



*Australia &
New Zealand
Driverless Vehicle
Initiative*

Thought Leadership Paper Driverless vehicles and parking

23 May 2017

**K Ralston, J Carslake, P Damen, L Duffy,
L Field, J Catbagan and C Burrell**



This paper represents a Thought Leadership position of the Australia and New Zealand Driverless Vehicle Initiative (ADVI) as a collaboration of its partners. It does not purport to reflect the position of individual partners nor commit them to a particular direction or technology position.

This thought leadership policy position is subject to change as new information and knowledge arises, and as the ADVI partnership evolves. All assumptions are based on the best available information and no responsibility is taken for any errors or omissions. Any use of the information provided in this paper is at the discretion of the reader.

Executive Summary

Whether it is by an individual, family, or business, the fact is that owning a vehicle is an expensive investment. The combined costs of insurance, fuel, maintenance, repairs, and registration often adds up to hundreds, if not thousands, of dollars annually.

Then consider that most vehicles typically sit idle for 96% of the time, restricting the use of the parking space needed.

The introduction of driverless cars, combined with changing transport trends by Australians, will bring substantial changes to the parking ecosystem - particularly the commercial parking sector - as well as on and off-street/home parking.

The emergence of Mobility-as-a-Service is a clear indicator that commuters will increasingly favour a pick-up and drop-off service, which will reduce demand for multiple parking options, and allow those spaces to be repurposed for other uses.

Valet parking is a logical first step

There are vehicles with technology already on Australian roads that can reverse parallel park without assistance from a driver, and manufacturers can be expected to further develop valet-assisted technology so that a vehicle can navigate off-street parking by itself.

While a vehicle will use a map of a parking structure and external vehicle sensors to select a suitable parking space, a driver will be able to summon it to a pick-up location when needed. With no need for space to open doors, vehicles will park more efficiently, and removal of human error will significantly reduce - if not eradicate completely - the volumes of parking-related claims experienced by insurance companies annually.

As technology further evolves and user acceptance grows, passengers can be delivered to a destination and collected afterwards without the vehicle needing to go near a parking lot.

Spaces will transform

Because driverless vehicles underpin the creation of a whole new city structure and architecture, it is critical that they are recognised as a central element in future transport planning. Parking infrastructure and spaces will give way to different land uses, and offices and homes may no longer have to factor in carparking spaces.

Future planners will no longer have to accommodate for large traffic volumes, with predictions that driverless vehicles would move to the outskirts of cities and suburbs when not in use, freeing up more room for pedestrians and cyclists. However, careful planning is required to facilitate the seamless movement of these vehicles as demand ebbs and flows so congestion does not occur at peak demand periods.

Preparation is critical

This paper provides an outline of issues that ADVI believes need to be considered in the face of such transformational change. Parking providers must consider how their current business model, parking technologies and infrastructure will adapt and expand to accommodate driverless vehicles, particularly with vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I) communication.

City planners, landlords, regulators, and lessors must investigate planning mechanisms for newly-constructed car parking structures to ensure they can be adapted at a future point.

Vehicle manufacturers have the opportunity to collaborate with technology providers to guide the development of new autonomous vehicle fleet and commuter services that deliver value-add and business growth, and integrated mobility providers can partner with the parking industry.

To successfully meet the challenges ahead, an integrated approach is now more critical than ever before.

Introduction

There can be little doubt that the current car parking ecosystem will change significantly as a result of highly and fully automated (driverless) vehicles. In time, driverless vehicles have the potential to navigate and park themselves, find the most cost-effective parking, and are likely to be highly utilised. In response, parking demands in high-value locations, such as CBD areas, will potentially decrease and provide opportunity for those spaces to be repurposed.

The business model of the parking industry will be impacted, and those that are agile, have foresight, and are willing to adapt will ultimately benefit.

The emergence of Mobility-as-a-Service is an indicator that commuters will increasingly favour a pick-up and drop-off service, reducing the demand for multiple parking options such as multi-storey, on-street and at home. Based on current trends, ADVI predicts a convergence in the coming years where shared, connected and autonomous mobility combines to offer a Mobility-as-a-Service.

Parking adaptations for driverless vehicles must be part of broader infrastructure considerations, as outlined in ADVI's Integrated Transport Planning Position Paper. Also interlinked with this paper is the notion that potential change in ownership and use of vehicles will further influence future parking demands.

The current situation

Parking is provided in Central Business Districts, town business centres, shopping centres, hospitals, department stores, airports, universities, within residential and office precincts, and at entertainment and sporting facilities. Parking areas also serve as an entrance to city areas and businesses, ranging from small commercial stores and plazas to industrial and government buildings.

Commercial parking business models are structured to serve people, who expect clean, well-maintained, secure and easy to manoeuvre parking lots. The result is that owning, maintaining and parking a vehicle can be expensive – especially given most vehicles sit idle 96% of the time¹.

