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IS AUSTRALIAN LAW ADAPTABLE TO AUTOMATED VEHICLES?

MARK BRADY *

Recent deaths involving automated vehicles have sparked calls for legislative reform. Scholars argue that the law lags behind new and disruptive technological innovations. Automated vehicles are hailed as the next step in the shifting paradigm of disruptive technology. With the introduction of automated land vehicles, changes will occur in many areas of law and society. These changes will impact notions of property, identity, and the physical landscape of Australia, including the architecture of the future fleet of motor vehicles and the infrastructure surrounding mass road transport. The legal framework in Australia appears fairly well adapted to the introduction of automated vehicles. There are several structures in place that allow the law to investigate and adapt to new technology. This article seeks to outline some of the social and legal impacts arising from the introduction of highly automated vehicles. It is structured in three parts. First it defines the Society of Automotive Engineers ("SAE") standard for automated vehicles and outlines a brief history of automated vehicles. Then it considers some different areas of law intersected by the introduction of automated vehicles; criminal law, privacy law, personal injury, and product liability. Finally, it reflects on some of the potential physical and social impacts surrounding the introduction of automated vehicles. It concludes with whether the Australian law is adaptable to this new and disruptive technology.

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I INTRODUCTION

The problem with a human driven motor vehicle is the human driver. Humans get distracted,[1] they get drowsy,[2] they lose concentration,[3] they fall asleep,[4] they get overwhelmed,[5] they make mistakes,[6] and they all differ in experience and ability.[7] Vehicle control by human beings leads to potential errors at every stage.[8] According to Miller, the human:

> perceives, decides, and reacts (or responds) based on current stimuli with subsequent behaviour also being a function of both memory (short and long term) and psycho-physiological capability … everything the [hu]man perceives, be it through a sensing process or through his memory, is a source of potential error.[9]

Combine these 'sources of error' with the control of a motor vehicle, travelling at high speed, weighing on average well over 1500 kilograms,[10] and it is a recipe for disaster. Put 1.28 billion vehicles on the road,[11] and disaster becomes inevitable. The familiarity of motor vehicle use and resultant accidents tends to blunt the catastrophic social and economic costs of having a mechanised mass transport system based around individual humans piloting heavy vehicles at high speeds.

In the United States, according to the National Highway Traffic Safety Administration 2015 summary of traffic data, 'the total value of societal harm from

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[1] Amy Brueckner, 'Distracted Driving: How Technological Advancements Impede Highway Safety' (2011) 115 *Penn State Law Review* 709, 711.
[2] Queensland University of Technology, CARRS-Q Centre for Accident Research & Road Safety, 'State of the Road: Sleepiness and Fatigue' (April 2015) 1.
[3] Kaarin J Anstey et al, 'Cognitive, sensory and physical factors enabling driving safety in older adults' (2005) 25(1) (Jan) *Clin Psychol Rev* 45, 46-48.
[4] State of the Road: Sleepiness and Fatigue (n 2) 1.
[5] Klaus Bengler et al, 'Three Decades of Driver Assistance Systems: Reviews and Future Perspectives' (2014) (Winter) *IEEE Intelligent Transportation Systems Magazine* 6, 12.
[6] Miller C O, 'The Design-Induced Part of the Human Error Problem in Aviation' (1976) 42 *Journal of Air Law and Commerce* 119, 120-121.
[7] Anstey et al (n 3) 46-59.
[8] Miller (n 6) 125.
[9] Ibid.
[10] See, eg, Statista, The Statistics Portal, *Number of vehicles in use worldwide 2006-2015* (Web page) <https://www.statista.com/statistics/281134/number-of-vehicles-in-use-worldwide/>; Department of Infrastructure and Regional Development, *New passenger vehicle fuel consumption trends, 1979 to 2013*, (Bureau of Infrastructure, Transport and Regional Economics 2013) 66; Patrick Blain, 'Steel Perspectives for the Automotive Industry' (Organisation Internationale des Constructeurs d'Automobile, 2012) 1, 9.
[11] Australian Bureau of Statistics, *Motor Vehicle Census*, Australia, (Catalogue No 9309.0, 31 Jan 2015).

motor vehicle crashes was $836 billion'.[12] In the US there were 7.277 million motor vehicle crashes in 2016,[13] including 37,461 fatalities.[14] Proportionate figures are available for Australia. In Australia, the numbers of fatalities plateaued over the past decade at around 1,300 fatalities annually.[15] Additionally, in 2016 almost 33,000 people sustained serious and life-threatening injuries due to road accidents; with this trend steadily increasing.[16] The annual cost of motor vehicle collisions in Australia is estimated to be $33.16 billion.[17]

Improvements in road design,[18] public education campaigns,[19] and changes in driver attitude towards dangerous driving behaviours like speeding and drink driving,[20] and the inclusion of passive safety systems within vehicles,[21] have reduced but not eliminated accidents on the road.[22] In a context where one death, or one accident causing injury, is one too many,[23] the ongoing social cost of human driven vehicles has led to calls for the implementation of a safer mass transport system in Australia.[24] After addressing accident causing factors such as road

[12] Lawrence Blincoe et al, 'The Economic and Societal Impact of Motor Vehicle Crashes, 2010 (Revised)' National Center for Statistics and Analysis, (National Highway Traffic Safety Administration, 2015) 1.
[13] US Department of Transportation, 'Summary of Motor Vehicle Crashes 2016', *National Highway Traffic Safety Administration* (Web Page, September 2018), <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812580>.
[14] Blincoe et al (n 12) 2.
[15] National Transport Commission 'Cooperative Intelligent Transport Systems - Final Policy Paper' (2013) 1; see also, Department of Infrastructure, Regional Development and Cities, (Road Deaths Australia Report, 2017).
[16] Bureau of Infrastructure, Transport and Regional Economics, 'Road Trauma Australia 2016 Statistical Summary' (Department of Infrastructure and Regional Development, 2016) 1; Cooperative Intelligent Transport Systems (n 15) 2.
[17] Frederick Litchfield, 'The cost of road crashes in Australia 2016: An overview of safety strategies' (2017) Australian National University Report, iv.
[18] Jessica Edquist et al, 'Road Design Factors and their Interaction with Speed Limits' Monash University Accident Research Centre, (2009) 3-24.
[19] Joe Motha, 'Road Safety in Australia: A Publication Commemorating World Health Day 2004' Australia Transport Safety Bureau (2004) 38.
[20] Ibid 125-126.
[21] See generally, Bengler et al (n 5).
[22] Bureau of Infrastructure, Transport and Regional Economics, 'Impact of road trauma and measures to improve outcomes' (Department of Infrastructure and Regional Development, 2014) 8-14.
[23] Motha (n 19) 8.
[24] Cooperative Intelligent Transport Systems (n 15) 1.

design, passive vehicle safety and preventable behaviour,[25] the obvious next step is to eliminate the driver.[26]

Automated and connected land vehicles ("automated vehicles") remove the driver from the equation and have the potential to perform 'at safety levels significantly higher than human drivers'.[27] In the United States and Europe, there has been extensive development of automated vehicle technology,[28] and policy,[29] over the last several years. Legislators have now begun to prepare for the arrival of automated vehicles,[30] with safety as their primary goal.[31] Proponents claim automated vehicles have the ability to 'dramatically improve the safety, efficiency and mobility' of mass transportation,[32] and to 'significantly reduce property damage, injuries, and casualties'.[33] Automated vehicles are claimed to enable a situation where 'artificial intelligence acts on behalf of a human with life or death consequences'.[34] However, the automation of the motor vehicle is not a sudden technological innovation.[35] It must be seen as the next step in a long process of evolution where, in the name of safety,[36] intelligent systems have reached a point

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[25] Anna Devlin et al, 'Designing Safer Roads to Accommodate Driver Error' (Curtin–Monash Accident Research Centre, 2011) 21.

