, Canberra

University of Canberra

- Dr Damith Herath, Human Centred Technology Research Centre

Curtin University

- Professor Simone Pettigrew, School of Psychology and Speech Pathology

Council of Capital City Lord Mayors

- Ms Deborah Wilkinson, Executive Director
- Mr Steven Harrison, Chief Advisor, City of Adelaide (member)

National Farmers' Federation

- Mr Mark Harvey-Sutton, Manager, Rural Affairs
- Ms Maxie Hanft, Policy Officer

Wednesday, 21 June 2017, Canberra

Department of Infrastructure and Regional Development

- Mr Alex Foulds, Executive Director, Surface Transport Policy Division
- Ms Philippa Power, Executive Director, Policy and Research Division

Department of Industry, Innovation and Science

- Ms Francesca, Acting General Manager, Strategic Policy and Digital Economy, Portfolio Policy and Innovation Strategy
- Mr Darren Atkinson, Manager, Advanced Manufacturing Policy, Industry Growth

Geoscience Australia

- Mr Gary Johnston, Branch Head, Geodesy and Seismic Monitoring Branch

C. Exhibits

1 *Why public health should embrace the autonomous car*, Professor Simone Pettigrew

2 *Clarifying Control of Automated Vehicles*, Australian Trucking Association

3 When human beings are like drunk robots: Driverless vehicles, ethics, and the future of Transport, Professor Sparrow and Dr Howard