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2017/19: Should Australia adopt driverless vehicles?

What they said...

'A large proportion (of car accidents) could be avoided by using self-driving vehicles'
Hussein Dia, chair of Civil Engineering at Swinburne University of Technology

' If we see children distracted by the ice cream truck across the street, we know to slow down, as they may dash toward it. Today's computers aren't nearly as skilled at interpreting complex situations like these'
Andrew Ng, director of Baidu's Institute of Deep Learning

The issue at a glance
On November 29, 2017, it was announced that Perth would be one of the first cities in the world to test fully-automated vehicles in 2018. The city will trial driverless hire cars capable of picking up passengers. http://www.abc.net.au/news/2017-11-29/uber-style-driverless-cars-to-be-tested-in-perth-in-global-trial/9207120
The year before, in August 2016, Perth began trialling Australia's first driverless shuttle bus along the foreshore in South Perth. http://www.abc.net.au/news/2016-08-31/driverless-bus-trialed-in-south-perth/7802976
The technology is proving attractive to other Australian states and territories who are already making changes to road laws to ready themselves for trials of automated vehicles.
https://www.ntc.gov.au/current-projects/changing-driving-laws-to-support-automated-vehicles/
However, a range of analysts have suggested the enthusiasm for automated vehicles is premature and that the new technology will be more problematic than many realise.
http://www.abc.net.au/7.30/is-australia-ready-for-driverless-cars/7940940

Background
(The information below has been taken from an explanation published by the United States Society of Automotive Engineers and from the Wikipedia entry titled Autonomous Car. They can be accessed in full at http://www.sae.org/misc/pdfs/automated_driving.pdf and http://www.sae.org/misc/pdfs/automated_driving.pdfhttps://en.wikipedia.org/wiki/Autonomous_car
The suggested timeline for the adoption of automated vehicles in Australia is taken from an Australian Government Department of Infrastructure and Regional Development brochure titled ' Preparing Australia for Automated Vehicles'. It can be read in full at https://infrastructure.gov.au/transport/automatedvehicles/files/automated-vehicles-brochure.pdf)

History
Experiments have been conducted on automating driving since at least the 1920s. Promising trials took place in the 1950s. The first truly autonomous prototype cars appeared in the 1980s, with Carnegie Mellon University's Navlab and ALV projects in 1984 and Mercedes-Benz and Bundeswehr University Munich's EUREKA Prometheus Project in 1987. Since then, numerous companies and research organizations have developed prototypes. In 2015, the United States states of Nevada, Florida, California, Virginia, and Michigan, together with Washington, D.C. allowed the testing of autonomous cars on public roads.
In 2017, Audi stated that its latest A8 would be autonomous at up to speeds of 60 km/h using its "Audi AI". The driver would not have to do safety checks such as frequently gripping the steering wheel. The Audi A8 was claimed to be the first production car to reach level 3 autonomous driving and Audi would be the first manufacturer to use laser scanners in addition to cameras and ultrasonic sensors for their system.

In November 2017, Waymo announced that it had begun testing driverless cars without a safety driver at the driver position, however; there is still an employee in the car.

The United States Society of Automotive Engineers (SAE) has developed a set of levels widely used in Australia and other nations to explain the degree of automation of various types of automated vehicle.
The SAE has identified six levels of automation from 'no automation' to 'full automation'.
Level 0: Automated system issues warnings, may momentarily intervene, but has no sustained vehicle control.
Level 1 ("hands on"): Driver and automated system share control over the vehicle. An example would be Adaptive Cruise Control (ACC) where the driver controls steering and the automated system controls speed. Using Parking Assistance, steering is automated while speed is manual. The driver must be ready to retake full control at any time. Lane Keeping Assistance (LKA) Type II is a further example of level 1 self driving.
Level 2 ("hands off"): The automated system takes full control of the vehicle (accelerating, braking, and steering). The driver must monitor the driving and be prepared immediately to intervene at any time if the automated system fails to respond properly. The shorthand "hands off" is not meant to be taken literally. In fact, contact between hand and wheel is often mandatory during SAE 2 driving, to confirm that the driver is ready to intervene.
Level 3 ("eyes off"): The driver can safely turn their attention away from the driving tasks, e.g. the driver can text or watch a movie. The vehicle will handle situations that call for an immediate response, like emergency braking. The driver must still be prepared to intervene within some limited time, specified by the manufacturer, when called upon by the vehicle to do so. In 2017 the Audi A8 Luxury Sedan was the first commercial car to claim to be able to do level 3 self driving. The car has a so-called Traffic Jam Pilot. When activated by the human driver the car takes full control of all aspects of driving in slow-moving traffic at up to 60 kilometres per hour. The function works only on highways with a physical barrier separating oncoming traffic.
Level 4 ("mind off"): As level 3, but no driver attention is ever required for safety, i.e. the driver may safely go to sleep or leave the driver's seat. Self driving is supported only in limited areas or under special circumstances, like traffic jams. Outside of these areas or circumstances, the vehicle must be able safely to abort the trip, i.e. park the car, if the driver does not retake control.
Level 5 ("steering wheel optional"): No human intervention is required. An example would be a robotic taxi.