[26] Dr Sven A Beiker, 'Legal Aspects of Autonomous Driving: The need for a legal infrastructure that permits autonomous driving in public to maximize safety and consumer benefit.' (2012) 52 *Santa Clara Law Review* 1145, 1146.

[27] Bengler et al (n 5) 10.

[28] See, eg, Andrew P Garza, '"Look Ma, No Hands!": Wrinkles and Wrecks in the Age of Autonomous Vehicles' (2012) 46 *New England Law Review* 581, 587-588; Beverley Lu and Matthew Michaels Moore, 'Autonomous Vehicles for Personal Transport: A Technology Assessment' (2011) *Social Science Research Network* 1 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1865047>; Frank Douma et al, 'Self-Driving Vehicles and Policy Implications: Current Status of Autonomous Vehicle Development and Minnesota Policy Implications' (2015) 16(2) *Minnesota Journal of Law Science & Technology* 735; Jamie Patrick Hopkins and Sophia H Duffy, 'Sit, Stay, Drive: The Future of Autonomous Car Liability' (2013) 16 *SMU Science and Technology Law Review* 453, 453-456.

[29] See generally, Andrew R Swanson, '"Somebody Grab the Wheel!": State Autonomous Vehicle Legislation and the Road to a National Regime' (2014) 97(4) *Marquette Law Review* 1085.

[30] Rachael Roseman, 'When Autonomous Vehicles Take Over the Road: Rethinking the Expansion of the Fourth Amendment in a Technology-Driven World' (2013-2014) 20(1) *Richmond Journal of Law & Technology* 11, 11-14.

[31] Swanson (n 29) 1108.

[32] Beiker (n 26) 1146.

[33] Ibid 1150.

[34] Ibid 1152.

[35] Kyle Graham, 'Of Frightened Horses and Autonomous Vehicles: Tort Law and its Assimilation of Innovations' (2012) 52 *Santa Clara Law Review* 101.

[36] Gary E Marchant and Rachel A Lindor, 'The Coming Collision Between Autonomous Vehicles and the Liability System' (2012) 52 *Santa Clara Law Review* 1321, 1330; see also, Bengler et al (n 5).

where they can now intervene between a driver's control inputs and the vehicle's automated response.[37]

The recent public death of a pedestrian following a collision with a Volvo XC90 operated by Uber,[38] and the driver of a Tesla Model X,[39] have heightened already intense media scrutiny into automated vehicles.[40] There have been calls for the banning of automated vehicles until manufacturers can guarantee the safety of their products for the general public.[41] There have been similar arguments for changing law in relation to this disruptive technology in Australia.[42] This

[37] Bengler et al (n 5) 7.
[38] See, eg, 'Disturbing and Heartbreaking Footage of Fatal Self-driving Crash Released', *ABC News* (Online, 22 March 2018) < https://www.abc.net.au/news/2018-03-22/self-driving-uber-fatal-crash-footage-released/9575624>; Lacey Johnson, 'Arizona Suspends Uber's Autonomous Cars After a Death. What's Next for Driverless Cars?' (Online, 27 March 2018) *GTM Mobility* <https://www.greentechmedia.com/articles/read/uber-autonomous-cars-death#gs.S7qkBSM>; George Nott, 'Could an autonomous vehicle death happen on Australian roads too?' (Online, 4 April 2018) *CIO* <https://www.cio.com.au/article/635727/could-an-autonomous-vehicle-death-happen-australian-roads-too/>; The Engineer, 'Last week's poll: responses to Uber crash', (Online, 27 March 2018) *The Engineer* <https://www.theengineer.co.uk/uber-crash/>.
[39] See, eg, Victor Tangermann, 'Tesla Model X in Autopilot Killed a Driver. Officials Aren't Pleased With How Tesla Handled It' (Online, 2 April 2018) *Futurism* <https://futurism.com/officials-tesla-model-x-autopilot-killed-driver/>; Jackie Wattles, 'Tesla Model X was in autopilot before fatal crash' (Online, 31 March 2018) *CNN Tech* <http://money.cnn.com/2018/03/31/technology/tesla-model-x-crash-autopilot/index.html>; Megan Rose Dickey, 'Tesla Model X fatal crash investigation' (Online, 8 June 2018) *Tech Crunch* <https://techcrunch.com/story/tesla-model-x-fatal-crash-investigation/>; Dana Hull and Tim Smith, 'Tesla Model X driver death raises questions about autopilot' (Online, 1 April 2018) *Financial Review* <http://www.afr.com/technology/tesla-model-x-driver-death-raises-questions-about-autopilot-20180331-h0y75x>.
[40] See, eg, Zia Wadud, 'Transportation Research Part A: Policy and Practice' (2017) 101 *Elseiver* 163, 163-164; Faiz Siddiqui, 'Tech firms, government officials put the brakes on testing self-driving vehicles after fatal Uber crash' (Online, 27 March 2018) *The Washington Post* <https://www.washingtonpost.com/news/dr-gridlock/wp/2018/03/27/arizona-governor-suspends-testing-of-ubers-self-driving-cars-i-was-very-disturbed-by-video-of-fatal-crash/?noredirect=on&utm_term=.c40e5f890985>; Disturbing and heartbreaking, (n 38); Johnston, (n 38); Nott (n 38); Last week's poll: responses to Uber crash, (n 38); Joel Hruska, 'Uber, Lyft Want to Ban Personal Use of Self-Driving Cars in Urban Areas' (Online, 5 February 2018) *Extreme Tech* <https://www.extremetech.com/extreme/263294-uber-lyft-want-ban-personal-use-self-driving-cars-urban-areas>; James F Zender, 'Should We Ban Autonomous Vehicles?' (Online, 29 March 2018) *Psychology Today* <https://www.psychologytoday.com/us/blog/the-new-normal/201803/should-we-ban-autonomous-vehicles>; Matt McFarland, 'The backlash against self-driving cars officially begins' (Online, 10 January 2017) *CNN Tech* <http://money.cnn.com/2017/01/10/technology/new-york-self-driving-cars-ridesharing/index.html>.
[41] See, eg, Eric Newcomer, 'Uber's Autonomous Cars Banned in Arizona After Fatal Crash' (Online, 27 March 2018) *Bloomberg Technology* <https://www.bloomberg.com/news/articles/2018-03-27/uber-s-autonomous-cars-suspended-by-arizona-after-fatal-crash>; Hruska, (n 40); Zender, (n 40); McFarland, (n 40).
[42] See, eg, Craig Duff, 'Australia lags most countries on readiness for autonomous cars, says report' (Online, 18 January 2018) *News.com.au* <http://www.news.com.au/technology/innovation/motoring/australia-lags-most-countries-on-readiness-for-autonomous-cars-says-report/news-

reactionary tendency, to call for increased regulation of new and potentially disruptive technology, is not new.[43] For more than a century there have been technological innovations that have significantly changed, or disrupted, both human society and the physical landscape.[44] When a major scientific advancement arrives there are always people who claim 'the law lags behind technology' and that law must 'catch up' with new technology.[45] Automated vehicles are seen as a disruptive technology, with the potential to significantly alter current social and legal paradigms.[46] In order to understand the adaptability of a system of law, to cope with new technologies, the first thing to consider is why law is often seen as lagging behind new and disruptive technologies.[47]

When automated vehicles arrive they will likely have a significant impact on many areas of law.[48] They will alter the way civil liability claims are handled following

story/11c5b9d91a8709c0f2ffcb5967627142>; Sandeep Gopolan, 'Legal lessons for Australia from Uber's self-driving car fatality' (Online, 20 March 2018) *The Conversation* <http://theconversation.com/legal-lessons-for-australia-from-ubers-self-driving-car-fatality-93649>; Adi Snir, 'Dealing with the Law Lag' *LegalVison* (Blog Post, 6 May 2016) *LegalVision* <https://legalvision.com.au/dealing-with-the-law-lag/>; David Mercer, 'Technology and the law: dealing with the "law lag"', David Mercer, (Online, 4 July 2011) *Weekend Australian* <https://www.theaustralian.com.au/archive/business/technology-and-the-law-dealing-with-the-law-lag/news-story/b312d05074f757b67cfbe74d9d85615c?sv=2324c990c642936b884b2f9a8cfbbd12>; John Ahern, 'Keeping up with the technology in the changing legal landscape' (Online, 16 November 2016) *InfoTrack* <https://www.infotrack.com.au/blog/keeping-up-with-the-technology-in-the-changing-legal-landscape/>; Beverley Head, 'Law is falling far behind the tech' (Online, 27 November 2017) *InnovationAus.com* <https://www.innovationaus.com/2017/11/Law-is-falling-far-behind-the-tech>.

[43] See generally, Kieran Tranter, 'Disrupting Technology Disrupting Law' (2017) *Law, Culture and the Humanities* <https://doi.org/10.1177/1743872117704925>; Arthur Cockfield and Jason Pridmore, 'A Synthetic Theory of Law and Technology' (2007) 8 *Minnesota Journal of Law Science & Technology* 475; Bennett Moses, 'Adapting the Law to Technological Change: A Comparison of Common Law and Legislation' (2003) 26(2) *UNSW Law Journal* 394, 396; Lyria Bennett Moses, 'Agents of Change: How the Law "Copes" with Technological Change' (2011) 20(4) *Griffith Law Review*, 763, 764.

[44] See, eg, Graham (n 35); Vivek Wadhwa, 'Laws and Ethics Can't Keep Pace with Technology' (2014) *MIT Technology Review* <https://www.technologyreview.com/s/526401/laws-and-ethics-cant-keep-pace-with-technology/>; Douglas W Allen and Yoram Barzel, 'The Evolution of Criminal Law and Police during the Industrial Revolution' (2007) *Research Gate* <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.186.1779&rep=rep1&type=pdf>.

[45] Bennett Moses, Agents of Change (n 43).

[46] Stephen P Wood et al, 'The Potential Regulatory Challenges of Increasingly Autonomous Motor Vehicles' (2012) 52 *Santa Clara Law Review* 1423, 1501; Bengler et al (n 5) 10.

[47] For law as 'technology' see, Eugene McNamee, 'An Egg Shaped Bowl: Law, Invention, Technology' (2012) 37 *Australian Feminist Law Journal* 83.

[48] Maurice Schellekens, 'Self-driving cars and the chilling effect of liability law' (2015) 31 *Computer Law & Security Review* 506.

motor vehicle accidents,[49] and raise questions about criminal law and data security regarding malevolent hacking causing them to crash.[50] Additionally, there are serious issues raised in relation to privacy laws protecting personal information transmitted in the data stream of automated vehicles.[51] Product liability law is also set to impact the use and operation of automated vehicles where showing which party is responsible for a malfunction may prove difficult.[52] Questions arise as to whether or not the artificial intelligence controlling the automated vehicle is the 'driver' for the purposes of an accident investigation.[53] This article considers whether the current legal frameworks have the capacity to adapt to new and disruptive technology, in particular to highly automated vehicles.

This article is structured in three parts. Part one describes the SAE standard for the different levels of automation and outlines a brief history surrounding the development of automated vehicles and the artificial intelligence controlling them. Part two examines several different areas of Australian law affected by the introduction of automated vehicles; criminal law, privacy law, personal injury and product liability. Part three will discuss possible impacts of automated vehicles on both society and the physical landscape of Australia. This article will conclude by stating whether Australian law is adaptable to the disruptive technology of highly automated vehicles.

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[49] Mark Brady et al, 'Automated Vehicles and Australian Personal Injury Compensation Schemes' (2017) 24 *Torts Law Journal* 32.
[50] See Frank Douma and Sarah Aue Palodichuk, Criminal Liability Issues Created by Driverless Cars, (2012) 52(4) *Santa Clara Law Review* 1157.
[51] Chasel Lee 'Grabbing the Wheel Early: Moving Forward on Cybersecurity and Privacy Protections for Driverless Cars' (2017) 69(1) *Federal Communications Law Journal* 25, 32; Dorothy J Glancy, 'Privacy in Autonomous Vehicles' (2012) 52(4) *Santa Clara Law Review* 1171, 1194; Jay P Kesan et al, 'A Comprehensive Empirical Study of Data Privacy, Trust, and Consumer Autonomy,' (2016) 91 (2) *Indiana Law Journal* 267.
[52] See generally, Mark Brady et al, Submission to National Transport Commission, in response to the *National Transport Commission Regulatory Options of Automated Vehicles: Discussion Paper*, 4 July 2016 <https://www.ntc.gov.au/media/1426/ntc-discussion-paper-regulatory-options-for-automated vehicles-may-2016-kieran-tranter-griffith-law-school-jul-2016.pdf>.
[53] For an examination of 'driver' and 'person in control' of a vehicle see, Brady et al, Automated Vehicles (n 49).

II A BRIEF HISTORY OF AUTOMATED VEHICLES

Automated vehicles have captured the imagination of people for almost 100 years.[54] In the early 20th century, automated vehicles were considered a futuristic yet achievable dream.[55] An automated vehicle is defined as 'a vehicle that includes a set of technologies allowing it to perform complex mobility tasks with little or no human intervention'.[56] One of the first real automated vehicles was created by Stanford University to perform functions as a robotic lunar rover.[57] Nicknamed the 'Stanford Cart' this vehicle was notoriously slow; taking a long time to travel only very short distances.[58] In 1979, it took almost 5 hours to navigate a room full of chairs.[59] Growth of modern automated road vehicles really only started with the United States Defence Advanced Research Projects Agency ('DARPA') grand challenges in the early 21st century.[60] Compared with the Stanford Cart, these vehicles were much faster.[61] The development of the current automated vehicle fleet is a direct result of the integration of digital computer control with modern passenger vehicle operating systems.