Advantages and disadvantages of automated vehicles

Autonomous cars use a variety of techniques to detect their surroundings, such as radar, laser light, GPS, odometry and computer vision. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage. Autonomous cars must have control systems that are capable of analysing sensory data to distinguish between different cars on the road.
The potential benefits of autonomous cars include reduced mobility and infrastructure costs, increased safety, increased mobility, increased customer satisfaction and reduced crime. Specifically a significant reduction in traffic collisions; the resulting injuries; and related costs, including less need for insurance. Autonomous cars are predicted to increase traffic flow; provide enhanced mobility for children, the elderly, disabled and the poor; relieve travellers from driving and navigation chores; lower fuel consumption; significantly reduce needs for parking space; reduce crime; and facilitate business models for transportation as a service, especially via the sharing economy. This shows the vast disruptive potential of the emerging technology. A frequently cited paper by Michael Osborne and Carl Benedikt Frey found that autonomous cars would make many jobs redundant.
Among the main obstacles to widespread adoption are technological challenges, disputes concerning liability; the time period needed to replace the existing stock of vehicles; resistance by individuals to forfeit control; consumer safety concerns; implementation of a workable legal

framework and establishment of government regulations; risk of loss of privacy and security concerns, such as hackers or terrorism; concerns about the resulting loss of driving-related jobs in the road transport industry; and risk of increased suburbanization as travel becomes less costly and time-consuming.

Anticipated roll-out in Australia
Within the next few years cars will be available that can drive themselves in certain situations such as on highways, but with a human driver ready to take back control. At other times, the human will need to drive as normal.
As the technology develops over the next decade, the next step will be cars able to drive on certain roads without a driver, and without a person ready to take back control.
Experts are divided about when a truly 'driverless vehicle' will be available. There are a number of technical challenges to overcome before a vehicle can safely drive itself in every situation.

Internet information
On December 22, 2017, The Victoria Transport Policy Institute released a report titled 'Autonomous Vehicle Implementation Predictions: Implications for Transport Planning'
This is a highly detailed, thoughtful and balanced consideration of the possible development and impact of autonomous vehicles.'
The full text can be accessed at https://www.vtpi.org/avip.pdf

On December 1, 2017, the federal Department of Infrastructure, Regional Development and Cities issued a statement titled 'Automated Vehicles in Australia' which outlined the work being undertaken across Australia to ready the country for automated vehicles.
The full text can be accessed at https://infrastructure.gov.au/transport/automatedvehicles/index.aspx

On November 30, 2017, ABC News published a report titled ' Uber-style driverless cars set for Perth as part of international trial' detailing Perth's plans to trial driverless taxis. The vehicles will arrive in the city in April, 2018, and will be trialled soon after. Perth is the first Australian city to take and is part of an international trial.
The full text can be accessed at http://www.abc.net.au/news/2017-11-29/uber-style-driverless-cars-to-be-tested-in-perth-in-global-trial/9207120

On November 13, 2017, The Herald Sun published a news report titled 'Driverless cars set to be on Victorian roads in 2018'
The report details the proposed changes to Victoria's road laws to accommodate driverless vehicles and the timeline within which these vehicles are intended to operate in Victoria.
The full text can be accessed at http://www.heraldsun.com.au/news/victoria/driverless-cars-set-to-be-on-victorian-roads-in-2018/news-story/4ee120378ba43c11220618f5c7785043

On November 11, 2017, a bill was introduced into the Victorian Parliament titled ' Road Safety Amendment (Automated Vehicles) Bill 2017'
It details changes to be made to Victorian road laws to allow for the safe operation of automated vehicles.
The full text can be accessed at http://www.legislation.vic.gov.au/domino/Web_Notes/LDMS/PubPDocs.nsf/ee665e366dcb6cb0ca256da400837f6b/181f39fd4e7ae776ca2581d800719551/$FILE/581409bi1.pdf

On October 23, 2017, The West Australian published a news report titled 'Humans a hurdle to driverless cars' which focused on recent research findings that indicated automated cars could lead to the de-skilling of human drivers.
The full text can be accessed at https://thewest.com.au/news/wa/human-hurdle-to-robot-cars-ng-

b88627469z

On September 26, 2017, Swinburne Online published a report titled ' Self-driving cars could dramatically reduce the road toll'
The article reported on the work of Hussein Dia, chair of Civil Engineering at Swinburne University of Technology on the capacity of automated cars to bring an end to road accidents caused by human error.
The full text of the article can be accessed at http://www.swinburne.edu.au/news/latest-news/2017/09/self-driving-cars-could-dramatically-reduce-the-road-toll.php

On September 12, 2017, medium.com published an article by Kyle Vogt, chief executive officer of Cruise (a developer and manufacturer of automated vehicles), titled 'How we built the first real self-driving car (really)' outlining the processes involved in the development of an automated car.
The full text can be accessed at https://medium.com/kylevogt/how-we-built-the-first-real-self-driving-car-really-bd17b0dbda55

In August, 2017, a Standing Committee report was released titled ' Social issues relating to land-based automated vehicles in Australia'
The Committee recommended that the Australian government support the introduction of automated vehicles, primarily because of their capacity to reduce the road toll; however, it noted that these vehicles will have wide-ranging implications, some of which will require governments to make policy adjustments.
The full text can be accessed at https://www.aph.gov.au/Parliamentary_Business/Committees/House/Industry_Innovation_Science_and_Resources/Driverless_vehicles/Report

On August 10, 2017, Bloomberg Technology published a comment and analysis titled 'Robots are ruining your driving skills' which reported on a series of findings, some from automobile manufacturers, suggesting that semi-automated cars are deskilling drivers.
The full text can be accessed at https://www.bloomberg.com/news/articles/2017-08-10/as-robots-take-the-wheel-driving-skills-begin-to-hit-the-skids

In August, 2017, The House of Representatives Standing Committee on Industry, Innovation, Science and Resources released its report on ' Social issues relating to land-based automated vehicles in Australia'.
The Committee recommended that given the capacity of the technology to save lives Australia should make its adoption a priority.
The full text can be accessed at https://www.aph.gov.au/Parliamentary_Business/Committees/House/Industry_Innovation_Science_and_Resources/Driverless_vehicles/Report

On June 22, 2017, Tribune News Services published a comment by William Noack titled 'Autonomous Vehicles Will Improve Safety, Lower Costs to Drivers'
The opinion piece outlines a range of advantages that may derive from the use of automated vehicles. The full text can be accessed at http://www.govtech.com/fs/Autonomous-Vehicles-Will-Improve-Safety-Lower-Costs-to-Drivers.html