Technological augmentation of driver systems began with early safety improvements, such as antilock brakes, cruise control, electronic stability control and traction control.[62] Following this, the architecture of motor vehicles began to be increasingly computer controlled. Eventually, manufacturers integrated electronic power steering into the control systems of motor vehicles which permits the computer to steer a vehicle, where necessary.[63] The computer control of all major systems in modern passenger vehicles enable the functioning of advanced driver assistance systems such as adaptive cruise control, lane

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54 Fabian Kroger 'Automated Driving in its Historical and Social Contexts' in Markus Maurer, J Christian Gerdes, Barbara Lenz, Hermann Winner (Eds) *Autonomous Driving: Technical, Legal and Social Aspects* (Springer, Berlin, 2016) 41-68.
55 Ibid.
56 Dana Sanchez, 'Collective technologies: autonomous vehicles' (Australian Council of Learned Academies, 2015) 4 <https://acola.org.au/wp/PDF/SAF05/2Collective%20technologies.pdf>.
57 Jenn U, 'The Road to Driverless Cars: 1925 – 2025' (Blog Post, 2016) *Engineering.com* <https://www.engineering.com/DesignerEdge/DesignerEdgeArticles/ArticleID/12665/The-Road-to-Driverless-Cars-1925--2025.aspx>.
58 Ibid.
59 Ibid.
60 Defense Advanced Research Projects Agency, <http://www.darpa.mil/about-us/about-darpa>.
61 Jenn U (n 57).
62 See Bengler et al (n 5).
63 Bengler et al (n 5) 9.

departure warning, automatic reverse parking and valet parking.[64] Many manufacturers now offer semi-automated vehicle systems as standard equipment in their latest road-going models.[65] In certain circumstances the automated control systems of current vehicles can override the human drivers' control inputs altogether.[66]

Automated vehicles detect their environment using a variety of sensors and, via internal maps or GPS, navigate the surrounding terrain.[67] To understand how automated vehicles operate we must consider the artificial intelligence that controls an automated vehicle.[68] A robotic artificial intelligence operates the automated vehicle and makes decisions based on complex algorithms and machine logic.[69] In making these decisions, the artificial intelligence implies an ethical consideration (reflecting the underlying ideology of the programmers),[70] towards the safety of human passengers, other road users, and pedestrians.[71]

A *Levels of Automation*

The SAE standard J-3016[72] incrementally categorises the different levels of human control or monitoring, of automated systems between non-automated, semi-automated, and fully automated vehicles. The SAE standard has been broadly

[64] Bengler et al (n 5).
[65] These include; NVidia, Volkswagen, Baidu, Uber, Volvo, Fiat-Chrysler, Apple, Intel, BMW, Audi, Google, NuTonomy, Bosch, Tesla, Ford, and Five AI, see Christina Mercer, 'Which companies are making driverless cars?' (2018) *Techworld* <https://www.techworld.com/picture-gallery/data/-companies-working-on-driverless-cars-3641537/>.
[66] Bengler et al (n 5) 9-10.
[67] For a comprehensive analysis of the operation of automated vehicles, see Harry Surden and Mary-Anne Williams 'Technological Opacity, Predictability, and Self-Driving Cars' (2016) 38 *Cardozo Law Review* 121; see also, Alex Davies, 'What is Lidar, Why do Self-Driving Cars need it, and can it see Nerf Bullets?', *Wired* (Online, 6 February 2018) <https://www.wired.com/story/lidar-self-driving-cars-luminar-video/>.
[68] See Roderick Currie, 'Developments in Car Hacking' (White Paper 2015, The Sans Institute InfoSec Reading Room, 5 December, 2015).
[69] See Qing Li et al, 'Springrobot: A Prototype Autonomous Vehicle and its Algorithms for Lane Detection' (2004) 5(4) *IEEE Transactions on Intelligent Transportation Systems* 300.
[70] Tom Simonite, 'Artificial Intelligence Seeks an Ethical Conscience' *Wired*, (Online, 7 December 2017) <https://www.wired.com/story/artificial-intelligence-seeks-an-ethical-conscience/>.
[71] See generally, Keith Frankish and William M. Ramsey (eds) *The Cambridge Handbook of Artificial Intelligence* (Cambridge University Press, 2011).
[72] Bryant Walker Smith, in 'SAE Levels of Automation', *Center for Internet and Society* SAE Standard J3016 (Stanford University, 2013).

adopted; by the UK in 2015,[73] Australia in May 2016,[74] and the US in September 2016.[75] The different levels of automation are displayed in the SAE standard J-3016 as follows:

Level	Name	Narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving task*	System capability (*driving modes*)	BASt level	NHTSA level
Human driver monitors the driving environment								
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes	Partially automated	2
Automated driving system ("system") monitors the driving environment								
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes	Highly automated	3
4	High Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes	Fully automated	3/4
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**	-	

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73 Department for Transport (UK), *The Pathway to Driverless Cars: Summary Report and Action Plan* (2015).
74 National Transport Commission, 'Regulatory Options for Automated Vehicles: Discussion Paper', (2016).
75 National Highway Traffic Safety Administration, 'Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety' United States Department of Transport, Washington, 2016, 9, <https://www.transportation.gov/sites/dot.gov/files/docs/AV%20policy%20guidance%20PDF.pdf>.
76 SAE Standard J3016, in 'SAE Levels of Automation', Bryant Walker Smith, 2013, *Center for Internet and Society*, Stanford University**.**

For the purposes of this article, references to automated vehicle apply to highly automated vehicles, of level 4 or 5, unless otherwise stated. As the introduction of automated vehicles approaches there are increasing calls to regulate them.[77] It is significant, for the discussion surrounding disruptive technology, that questions regarding the law's ability to adapt to new and disruptive technology are answered.[78] Automobiles were first introduced to public roads in the late 19th century and at that time there were demands around the world to regulate the new and often dangerous technology.[79] Some of the proposed regulation would appear absurd by today's standards. Indeed, in England, although originally aimed at dreadnoughts, there was a law requiring a person to walk in front of early motorised vehicles carrying a red flag in their hand.[80] While UK legislators were apprehensive about this new and potentially disruptive technology, Australia in contrast welcomed motorised vehicles.[81]

III AUTOMATED VEHICLES AND AUSTRALIAN LAW

When the first automobiles were introduced in the late 19th century, Australia was proactive in adopting the new and disruptive technology.[82] Australia put in place frameworks for registering and licensing motor vehicles and drivers respectively.[83] While other countries viewed the new technology of automobiles as frightening and in need of controlling,[84] Australia historically embraced new technology.[85] In the 21st century this can be seen by Australia's proactive approach towards adopting disruptive technology, most notably in the ongoing examination and discussion surrounding the introduction of automated vehicles on Australian roads.

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[77] See, Cockfield and Pridmore (n 43); Moses, Adapting the Law (n 43) 396; Bennett Moses, Agents of Change (n 43) 764.
[78] See generally, Tranter, Disrupting Technology Disrupting Law (n 43); Cockfield and Pridmore (n 43); Moses, Adapting the Law (n 43) 396; Bennett Moses, Agents of Change (n 43) 764.
[79] Graham (n 35).
[80] *Locomotive Act 1865* (Imp) s 3(2).
[81] See, Kieran Tranter, 'The History of the Haste-Wagons': The Motor Car Act (1909) (Vic.), emergent technology and the call for law' (2005) 29 *Melbourne University Law Review* 843.
[82] Ibid.
[83] Ibid 848-855.
[84] Graham (n 35).
[85] See, Tranter, History of the Haste-Wagons (n 78).

Australia has a well-developed system of law reform in relation to changing the law in Australia. For example, bodies such as the Australian Law Reform Commission,[86] the Victorian Law Reform Commission,[87] the New South Wales Law Reform Commission,[88] the National Transport Commission,[89] and Parliamentary enquiries, whether at the state or Federal level, enable Australia to make legislative change in a timely manner.[90] When this is combined with research and development, Australia is well placed to enquire into legislation regarding disruptive technology. The introduction of automated vehicles brings with it new concerns, in relation to safety, privacy, and civil litigation. To understand the effects of automated vehicles when they are introduced, it is necessary to look at some potential intersections of automated vehicles and Australian law, starting with the most serious concern; the effect automated vehicles will have on the criminal law.

A *Automated Vehicles and Criminal Law*

At higher levels of automation, automated vehicles have the potential to remove many laws from the criminal statutes. When the fully automated vehicle fleet is integrated into society the driving task will no longer be undertaken by the occupants of a vehicle; rendering many laws surrounding the operation of a motor vehicle obsolete. Laws relating to drink driving, speeding, and licensing are likely to be unnecessary as the occupant will be have no control input at higher levels of automation. Moreover the operation of an automated vehicle causing death or serious injury to another person may not attract the same criminal sanctions as presently in force; as the occupants will likely be considered no more at fault than if they were a passenger in a taxi or bus, for example. This will also yield a corresponding reduction in the tasking of law enforcement to traffic matters.

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[86] *Law Reform Commission Act 1973* (Cth): Established the Law Reform Commission to, 6(1)(a) review laws to which this Act applies with a view to the systematic development and reform of the law.

[87] Established under the *Victorian Law Reform Commission Act 2000* (Vic).

[88] Established under the *Law Reform Commission Act 1967* (NSW).

[89] Established under the *National Transport Commission Act 2003* (Cth).

[90] See generally, Joint Standing Committee on Road Safety (Staysafe) *Driverless Vehicles and Road Safety in NSW*, Report 2/56 September 2016; 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,* (2017).

Automated vehicles, however, may still be vulnerable to unlawful interference, in particular the hacking of an automated vehicle causing it to crash.

The 2015 hacking of a Jeep Cherokee highlighted the vulnerability of the modern digitised motor vehicle to malevolent interference by third parties.[91] With a reporter in the vehicle at the time, the Jeep Cherokee was remotely hacked by researchers who were able to disable the brakes and control systems ultimately causing it to crash.[92] This practical example served as a wakeup call to manufacturers' and the public showing how susceptible the modern motor vehicle is to unauthorised interference. A malevolent entity, wanting to damage automated transport, could override the in-vehicle computer and give new instructions to the vehicle control system causing it to crash.[93] Alternatively, it might interpose a false input signal causing the automated vehicle to change its vector, direction, or course heading.[94] Were this to occur with multiple vehicles at once it would be catastrophic for public safety. Determining whether Australian law is adaptable to automated vehicles regarding the unauthorised hacking of an in-vehicle control system requires evaluation of the existing law that protect against interference with automated vehicles.

Under the *Telecommunications, (Interception and Access) Act*,[95] the *Commonwealth Criminal Code,*[96] and the *Telecommunications Act*,[97] there are several provisions which cover the unauthorised interference with an in-vehicle computer or computer system.[98] These are general provisions, aimed at prevention of interference with 'restricted' computers, which may be applicable to automated vehicles with minor amendments. All that is really required is the recognition of the 'in-vehicle computer' of an automated vehicle as being 'restricted' for the purposes of the Act. Amending the Telecommunications Acts to include automated

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91 Andy Greenburg, 'Hackers Remotely Kill a Jeep on the Highway—With Me in It', *Wired* (Online, 27 July 2015) <https://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/>.
92 Ibid.
93 See generally, Currie (n 68).
94 Ibid.
95 *Telecommunications (Interception and Access) Act 1979* (Cth).
96 *Commonwealth Criminal Code Act 1995* (Cth), '(*Commonwealth Criminal Code*)', ss 100, 474, 476-8.
97 *Telecommunications Act 1997* (Cth).
98 *Commonwealth Criminal Code* (n 96) ss 474, 477.

vehicles as a form of 'restricted' communication would likely rectify this. Further, the general provisions are supported, and supplemented by the anti-terrorism provisions under the *Commonwealth Criminal Code*.[99] The *Criminal Code* provides coverage where a terrorist attack is made inter alia with the intention of advancing a political, religious, or ideological cause.[100] Although there are large areas across Australia which are sparsely populated, automated vehicles in Australia will likely carry many thousands of people and such interference could nevertheless be deadly. A further concern, beyond the potential threat of hacking, is the amount of data that automated vehicles are set to generate and the vulnerability of the information contained in the data stream to interferences with individual personal privacy.

B *Data Privacy & Automated Vehicles*

An operational automated vehicle fleet will be continuously communicating with infrastructure, other vehicles, and the Internet. This ongoing communication may contain information about the vehicle's owner, the control system parameters, the surrounding environment, and also about the identity of the occupants and the vector, velocity, and vehicle location in the data stream. The information generated will be in the order of four terabytes of data each eight hours of operation.[101] Data mining technology sift through such massive amounts of data and derive person specific information from it, enabling the profiling of a person's private life to a very high degree.[102]

Cross-referencing the data stream from an automated vehicle against other seemingly innocuous information enables personal information about an individual to be identified with pinpoint accuracy.[103] In Australia, the *Privacy Act* applies only to 'personal information', defined as 'information or opinion about an identified individual, or an individual who is reasonably identifiable, whether or

[99] *Commonwealth Criminal Code* (n 96) s 100.
[100] Ibid ss 100.1(b), (c).
[101] Patrick Nelson, 'Just one Autonomous Car will use 4,000 GB of data/day' *Networked World* (Online, 7 December 2016) <http://www.networkworld.com/article/3147892/internet/one-autonomous-car-will-use-4000-gb-of-dataday.html>.
[102] See Lee (n 51).
[103] Ibid.

not true and whether or not in material form'.[104] In Australia, the recent decision in '*Privacy Commissioner v Telstra Corporation Limited ("Telstra"),*[105] has left the information contained within a data stream open to data mining,[106] without adequate legal protection. In *Telstra*, the Full Federal Court considered whether data, generated by the use of a mobile telephone, was information 'about' a person, and upheld the decision in *Telstra Corporation Limited and Privacy Commissioner,*[107] stating:

> The questions that are asked must be framed in terms of the definition. They cannot be asked against a different frame of reference that has, as its starting point, the question: is it possible to use this information or opinion or to marry it with other information by using a computerised search engine or in some other way to ascertain the identity of an individual. The starting point must be whether the information or opinion is about an individual. If it is not, that is an end of the matter and it does not matter whether that information or opinion could be married with other information to identify a particular individual.[108]

Accordingly, where personal information is not specifically identified in an individual data stream it falls outside the protection of Australian privacy legislation.[109] However, when information contained in the data stream, which of itself does not identify a person, is combined with other data streams it may enable them to be identified in minute detail. The combined information streams allow private data mining firms to unlock for identification the places a person visits, and what they do, which can include potentially harmful information such as the social, political, sexual proclivities of the individual.[110]

Privacy legislation in Australia is, therefore, ill prepared to deal with the introduction of automated vehicles, as the qualifying term 'reasonably identifiable' is too broad allowing data not specifically about a person to go unprotected.[111]

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[104] *Serious Invasions of Privacy in the Digital Era* (n 4) 41–53.
[105] *Privacy Commissioner v Telstra Corporation Limited* [2017] FCAFC 4 (19 January 2017).
[106] See Lee (n 51).
[107] *Telstra Corporation Limited and Privacy Commissioner* [2015] AATA 991 (18 December 2015).
[108] Ibid [95].
[109] *Privacy Commissioner v Telstra Corporation Limited* [2017] FCAFC 4, [57–65] (Kenny and Edelman JJ).
[110] See Lee (n 51).
[111] *Privacy Act 1988* s 6(1).