On June 1, 2017, The Australian published a report titled ' Driverless vehicles to cut truckies' jobs' which looked at problem job losses among professional transport drivers as autonomous vehicles become more common.
The full text can be accessed at http://www.theaustralian.com.au/business/technology/driverless-vehicles-to-cut-truckies-jobs/news-story/8f3adcb9876c518adcf1a1c04fded84e

On May 26, 2017, Forbes published in its Science section a report titled 'Just One Driverless Car Could Ease Traffic Jams'

The report explains the driving behaviours that tend to promote traffic jams and the manner in which a small number of automated cars could modify this.
The full text can be accessed at https://www.forbes.com/sites/lauriewinkless/2017/05/26/just-one-driverless-car-could-ease-traffic-jams/#1784508e1f9b

On May 12, 2017, British Telecommunications online publication, BT, published a comment and analysis titled 'Driverless cars could be a solution to traffic congestion'. The article cites United States research which suggests that even a relatively small number of cars on the road could improve traffic flow.
The full text can be accessed at http://home.bt.com/tech-gadgets/future-tech/driverless-cars-could-reduce-traffic-11364179569658

On March 1, 2017, Drive published a comment and analysis titled 'But the transport industry needs to start getting ready for a shake-up in unskilled jobs' The item considers some of the ramifications of semi-automated and automated vehicles, including their impact on job losses.
The full text can be accessed at https://www.drive.com.au/motor-news/australian-government-fully-selfdriving-cars-decades-away-20170301-gunyh6

On January 19, 2017, The Los Angeles Times published a news report titled 'U.S. ends investigation of fatal Tesla crash and finds "no safety defects" in car's Autopilot'
The report details the investigation into the first automated vehicle-related fatality.
Te full text can be accessed at http://www.latimes.com/business/autos/la-fi-hy-tesla-autopilot-20170119-story.html

On December 15, 2016, VicRoads released a discussion paper titled 'Future Directions Paper: How Victoria will continue to support the development of automated vehicles'
The paper outlines the regulatory framework that will need to be established to ensure that automated and semi-automated vehicles can be adequately tested before they are allowed on Victorian roads.
The full text can be accessed at https://engage.vicroads.vic.gov.au/on-road-trials-of-automated-vehicles

On September 20, 2016, Robotics Trends published a comment and analysis titled ' Self-Driving Cars Need to Be More Reliable' which outlined the limits of GPS technology and suggested alternative navigation systems.
The full text can be accessed at http://www.roboticstrends.com/article/self_driving_cars_need_to_be_more_reliable

On August 25, 2016, Business Insider published an analysis titled '6 scenarios self-driving cars still can't handle'. The second of these was heavy rain and snow, which, it is said, confuse the cars' sensors and cameras. The full text can be found at http://www.businessinsider.com/autonomous-car-limitations-2016-8/?r=AU&IR=T/#2-self-driving-cars-also-struggle-to-see-in-inclement-weather-2

On August 11, 2016, Smith's Lawyers online site detailed some of the job losses to be expected as automated cars become more common. The piece is titled 'Self-Driving Vehicles Will Save Lives But Destroy Jobs, and can be accessed at https://www.smithslawyers.com.au/blog/road-safety/self-driving-vehicles-save-lives-destroy-jobs/

On June 14,2016, Business Insider Australia published a report on ways in which automatic cars could be advantageous. The report considers road safety, traffic flow and fuel efficiency and time savings.
The report can be accessed at https://www.businessinsider.com.au/advantages-of-driverless-

cars-2016-6#/#roads-will-be-safer-1

On March 15, 2016, Wired published a comment and analysis titled 'Self-driving cars won't work until we change our roads - and attitudes'. The piece argues that automated cars cannot be expected to read all the complex visual cues that human beings can and that until we make modifications to roads and signage they will not be feasible.
The full text can be accessed at https://www.wired.com/2016/03/self-driving-cars-wont-work-change-roads-attitudes/

On October 14, 2015, The Washington Post published a news report titled ' Elon Musk vents about California's lane markings confusing Tesla's autopilot' which dealt with Tesla's chief executive complaining that certain types of ambiguous road markings cannot be accurately read by some automated vehicles.
The full text can be accessed at https://www.washingtonpost.com/news/innovations/wp/2015/10/14/elon-musk-vents-about-californias-lane-markings-confusing-teslas-autopilot/?utm_term=.77a64046f1df

On September 29, 2015, The Atlantic published an analysis by Adrienne LaFrance titled ' Self-Driving Cars Could Save 300,000 Lives Per Decade in America' dealing with the potential of automated cars to save lives'
The full text can be accessed at https://www.theatlantic.com/technology/archive/2015/09/self-driving-cars-could-save-300000-lives-per-decade-in-america/407956/

On May 10, 2015, Gizmodo published a comment and analysis titled ' The Reason We Won't Have Autonomous Cars Any Time Soon' which outlined the difficulties associated with reliably navigating automated vehicles.
The full text can be accessed at https://www.gizmodo.com.au/2015/05/how-to-teach-an-autonomous-car-to-drive/