However, removing the qualifying term 'reasonably' from 'reasonably identifiable' in the definition of 'personal information' under the *Privacy Act* may rectify this.[112] This amendment could potentially capture all data that might be used to identify an individual, but may prove to be too restrictive in relation to data usage by third parties, who would no longer be able to access or use meta-data if personal identification was possible by any means.

C *Automated Vehicles & Compulsory Third Party Insurance*

Another area impacted by automated vehicles is personal injury under the compulsory third party insurance schemes in Australia. When a person suffers bodily injury in Australia, as a result a motor vehicle accident, the injured persons are covered under state compulsory third party insurance schemes. Third party insurance is compulsory, and is paid with the cost of registration of motor vehicles in each state, which can be either no-fault or fault based schemes, or a combination of both. In a no-fault scheme, it is unnecessary to make enquiries as to the other party in a motor vehicle accident, as it is immaterial to the recovery of damages by the injured party. However, in a fault-based system this is not the case.[113] In a fault-based system there must be someone in whom to apportion liability which means that there must be another 'driver' who is held to be responsible for the accident in order to enliven the scheme.[114] This is problematic as drive or 'driver' is either not defined or is defined differently between states with the exception of the ACT which defines drive as to 'be in control of the steering, movement or propulsion of the vehicle'.[115] As Brady et al argue:

> Where 'driver' is defined as 'a person in control of a vehicle' but 'driver' is not further defined as 'person in charge of a vehicle', potential exists for inequity in

[112] Ibid.
[113] *Motor Accidents Compensation Act 1999* (NSW) ss 3, 3A; *Road Transport (Third-Party Insurance) Act 2008* (ACT) Chapter 4; *Motor Accident Insurance Act 1995* (Qld) s 5(1)(b); *Motor Vehicles Act 1959* (SA) Part 4; *Motor Vehicle (Third Party Insurance) Act 1943* (WA) s 4(1); For blameless accidents see for example, *Motor Accidents Compensation Act 1999* (NSW) Part 1.2.
[114] *Motor Accidents Compensation Act 1999* (NSW) ss 3, 3A; *Road Transport (Third-Party Insurance) Act 2008* (ACT) Chapter 4; *Motor Accident Insurance Act 1995* (Qld) s 5(1)(b); *Motor Vehicles Act 1959* (SA) Part 4; *Motor Vehicle (Third Party Insurance) Act 1943* (WA) s 4(1).
[115] *Road Transport (Third-Party Insurance) Act 1999* (ACT) Dictionary.

coverage between those injured by vehicles driven or operated by humans and those injured by Level 3 or Level 4 vehicles.[116]

The wording of the various Acts in states with fault-based systems is particularly challenging as the fault based systems require a 'driver' of a vehicle who is liable in order to enable the injured party to recover damages.[117] This is a problem with highly automated vehicles where the artificial intelligence in control at the time of the collision, is not recognised as a 'driver' and in fault-based schemes. This means that the victim cannot recover damages.[118] The solution to this problem, in states with fault-based compulsory third party insurance schemes, is to redefine 'driver' to include the in-vehicle computer.[119]

The *National Transport Commission Discussion Paper*, released in 2018 ("the Discussion Paper"), foresaw this to be a serious concern.[120] The Discussion Paper held that this would be a bar to recovery in personal injury claims if not addressed.[121] Another difficulty associated with automated vehicles is the definition of 'person in control' of the vehicle.[122] The prefix 'person' in control precludes recognition of the artificial intelligence that controls an automated vehicle.[123] These two definitions, as found in fault-based compulsory third party insurance schemes, require reform before the introduction of automated vehicles on Australian roads.

The third-party accident schemes may not be the only way automated vehicle accidents are dealt with under Australian law.[124] A person injured as a result of a malfunctioning automated vehicle might be able to bring a product liability claim under the Australian Consumer Law.[125]

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[116] Brady et al, Automated Vehicles (n 49) 45.
[117] See generally, Brady et al, Automated Vehicles (n 49).
[118] Ibid 46.
[119] See generally, Brady et al, Automated Vehicles, (n 49).
[120] National Transport Commission, *Motor Accident Injury Insurance and Automated Vehicles: Discussion Paper* (October 2018) 27-38.
[121] Ibid.
[122] See Brady et al, Automated Vehicles (n 49).
[123] National Transport Commission *Discussion Paper* (n 120) 27-38.
[124] For a discussion of regulatory reforms required for automated vehicles see National Transport Commission, *Regulatory Reforms for Automated Road Vehicles: Policy Paper*, National Transport Commission (2016).
[125] *Competition and Consumer Act 2010* (Cth) Schedule 2 the *Australian Consumer law* ('ACL').

D *Automated vehicles & the Australian Consumer Law*

When automated vehicles fails, and the occupant of the vehicle is injured or killed, it is arguable that the most effective model for compensation is to be found within manufacturers' liability.[126] When the manufacturer is held liable for the failure of an automated vehicle; it falls outside the motor vehicle compulsory third party schemes and is instead within a product liability model. In Australia, product liability is not limited in the same way as motor vehicle accidents.[127] In order to determine whether or not an automated vehicle failure falls within the current product liability model, it is necessary to examine the legislation in Australia surrounding product liability.