Arguments in favour of Australia adopting driverless vehicles
1. The wide-spread introduction of fully- or semi-automated cars will reduce the road toll
One of the major arguments offered in support of fully- or semi-automated cars is that were they in general use they could drop the road toll to almost nothing.
Researchers in the United States estimate that by the middle of this century fully-automated cars could reduce road fatalities by 90 percent. This reduction in loss of life has been claimed to be similar in size to that brought about by the introduction of modern vaccines. Extrapolating these figures world-wide it been suggested that driverless cares could save 10 million lives per decade.
https://www.theatlantic.com/technology/archive/2015/09/self-driving-cars-could-save-300000-lives-per-decade-in-america/407956/
A report released in September, 2017, by the United States National Highway Traffic Safety Administration indicated that two percent of major accidents were caused by the environment, two percent by vehicle failure and two percent by 'unknown' causes. The remaining 94 percent were attributed to human error. https://blog.lawinfo.com/2017/09/06/human-error-causes-94-percent-of-car-accidents/
Proponents of automated cars argue that figures such as these demonstrate the extent to which human lives could be saved by the widespread use of automated vehicles.
Hussein Dia, chair of Civil Engineering at Swinburne University of Technology, has stated, 'A large proportion (of car accidents) could be avoided by using self-driving vehicles and there is compelling logic in removing humans - the key source of the error - from the driving equation. Driven by artificial intelligence, these vehicles will not make errors of judgement the way a human driver does.
They will not drink and drive. They will not fall asleep behind the wheel. They will not get distracted by playing Pokâ€šmon Go.' http://www.swinburne.edu.au/news/latest-news/2017

/09/self-driving-cars-could-dramatically-reduce-the-road-toll.php
In August, 2017, The House of Representatives Standing Committee on Industry, Innovation, Science and Resources released its report on ' Social issues relating to land-based automated vehicles in Australia'. The Committee concluded, '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'
https://www.aph.gov.au/Parliamentary_Business/Committees/House/Industry_Innovation_Science_and_Resources/Driverless_vehicles/Report
It has been claimed that even should automated cars occasionally misread the road or traffic circumstances in which they are placed, the accidents they have will be far fewer than those attributable to human error. It has further been noted that improvements in technology will mean that the incidence of accidents in automated cars will continue to decline.
Hod Lipson, professor of mechanical engineering at Columbia University, has stated, 'Yes, driverless cars are going to have accidents. But they're going to have fewer accidents than humans. And unlike humans, driverless cars are going to keep getting better, halving the number of accidents per mile every so many months. The sooner we get on that exponential trajectory, the better.' http://www.latimes.com/business/autos/la-fi-hy-tesla-autopilot-20170119-story.html

2. Trials will be undertaken before fully automated vehicles are allowed onto Australian roads
Both car manufacturers and governments recognise that before semi- and fully-automated vehicles can be allowed on roads in Australia or elsewhere they will have to be exhaustively tested. This is necessary for two reasons. The first is to guarantee utility and safety, the second is to ensure public confidence in the vehicles. Without a high level of public trust in the safety and reliability of automated cars, consumers will not purchase them and other drivers will not agree to share the roads with them.
The development process for automatic vehicles involves ongoing trialling. The process has been described by Cruise, a designer and manufacturer of automatic cars. 'These robots [automatic vehicles] didn't appear overnight. We knew we'd discover new things along the way, so we took an iterative approach to development and built several generations of vehicles. In fact, by the time General Motors completed its acquisition of Cruise in mid 2016, we had already retrofitted our self-driving systems onto the Chevrolet Bolt EV platform to create our 1st generation test vehicles. We've already put hundreds of thousands of complex urban miles on these vehicles, and exposure to the many challenging situations we've encountered along the way has rapidly improved our software.' https://medium.com/kylevogt/how-we-built-the-first-real-self-driving-car-really-bd17b0dbda55
Once the cars have been brought to the state of readiness Cruise describes through research and development trialling, they are then tested further under the observation of government authorities. This is the situation in Australia where a series of state-based trials are about to begin.
On December 15, 2016, VicRoads released a discussion paper titled 'Future Directions Paper: How Victoria will continue to support the development of automated vehicles'
One of the key understandings around which the paper was written was 'Before we can experience the benefits, on-road trials will be critical to the safe development of these technologies'. The paper further noted, 'Given the potential safety benefits they present, VicRoads considers that on-road trials of automated vehicles are essential to guide their safe development for use in Australia, and for enhancing public acceptance.' https://engage.vicroads.vic.gov.au/on-road-trials-of-automated-vehicles
Perth is set to become the first Australian city, and one of the first places in the world, to trial on-demand driverless cars capable of picking up passengers.
On November 30, 2017, it was announced that a driverless taxi service is to be trialled in Perth beginning in April, 2018. The Western Australian Government has partnered with the Royal Automobile Club (RAC) and the French company behind the technology, NAVYA, to bring several driverless cars to the state for testing in 2018. Perth was one of three cities chosen for the trial,

the others being Paris and a United States city yet to be announced.
The vehicles will be tested on private roads before being taken onto city streets later in the year. If the trials are successful it is anticipated that the service will be operating in Perth by 2021.
http://www.abc.net.au/news/2017-11-29/uber-style-driverless-cars-to-be-tested-in-perth-in-global-trial/9207120

3. Adjustments to roads and regulations will be made to ensure safety
All Australian state and territory governments have demonstrated an awareness that before automated vehicles can be safely tested on Australian roads there will need to be adjustments made to roads and signage and alterations made to the rules and regulations that govern road use.
The Australian Government's Department of Infrastructure, Regional Development and Cities has begun planning for some of the physical changes to roads and signage that will be required when automated cars are trialled and then in more general use. In a statement issued on December 1, 2017, the Department declared its determination to 'make sure our roads are ready and that road signs, traffic lights and road markings are compatible with connected and automated vehicles'.
https://infrastructure.gov.au/transport/automatedvehicles/index.aspx
Changes are also being made to road laws and regulations to accommodate the trialling of automated cars and their subsequent general use.
National guidelines were put in place on May 31, 2017. The intention of the national regulations is to support nationally consistent conditions for automated vehicle trials in Australia; provide certainty and clarity to industry regarding expectations when trialling in Australia; help road transport agencies manage trials in their own state or territory as well as across state borders; establish minimum standards of safety; help assure the public that roads are being used safely and help raise awareness and acceptance of automated vehicles in the community.
http://www.ntc.gov.au/Media/Reports/(00F4B0A0-55E9-17E7-BF15-D70F4725A938).pdf
Most states have also set up state-based modifications to road laws and regulations to cover some of the challenges posed by automated vehicles.
On November 14, 2017, a Bill was introduced into the Victorian State Parliament titled 'Road Safety Amendment (Automated Vehicles) Bill 2017'. The Bill covered provisions including the designation of an automated vehicles, defining the circumstances under which a person can be considered in charge of such a vehicle, the responsibilities of the driver or person in charge of an automated vehicle, and the impoundment, immobilisations and forfeiture of such vehicles.
http://www.legislation.vic.gov.au/domino/Web_Notes/LDMS/PubPDocs.nsf/ee665e366dcb6cb0ca256da400837f6b/181f39fd4e7ae776ca2581d800719551/$FILE/581409bi1.pdf
Under the proposed changes, drivers will no longer have to touch the wheel of a car during testing and unmanned autonomous vehicles will also be allowed on Victorian roads as research continues. The new laws will give VicRoads oversight of all trials and will establish responsibility in the event of accidents.
The proposed legislation goes a step further than automated vehicle laws already introduced in South Australia and New South Wales as it will allow fully unmanned autonomous cars to appear on Victorian roads. http://www.heraldsun.com.au/news/victoria/driverless-cars-set-to-be-on-victorian-roads-in-2018/news-story/4ee120378ba43c11220618f5c7785043

4. Automated vehicles will reduce many costs associated with owning a vehicle as well as reducing transport costs
It has been argued that though the vehicles themselves will be initially more expensive, over time they will reduce costs.
On June 22, 2017, Tribune News Services published an opinion piece claiming, ' Of all the benefits of automated vehicles, none will be more welcomed by consumers than those that impact the pocketbook. With this technology, the costs of medical bills, lost work time and vehicle repair will diminish. Insurance costs should also drop. Smoother flowing traffic will reduce fuel costs, and

car sharing - which reduces overall vehicle costs - is expected to become more commonplace.' http://www.govtech.com/fs/Autonomous-Vehicles-Will-Improve-Safety-Lower-Costs-to-Drivers.html
The probability of lower insurance premiums has been stressed by many commentators. An article published in forbes.com on August 18, 2015, stated, '[S]elf-driving cars could save consumers an average $1,000 per year, given their near perfect safety record. If self-driving cars really do live up to the hype and eliminate collision-related crashes, then drivers will only have to pay for insurance for things like break-ins and acts of god.' https://www.forbes.com/sites/bethbraverman/2015/08/18/4-ways-self-driving-cars-will-save-you-money/#fcba18d26beb
In addition to the savings that could come to individual drivers, it has been suggested that automatic vehicles would create large saving for transport fleet owners whose vehicles typically transport goods over long distances.
A Pittsburgh Swanson School of Engineering student, Scott Maskal, has noted, 'Even though self-driving cars might be expensive when they become available for consumers, the costs would be less for a firm. In the case of truck deliveries of goods, an automated vehicle would take the job of that truck driver. Thus, firms would save more money by not paying wages to delivery drivers.' http://www.pitt.edu/~sjm160/Images/SelfDrivingCarsWA3.pdf
Analysts have further predicted that share-drive fleets such as Uber and taxi services generally will become cheaper if driverless vehicles are generally adopted. Savings are expected to come to fleet owners from not having to pay drivers and from greater utilisation of vehicles which are expected to be on road virtually all the time. It is anticipated that a portion of these saving will be passed on to consumers. https://www.marketwatch.com/story/demand-for-driverless-cars-could-boost-uber-to-2016-09-19

5. Automated vehicles will improve traffic flow and fuel efficiency
It has been argued that automated vehicles will greatly enhance the experience of driving, improving traffic flow and increasing fuel efficiency.
Erik Coelingh, Volvo's Senior Technical Leader for Safety and Driver Support Technologies, has stated, ' There's potential in efficiency, efficiency in terms of better traffic flow, but also less fuel consumption.' https://www.businessinsider.com.au/advantages-of-driverless-cars-2016-6#/#traffic-and-fuel-efficiency-will-greatly-improve-2
The reduced incidence of accidents caused by human error are expected to result in less traffic congestion. It is also expected that an increase in self-driving taxis will decrease the total number of cars on the road resulting in a further lessening of congestion. While gasoline-fuelled cars still remain the norm, because driverless vehicles are designed to optimise efficiency in acceleration and braking, it is anticipated they will also help improve fuel efficiency and reduce carbon emissions. https://www.businessinsider.com.au/advantages-of-driverless-cars-2016-6#/#traffic-and-fuel-efficiency-will-greatly-improve-2
One of the principal causes of traffic jams on roads is that human drivers have difficulty maintaining a constant speed. The ripple effect of constant small accelerations and decelerations frequently results in a traffic jam where there is no physical blockage on the road to account for it. Tests have demonstrated that even a small number of automated vehicles in a built-up area able to maintain a constant speed prevents these ripples or waves from forming.
https://www.forbes.com/sites/lauriewinkless/2017/05/26/just-one-driverless-car-could-ease-traffic-jams/#36e023c31f9b
According to researchers from across the United States, as little as 5% of traffic being made up of automated vehicles could help eliminate 'stop and go driving' which can cause congestion. Researchers at the University of Illinois found that with a driverless vehicle there to control the pace, the traffic flow of all the cars smoothed out. http://home.bt.com/tech-gadgets/future-tech/driverless-cars-could-reduce-traffic-11364179569658
Stop-start driving is a major cause of inefficient fuel use; therefore, it has been estimated that the capacity of automated cars to maintain a constant speed irrespective of traffic density will reduce fuel consumption.
The capacity of automated vehicles to maintain a constant speed also means they are able to

move in groups, referred to as 'platoons'. Reduced wind resistance per vehicle created by such formations results in lower fuel consumption.
A study released by the United States Energy Information Administration in April, 2017, estimated that by 2050, connected autonomous vehicles could reduce fuel consumption by as much as 44 percent for passenger vehicles and 18 percent for trucks. The study noted, 'In one representative platooning test, two semi-trucks were platooned at a constant 64 mph at a 36-foot following distance. This configuration resulted in an average fuel consumption saving of 4.5% for the lead truck and 10% for the following truck.' https://www.forbes.com/sites/jeffmcmahon/2017/04/17/big-fuel-savings-from-autonomous-vehicles/#1a4b85694390