This is found under the *Australian Consumer Law* ("ACL") located in the *Competition and Consumer Act 2010* (Cth).[128] Under the ACL, goods must be fit for purpose, of acceptable quality, and free from safety defects.[129] Safety defects under the ACL do not require 'any contractual relationship between the producer of the goods and the injured person'.[130] Manufacturers are liable where goods supplied in trade or commerce,[131] have a safety defect,[132] which causes injury, loss, or damage.[133] The definition of 'goods' includes 'ships, aircraft and other vehicles'.[134] Therefore the ACL has the scope to include an automated vehicle or any of its sub-assemblies, such as the computer software,[135] or 'any component part of, or accessory.'[136]

At first instance it appears that the product liability model can adequately cover the injuries sustained in an automated vehicle accident. If the product malfunctions, it would seem reasonable to hold the manufacturer to be

[126] ACL s 7(1).
[127] See generally, Brady et al, Automated Vehicles (n 49).
[128] *Competition and Consumer Act 2010* (Cth).
[129] ACL s 54.
[130] Stephen Corones, *The Australian Consumer Law* (Thomson Reuters, 2nd ed, 2013) 494.
[131] ACL s 3.
[132] Ibid s 9.
[133] Ibid s 138 (personal injuries to an individual), s 139 (loss or damage to another person because of an individual's injuries), s 140 (destruction or damage to other goods), s 141(destruction or damage to land, building or fixtures).
[134] Ibid s 2(a).
[135] Ibid s 2(e).
[136] Ibid s 2(g).

accountable. However, apportioning liability in relation to an automated vehicle could be problematic. In the US, product liability for new technology has been somewhat more difficult to prove as several strong defences are available.[137] The prime consideration is whether liability can be apportioned to the manufacturer following an accident. The next question is to what extent can the liability be apportioned between the manufacturer of the vehicle and the manufacturers of the various component parts and sub-assemblies? Liability may be spread between the manufacturer of the vehicle, the software provider, the sensor manufacturers, the internet service provider, the computer manufacturer, or other stakeholders involved in the provision of component parts or infrastructure.[138]

Determining which of the stakeholders' liability applies, and to what extent, is a question of fact to be decided by the court. In determining this, the court must take into consideration whether or not any defences apply.

When considering whether manufacturers' liability applies to the failure of an automated vehicle; several things need be considered, such as:

1. Was the invasion caused by an act or omission by the manufacturer?

2. Was the manufacturing process used seen to be the state of the art at the time of manufacturing?

3. Did the operator of the automated vehicle fail to respond to any warnings to retake control of the vehicle?

4. Do any other defences apply?[139]

[137] See generally, Jeffrey K. Gurney, 'Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles' (2013) 2 *University of Illinois Journal of Law, Technology & Policy* 247.
[138] See generally, Brady et al, Submission to National Transport Commission (n 52).
[139] Ibid.

In Australia, the state-of-the-art defence exists, which considers whether the production methods used in the manufacturer of the goods were best practice at the time of manufacture.[140] The ACL provides the following defences:

> (a) the safety defect in the goods that is alleged to have caused the loss or damage did not exist:
>
> > (i) in the case of electricity-at the time at which the electricity was generated, being a time before it was transmitted or distributed; or
> >
> > (ii) in any other case-at the time when the goods were supplied by their actual manufacturer; or
>
> (b) the goods had that safety defect only because there was compliance with a mandatory standard for them; or
>
> (c) the state of scientific or technical knowledge at the time when the goods were supplied by their manufacturer was not such as to enable that safety defect to be discovered; or
>
> (d) if the goods that had that safety defect were comprised in other goods--that safety defect is attributable only to:
>
> > (i) the design of the other goods; or
> >
> > (ii) the markings on or accompanying the other goods; or
> >
> > (iii) the instructions or warnings given by the manufacturer of the other goods.[141]

If any of the statutory defences can be made out, then the victim cannot recover compensation for their injuries. Although the product liability model is likely to cover injuries sustained in automated vehicle collisions, it may act as a disincentive to manufacturers of automated vehicle technologies,[142] absent some statutory immunity.[143] Significantly, recent South Australian legislation allowing

[140] ACL s 142(c).
[141] Ibid s 142.
[142] M Ryan Calo, 'Open Robotics' (2011) 70 *Maryland Law Review* 101, 123.
[143] Ibid 131-138.

testing of automated vehicles specifically provides for exemptions, from the operation of some state laws, at Ministerial discretion.[144]

The exemptions operate to incentivise automated vehicle development in South Australia, so that manufacturers can afford to develop and test without the burden of complicated regulatory compliance.[145] Absent similar government protections, manufacturers might be reluctant to develop automated vehicle technologies in order to avoid liability arising from injury caused by malfunction during the development and testing phase. The pharmaceutical industry serves as a warning in this instance.[146] Notwithstanding these difficulties, where inherent safety defect or design flaws exist the product liability model might be appropriate for protecting consumers from injuries sustained due to automated vehicle malfunction. However, the field would be better covered by a blanket no-fault motor accident injury scheme as it would provide more predictable outcomes for injured persons.[147]

This section has shown that automated vehicles potentially intersect with many areas of Australian law. It would appear that although the present Australian legislative frameworks may not adequately cover automated vehicles, they are nevertheless readily adaptable to this disruptive technology. It suggests that Australian law is flexible enough to accommodate the introduction of automated vehicles with the enactment of dedicated automated vehicle legislation and some minimal amendment to other existing legislation. The next thing to consider is what does the future hold for automated vehicles in Australia?

IV FUTURE IMPACTS OF HIGHLY AUTOMATED VEHICLES

The future landscape of Australian society is likely to be very different from how we live at present. In today's society, the automated vehicle is still in the inception phase and Australia's transport infrastructure is currently based around the

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[144] *Motor Vehicles (Trials of Automotive Technologies) Amendment Act 2016* (SA) s134E.
[145] Ibid.
[146] See generally, Mabel Tsui, 'An Analysis of Australia's Legal Regime for Imposing Liability on Manufacturers of Pharmaceutical Drugs' (2014) 21(3) *Journal of Law and Medicine*, 700.
[147] See generally, Brady et al, Automated Vehicles (n 49).

human driven vehicle model. The human driven motor vehicle requires specific visual cues such as signage, traffic lights, lane markings, pedestrian access, and safety barriers to prevent harm to the occupants of motor vehicles, pedestrians, and the general public. Few of these structures would be necessary with a fully automated vehicle fleet, as the on-board in-vehicle control system of these vehicles will undertake the operating task, not the human occupant. Consequently, the physical landscape of Australian society is likely to be indelibly altered, such that it may be unrecognisable to present society with the adoption of a fully automated vehicle fleet.

Additionally, the architecture of the motor vehicle appears set to change. There will likely no longer be the need for all-round vision in a motor vehicle, other than purely for viewing scenery, as windows are not be necessary for the effective functioning of an automated vehicle. Nor is the future automated vehicle likely to be as wide as current vehicles. Fully automated vehicles may well be far longer and narrower than current vehicles, while remaining inherently stable via computer control. This should allow multiple vehicles across a given carriageway, which would currently only carry two human-driven vehicles, with the vehicle length more than offset by increased velocity. This would serve to greatly increase the carrying capacity of current transport infrastructure with only minimal changes. The social importance of the car, as an object of individual personal property, is also likely to be radically different.

The future automated vehicle systems may reflect a lease model of ownership from the manufacturers' or service providers respectively. When a person buys an automated vehicle in the future, they are likely only going to be buying into the bundle of rights to use the automated vehicle system. The current notion of the motor vehicle as a "personal chattel" that sits idle in a garage for 23 hours a day could also vanish in favour of a mass transport system owned by a separate entity, such as the state, a transport service corporation, or the manufacturers themselves. The future architecture of houses, and possibly cities as well, may have no provision for the parking of passenger vehicles in the house as is the current custom. Further to this the social paradigm of the automobile as an icon of personal identity will likely be irrevocably altered.