Arguments against Australia adopting fully- and semi-automated vehicles
1. There are numerous on-road situations automated cars cannot manage
It has been noted that there are many on-road situations that automated vehicles cannot deal with.
John Dolan, principal systems scientist at Carnegie Mellon's Robotics Institute has noted, 'Heavy snow and rain tend to confuse LiDAR sensors and also cameras.' (LiDAR refers to the light sensing radar that allow the vehicle to 'see' what is around it.) http://www.businessinsider.com/autonomous-car-limitations-2016-8?IR=T/#2-self-driving-cars-also-struggle-to-see-in-inclement-weather-2
Indeed, anything that confuses the vehicle's cameras is a problem. For example, when the sun is immediately behind a traffic light, most cameras cannot recognize the colour of the signal through the glare. https://www.wired.com/2016/03/self-driving-cars-wont-work-change-roads-attitudes/ The first human fatality involving a semi-automated vehicle occurred when a lorry joined the road from a cross street. Unable to distinguish the white truck against the brightly lit sky, the self-driving system failed to apply the brakes. https://www.wired.com/2016/03/self-driving-cars-wont-work-change-roads-attitudes/https://www.newscientist.com/article/2095740-tesla-driver-dies-in-first-fatal-autonomous-car-crash-in-us/
It has also been noted that poorly or unclearly marked stretches of road create significant problems for semi-automated vehicles. Tesla chief executive, Elon Musk, noted the problem of unmarked or ambiguously marked highways in California, complaining '[Y]ou have the true lane position and the sort of fake-lane position, and they're diverging. The camera system would then follow the diverging system and go into the wrong lane.' https://www.washingtonpost.com/news/innovations/wp/2015/10/14/elon-musk-vents-about-californias-lane-markings-confusing-teslas-autopilot/?utm_term=.9e889fb36cb3
Andrew Ng, chief scientist at Baidu Research and Yuanqing Lin, director of Baidu's Institute of Deep Learning, acknowledged in a comment and analysis published in March, 2016, that automated vehicles are not able to assess complex situations involving multiple subtle cues, nor respond to human verbal or non-verbal cues. They noted, ' If we see a truck with a "Makes Wide Turns" sign, we know how to adjust our driving accordingly. If we see children distracted by the ice cream truck across the street, we know to slow down, as they may dash toward it. Today's computers aren't nearly as skilled at interpreting complex situations like these.'
https://www.wired.com/2016/03/self-driving-cars-wont-work-change-roads-attitudes/

2. Self-driving cars are vulnerable to the limitations of their navigating systems
Currently most semi-automatic cars rely on the interaction of their on-board sensory systems and global positioning system (GPS) to locate the car in time and space and direct it on the road. The current limitations of GPS make self-directing cars unreliable. Robotics expert David Bruemmer has noted, '[D]ependence on GPS can limit efficiency and reliability. GPS can't direct a robot through a narrow doorway or prevent a collision inside a parking garage. It can't slide your car into a parking space or allow a convoy of trucks to keep a meter apart. We have tried to solve this problem by adding sensors onto vehicles that build up maps and localize, but we can't put these on most of the things we'd like to track and control because the sensors are either too big, too power hungry or don't work in dirty, dusty, dynamic environments.'

Any situation where the satellite signal upon which the GPS relies is blocked makes the system unreliable as a means of navigation. Obstacles to the signals such as buildings, trees, mountain ranges and extreme atmospheric conditions such as geomagnetic storms can all disrupt its operation.
http://www.roboticstrends.com/article/self_driving_cars_need_to_be_more_reliable
One of the measures being developed to overcome some of the limitations associated with GPS navigation is a different type of mapping system loaded within a vehicle's computers which interacts with the vehicle's sensors without relying on global positioning. The autonomous cars developed by Google and Oxford University use these rich, 3D maps of the road known as 'prior maps' that are installed within the car. On-board sensors then compare what the car sees at any point in time to what it is stored in its memory. Though this system is more robust than GPS it relies on a myriad of 'prior maps' being stored in the vehicle's computers. To-date, most of these prior maps do not exist. https://www.gizmodo.com.au/2015/05/how-to-teach-an-autonomous-car-to-drive/

3. Semi-automated cars will de-skill drivers
There are currently many concerns that semi-automated cars are making drivers complacent and degrading their driving skills.
Current driver-assist technology is able to keep cars in their lanes, maintain a safe distance from other vehicles, warn of unseen traffic and apply the brakes to avoid rear-end crashes and this technology is rapidly spreading from luxury cars to widely-purchased Hondas and Nissans. The apprehension is that with the increasing use of these devices a growing number of drivers are forfeiting skill and alertness.
Adrian Lund, president of the United States Insurance Institute for Highway Safety states, 'There are lots of concerns about people checking out and we are trying to monitor that now. Everything we do that makes the driving task a little easier means that people are going to pay a little bit less attention when they're driving.' https://www.bloomberg.com/news/articles/2017-08-10/as-robots-take-the-wheel-driving-skills-begin-to-hit-the-skids
Mike Harley, group managing editor at Kelley Blue Book a car-shopping site, shares these concerns. He states, 'Without question, technology is making drivers lazier and less attentive. Most of today's digital "driver assistance" features are designed to overlay basic driving skills, which relaxes the driver's sense of responsibility.' https://www.bloomberg.com/news/articles/2017-08-10/as-robots-take-the-wheel-driving-skills-begin-to-hit-the-skids
A recent University of Michigan study investigated how people are using blind-spot detection systems. The study found a significant increase in drivers failing to look over their shoulder to check for themselves when changing lanes. Shan Bao, associate research scientist at the university's Transportation Research Institute, stated, 'The more [drivers] are exposed to these systems, the more they trust the systems.' Shan Bao further suggested that, in emergency situations ' they'll trust the systems more than they'll trust themselves.'
https://www.bloomberg.com/news/articles/2017-08-10/as-robots-take-the-wheel-driving-skills-begin-to-hit-the-skids
There has also been concern expressed that in addition to over-reliance on the automated features, drives might actually lose some of their skills. This possibility was explained in a 2016 Swedish study which stated, ' In absence of practice, driver will lose these skills to control the vehicle manually...which could lead to wrong decisions.' https://ac.els-cdn.com/S2352146516305968/1-s2.0-S2352146516305968-main.pdf?_tid=ef5e4f72-f426-11e7-ba2e-00000aab0f6b&acdnat=1515383552_4ab4a7a229e749c64cb2586a8a8c920f
Possible complacency and skill loss when driving a semi-automated vehicle are very concerning to experts because the current recommendation is that the driver has to be prepared to resume control of the vehicle whenever a circumstance arises with which the automated system cannot deal. De-skilled drivers are unlikely to be able to respond appropriately in emergency situations. This point was made in the 2016 Swedish study which found, '[I]f the [automated] system has low failure rate and high reliability, overreliance on the automation system will reduce the readiness for

transition to manual control of the vehicle.' https://ac.els-cdn.com/S2352146516305968/1-s2.0-S2352146516305968-main.pdf?_tid=ef5e4f72-f426-11e7-ba2e-00000aab0f6b&acdnat=1515383552_4ab4a7a229e749c64cb2586a8a8c920f
A federal investigation into the 2016 fatality in a Tesla Model S travelling in semi-autonomous Autopilot mode showed the driver had his hands on the wheel for just 25 seconds in the final 37 minutes before crashing into a semitrailer. https://www.bloomberg.com/news/articles/2017-08-10/as-robots-take-the-wheel-driving-skills-begin-to-hit-the-skids

4. The cost of fully-automated cars will be prohibitive for most drivers
A report released by the Victoria Transport Policy Institute on December 22, 2017, noted the probable costs associated with automated cars. It stated, 'Current new technologies can add thousands of dollars to vehicle purchase prices. For example, a package of optional electronic features such as remote starting, high beam assist, active lane assist, adaptive cruise control and top view camera typically increases new vehicle prices by more than $5,000, and navigation and security services, such as OnStar and TomTom, cost $200-600 per year. Since failures could be deadly, autonomous driving systems will need robust, redundant and abuse-resistant components maintained by specialists, similar to aviation standards, further increasing costs.' https://www.vtpi.org/avip.pdfThe report continued, 'Level 4 and 5 autonomous driving capabilities will probably increase vehicle purchase prices by many thousands of dollars, and require hundreds or thousands of dollars in additional annual services and maintenance costs. Experience with previous vehicle
innovations, such as automatic transmissions and airbags...suggests that autonomous driving capability will initially be available only on higher priced models, and will take one to three decades to be incorporated into middle- and lower-priced models.' https://www.vtpi.org/avip.pdfil
Estimates made in the United States are more specific and suggested that fully automated vehicles will be far outside the price range of many potential consumers. In an article published on January 31, 2014, Fast Company noted, 'According to the National Automobile Dealers Association, the average American spends around $30,000 on a new car or light truck. In contrast, Interest.com's 2013 Car Affordability Study says that the average American can only afford to spend $20,806 on a car.
The featured Prius [one shown in a popular advertisement for automated cars], which starts at around $24,000, is optioned up with a $75,000 to $80,000 Velodyne LIDAR system, visual and radar sensors estimated to cost about $10,000, and a nearly $200,000 GPS array. Not to mention the cost of the driving computer and software. Put into context: The staid-looking Toyota Prius [driven] around in the video costs more than a Ferrari 599. At $320,000, that's an exclusive purchase, and well above the mean cost of a car, truck or SUV.' https://www.fastcompany.com/3025722/will-you-ever-be-able-to-afford-a-self-driving-car
It has been estimated that even with improvements in technology, affordable self-driving cars are some way into the future, An opinion piece published in the Huffington Post on April 7, 2017, stated, ' Today's autonomous vehicles are what hybrid cars used to be; a more efficient means of driving that costs way more than the average person can afford. As is always the case with technology, constant refinement and the availability of cheaper materials will eventually make autonomous vehicles more affordable to the masses but that day is still a few years away. It's estimated that even in 2025, having self-driving features in a vehicle will drive up the cost to the consumer by at least $7,000-$10,000.' https://www.huffingtonpost.com/matthew-crawt/3-reasons-why-selfdriving_b_9631512.html

5. Fully automated vehicles will cost many jobs
Critics of vehicle automation have warned that this development will create large-scale job losses, particular in the transport of goods and public transport. In a report published in The Australian on June 1, 2017, the newspaper's economics correspondent, Adam Creighton, noted that more than 100,000 truckies - the fifth most common occupation in Australia - face redundancy over the next decade as driverless technology spreads to Australia's highways and ports. The impact on

employment in Australia will be significant as almost 190,000 Australians (almost 1.6 per cent of all employed people) are truck drivers, according to recent Australian Bureau of Statistics data. Creighton further explained the world-wide ramifications, adding that between 3.4 million and 4.4 million drivers were likely to lose their jobs if emerging technology started to be rolled out from the early 2020s. http://www.theaustralian.com.au/business/technology/driverless-vehicles-to-cut-truckies-jobs/news-story/8f3adcb9876c518adcf1a1c04fded84e

These predictions are contained within a report by the International Transport Forum, which estimated the demand and supply of truck drivers up to the year 2040. The report states, 'Even accounting for adverse demographic trends and prospective truck drivers being progressively dissuaded by the advent of driverless technology, over two million drivers across the US and Ã°Europe could be directly displaced by 2030.'http://www.theaustralian.com.au/business/technology/driverless-vehicles-to-cut-truckies-jobs/news-story/8f3adcb9876c518adcf1a1c04fded84e

Within Australia fully automated trucks are already being used on a limited scale on West Australian mining sites and in the Port of Rotterdam.