The car is likely to no longer be an instrument of social standing, or individual personal identity, as people will likely not "own" a particular vehicle, but rather merely have access to a "class" of vehicles. Where modern motor vehicles are divided into categories, based on price, with the highest luxury models costing exponentially greater amounts of money than the cheapest models.[148] The future automated vehicle fleet may be similarly stratified into different classes of vehicles. This would see people able to access the system according to their budget, or social standing. For example, in future less affluent people may access the cheaper version of automated vehicles; with the more affluent members of society able to access a premium automated vehicle service, albeit at a far higher price. This would serve to preserve and maintain current elitist paradigms within society. The social identity of an individual would therefore change and become less associated with the iconic private motor vehicle as an individual personal symbol of wealth and be subsumed into a "status by access" model. This nevertheless ensures that automated vehicles have the potential to reinforce unequal power divisions within future society.

Another challenge created by the introduction of automated vehicles will be the disruption of the motor vehicle maintenance and repair industries. With human error taken out of the smash repair equation, the motor vehicle smash repair industry and post-crash replacement part support industries will likely be devastated. Furthermore, the motor vehicle insurance schemes could themselves be disrupted by the lack of motor vehicle accidents, and the consequent reduction in demand for insurance. This is anticipated to occur over the next twenty to thirty years during the transition phase between mixed fleet, and a fully automated fleet.

Another significant effect of automated vehicles might be seen in the health sector through the reduction of motor vehicle accidents. The reduction in collisions caused by human error, even allowing for deaths caused by malfunctioning automated vehicles, will still result in a substantial decrease in deaths and serious injuries every year with the introduction of a fully automated vehicle fleet.[149]

[148] See Robert H Frank and Philip J Cook, *The Winner-take-all Society: Why the Few at the Top Get So Much More than the Rest of Us* (Random House, 2010).
[149] International Traffic Safety Data and Analysis Group Road Safety Annual Report 2017, (OECD Publishing, Paris, 2017).

Consequently, the number of severe road trauma hospital admissions will likely also decrease. As a result, the hospital and health care systems would be far less taxed due to the massive reduction in physical injury that is currently generated by motor vehicle accidents. This may inadvertently place a higher burden on infrastructure with many more people surviving to old age.

There has been much speculation about the ethical decision-making capabilities of an automated vehicle in relation to deciding whom to protect in a motor vehicle accident.[150] This ethical decision making problem is very often referred to as the 'trolley car model' where a choice has to be made as to who is saved and who is injured or killed.[151] In this situation, it is anticipated that the artificial intelligence governing automated vehicles will make a decision to cause the least amount of damage or injury to human beings.[152] As the growth of the computing power of artificial intelligence constantly increases, it is thought that at some point, termed the 'singularity', an artificial intelligence will surpass that of human beings,[153] and progress towards attaining sentience.

This question has stirred much debate over the past 50 years, beginning with Alan Turing who devised a test to determine if an artificial intelligence can pass as human.[154] Questions then arise whether an artificial intelligence, such as that controlling an automated vehicle, can one-day attain self-awareness, and whether it would then require recognition as having rights.[155] At the very least, some scholars argue that such a robotic artificial intelligence should be classified as a separate legal entity unto itself.[156] Where this occurs, similar to the legal fiction of

[150] See Patrick Lin, 'Why Ethics Matters for Autonomous Cars', in Gereon Meyer and Sven Beiker (eds) *Road Vehicle Automation* (Springer, 2014) 78-79.
[151] Lee, (n 51), 28; See generally, Noah J Goodall, 'Machine Ethics and Automated Vehicles', in Gereon Meyer and Sven Beiker (eds) *Road Vehicle Automation* (Springer, 2014).
[152] See Gereon Meyer and Sven Beiker (eds) *Road Vehicle Automation* (Springer, 2014).
[153] Vernon Vinge, 'Signs of the Singularity: Hints of the Singularity's Approach can be found in the Arguments of its Critics' Special Report: The Singularity, (2008) *IEEE Spectrum*.
[154] Alan M Turing (1950) 'Computing Machinery and Intelligence', In: Epstein R, Roberts G and Beber G (eds) *Parsing the Turing Test* (Springer, Dordrecht, 2009).
[155] See Mark Coeckelbergh, 'Robot Rights? Towards a Social-Relational Justification of Moral Consideration' (2010) 12(3) *Ethics and Information Technology* 209-221.
[156] Lynden Griggs 'A radical Solution for Solving the Liability Conundrum of Autonomous Vehicles' (2017) 25(2) *Competition & Consumer Law Journal* 151, 154-161; Morgan M Broman and Pamela Finckenberg-Broman, 'Socio-Economic and Legal Impact of Autonomous Robotics and AI Entities: The RAiLE© Project' (2018) 37(1) *IEEE Technology and Society Magazine* 70-79.

the corporation, or body corporate, or university,[157] it would enable the robotic artificial intelligence legal entity to engage in the broader society as a separate legal personality.[158] Whether this involves conceptualising artificial intelligence as a legal person, or other entity, remains to be seen over time.[159]

V CONCLUSION

In conclusion, although automated vehicle technologies appear daunting and fraught with risk, society may yet benefit from their introduction in ways which cannot presently be imagined. Worldwide, every year there are 1.3 million deaths, and many more people seriously injured, as a result of motor vehicle accidents of which 94 per cent are caused by driver error.[160] The potential to significantly reduce motor vehicle death and injury will be heralded as a great advance for society as a whole. The reality of automated vehicles is that they are likely to bring with them a whole new set of problems. Automated vehicles could be susceptible to hacking, or the privacy invasion of the occupants, as they generate large amounts of data that will be transmitted between the vehicle and infrastructure which could be vulnerable to attack.

Moreover, automated vehicles are set to subvert the existing paradigm of compulsory third-party insurance schemes and when they malfunction may even be located within a product liability model. The introduction of automated vehicle use could change the physical landscape of Australian society to such an extent that it may be unrecognisable to present society. Their introduction will radically alter transport infrastructure, housing, city planning, driver licencing, and penalty regimes, the property model of ownership, issues of personal identity, liability, insurance, and the overall impacts on society will be substantial.

[157] Timothy D Peters, 'I, Corpenstein: Mythic, Metaphorical and Visual Renderings of the Corporate Form in Comics and Film' (2017) 30 *International Journal of Semiotics and Law* 427.
[158] Griggs, (n 156), 154-161.
[159] See generally, Sam N Lehman-Wilzig, 'Frankenstein Unbound: Towards a legal definition of Artificial Intelligence' (1981) *Futures* 442.
[160] US Department of Transportation, 'Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey', *National Highway Traffic Safety Administration* (Web Page, February 2015), <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812115>.

Notwithstanding this, automated vehicles are coming to Australia, and the Australian law seems adaptable to the introduction of automated vehicles. In Australia, legislative development is underpinned by an active system of legal reform and examination, which undertakes enquiry and deliberates, prior to the enactment of new laws. Australia is therefore uniquely situated in the world stage to deal with disruptive technology, as it has a history of proactive legislative change and the ability to anticipate future legal needs. When automated vehicles arrive on Australian roads, Australia will be well placed to cope with their introduction. However, in order for automated vehicles to realise their full potential, we must prepare for them, whether at the Commonwealth or state level, and legislative reform is necessary before their introduction. How we conceptualise fully automated vehicles in future remains to be seen. Nevertheless, automated vehicles are coming, and a failure to make the necessary alterations to the law before their arrival may leave them in a legal vacuum, without adequate protection.

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