Not only drivers employed in the transport of goods, but also those in public transport will have their jobs at risk. A report published by Smith's Lawyers on August 11, 2016 stated, 'Taxi drivers, Uber drivers, and bus drivers will all be affected by the dawn of the technology that will see autonomous vehicles becoming the norm.' https://www.smithslawyers.com.au/blog/road-safety/self-driving-vehicles-save-lives-destroy-jobs/

Phillipa Power, executive director of policy and research at the Department of Infrastructure and Regional Development, has stated, 'The reality is that automation, whether it be for vehicles or other things, has the potential to impact in quite significant ways on Australia's labour market, particularly in areas where automation begins to replace what we would consider lower skilled or unskilled jobs.' https://www.drive.com.au/motor-news/australian-government-fully-selfdriving-cars-decades-away-20170301-gunyh6

In addition to reducing demand for drivers, another area in which fully- or semi-automated cars is likely to result in reduced employment is in vehicle repair. The House of Representatives Standing Committee on Industry, Innovation, Science and Resources released a report on the social impact of automated vehicles in August, 2017. The report stated, ' Another sector likely to change as a consequence of increasing automation of vehicles is vehicle repair - mechanics, panel beaters 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.' https://www.aph.gov.au/Parliamentary_Business/Committees/House/Industry_Innovation_Science_and_Resources/Driverless_vehicles/Report

Further implications

A number of analysts have stressed that the consequences of developing automatic vehicle technology may not be as clear-cut as is commonly thought. The discussion presented below has been taken from a report released on December 22, 2017, by the Victoria Transport Policy Institute, titled 'Autonomous Vehicle Implementation Predictions: Implications for Transport Planning'.

The full text can be accessed at https://www.vtpi.org/avip.pdf

'The future is ultimately unknowable, yet planning requires predicting future needs. Many decision-makers and practitioners (planners, engineers and analysts) wonder how autonomous (also called self-driving or robotic) vehicles will affect future travel, and therefore how best to design roads, parking and public transit systems, and whether our policies should encourage or restrict their use.

There is considerable uncertainty about these factors. Advocates predict that by 2030, autonomous vehicles will be sufficiently convenient and affordable to displace most human-operated vehicles, will provide independent mobility to non-drivers, reduce the stress and tedium

of driving, and be a panacea for congestion, accident and pollution problems, but there are reasons to be sceptical.

Most optimistic predictions are made by people with financial interests in the industry, and their predictions are often based on experience with electronic innovations such as digital cameras, smart phones and the Internet. Their analysis often overlooks significant obstacles and costs associated with transportation innovations, such as unsolved technical challenges, and ways that self-driving vehicles may increase traffic congestion and accident problems.

Motor vehicles last an order of magnitude longer, cost two orders of magnitude more, rely more on public infrastructure, and impose much greater external impacts than personal computers, cameras or telephones. Electronic systems often fail. With as digital cameras, mobile phones and the Internet, such failures are frustrating and wasteful; with motor vehicles, they can be deadly to occupants and other road users. As a result, autonomous vehicles are likely take longer to develop and provide smaller net benefits than optimists predict.

These factors have significant transportation policy and planning implications. Motor vehicle travel relies on public infrastructure and can impose significant external costs, and so require more public investment and regulation than most other technologies. For example, many potential benefits, including congestion and pollution reductions, depend on public roads having dedicated lanes for autonomous vehicle platooning (numerous vehicles driving close together at relatively high speeds). Policy makers will need to decide when the potential benefits justify devoting such valuable public assets to these expensive new vehicles, their terms of use, such as whether they should pay an extra road user fee, and the enforcement measures needed to prevent human drivers from trying to join those platoons...

Autonomous vehicles can provide independent mobility for non-drivers, including people with disabilities, adolescents, and others or who for any reason cannot or should not drive. This can provide direct benefits to those travellers, reduce chauffeuring burdens on their family members and friends, and in some cases increase their access to education and employment opportunities, increasing their economic productivity. Some affluent non-drivers living in sprawled areas may purchase personal autonomous vehicles, and a larger number of non-drivers are likely to use autonomous taxi services if they become convenient and affordable.

On the other hand, optimistic predictions of autonomous vehicle benefits may cause some communities to reduce support for public transit services which may reduce mobility options for non-drivers. Dedicating highway lanes for autonomous vehicle platooning may reduce capacity for human-operated traffic.

Autonomous vehicles can [also] reduce driver stress and tedium. Self-driving cars can be mobile offices, playrooms or bedrooms, as illustrated below, allowing passengers to be productive or rest while travelling (WSJ 2017). This can reduce travel time unit costs (dollars per hour).

On the other hand, self-driving vehicles can introduce new stresses and discomforts. Some studies suggest that travellers will experience 'access anxiety', if they fear that their vehicle cannot reach a desired destination, [while] to minimize cleaning and vandalism costs, self-driving taxis and buses will have 'hardened' interiors (vinyl seats and stainless steel surfaces), minimal accessories, and security cameras.'

The above discussion is a reminder that we cannot yet know what the future will bring regarding automatic vehicles and that they carry a mixed potential.