Revenue is often generated from these land uses, with people paying for the convenience of on-street, off-street, commercial at grade and multi-deck car parks, as well as local street parking.

¹ PwC 2015

Parking Risks and Insurance

From an insurance viewpoint, the common risks and incidents arising from drivers parking vehicles can be expensive, as shown in the following table using data provided by Zurich Insurance from its Motor Fleet portfolio between 2009-2012:

Parking related Claims Stats 2009-2012		
Incident Type	Percentages of Incidents	Percentages of Claims Payments
Damaged while Parked	8.90%	3.11%
Insd Hit Stationary Object	13.25%	11.54%
Reversing	16.25%	7.84%

These figures must be considered as conservative, given that many incidents fall below the excess, and must factor in a margin of error because some may not involve carparks.

ADVI's Insurance Position Paper considers the impact on insurance in a broader context.

Stages of driverless vehicle deployment

The introduction of highly and fully automated (driverless) vehicles on Australian roads will happen gradually over time. While there are no fully autonomous vehicles legally operating right across our road network right now, we are currently seeing an increasing amount of partially-automated vehicles, complemented by the progressive introduction of more sophisticated highly automated vehicles.

In the near future (beyond 2025) we expect to see fully autonomous vehicles and human-operated vehicles (some partially and highly-automated) sharing the road. Automated parking stations, and some retrofitting of infrastructure and new design processes will be needed.

The vehicle ecosystem will then progress to a mixed fleet with a higher percentage of autonomous vehicles, and less partially-automated vehicles. This may influence the design and location of parking in city centres and on its fringes. And finally when all vehicles on the road are autonomous this could potentially reduce the need for many driveways, garages and car parks.

The likely timeframes of driverless vehicle deployment is documented in the ADVI "Journey to Driverless Vehicles" Roadmap attached as Appendix A.

Valet parking – the first step

Valet-assisted technology is expected to be developed by a number of manufacturers in the years ahead, and will see a vehicle navigate off-street parking without the aid of a driver. Vehicles will most likely use a map of a parking structure and external vehicle sensors to find a suitable parking space. When the vehicle is required, the driver will potentially summon it using an internet-connected device such as a smartphone and the vehicle could meet the car at a designated location.

Impacts on parking spaces

One of the most direct impacts of driverless vehicles is likely to be reduced demand for car parking spaces and the associated supply requirements. Multiple factors will contribute to this reduction. For example, self-parking vehicles will not need space to open a door, because passengers will potentially be dropped off before it manoeuvres into a space. This means vehicles can use space more efficiently and bolster existing car parking capacity. It is also predicted that at a future point people will potentially be dropped at their destination and collected afterwards without going near a parking lot. The knock-on effect will see two-way aisle spaces, ticket machines, boom gates, pedestrian paths, lifts, stairways, access ways, and other associated parking elements becoming redundant. The parking and related road infrastructure may change enormously possibly requiring significant investment to assist.

As an example, consider how the current large retail developments need parking lots to support customers. The urban landscape will begin to change significantly over time with the arrival of driverless cars, in particular these shopping complexes could begin to adjoin high-density neighbourhoods close to urban environments. If vehicles are no longer owned as they are today and driverless vehicles become the norm, shopping complexes may have an opportunity to fill previous parking spaces with additional assets. Changing demands may see dedicated parking lanes on local streets disappear in favour of narrower streets, allowing greater space for development, wider roads, bicycle paths and nature strips.

However, a key consideration is what will the driverless vehicles do whilst waiting for their next ride? Roaming the streets between rides is not feasible because it will increase congestion and operational costs which is why the parking question for driverless vehicles must begin to be explored.

Future planning for parking infrastructure

Driverless vehicles must be considered as a central element of our future transport plans as they may transform our cities and underpin the creation of a whole new city structure and architecture. As part of this transformation, parking infrastructure, which represents a significant share of land use in Australian cities, may potentially give way to different land uses.

The design of Australian cities may be less dominated by the need to keep large volumes of vehicles flowing and more focussed on how they can be better used by people. Some predict that driverless vehicles could move to the outskirts of cities and suburbs when not in use, challenging the current mindset that close parking options are convenient and necessary for a successful commercial hub. However, for this to be effective, planning is crucial otherwise the ebbs and flow of traffic in such a model could increase congestion.

What may occur is future planning and zoning of bigger developments could embrace the more efficient inclusion of parking spaces at the edge of pedestrian-friendly zones to create dense, walkable spaces. There is potential for smarter parking options to open up roadways and create more room for cyclists and pedestrians but to work it may require focused open rapid flow autonomous vehicle roads to cater for key ride demand periods.

The economic lifespan of existing parking infrastructure may be limited because shared and autonomous vehicles will no longer park in the same way. Cities may slowly give way to spaces based on readjustments in supply and demand. This creates major planning challenges, and planners must have clear insight into the likely trajectory of change, boundary planning, public-private collaboration, and sustainable funding of infrastructure if they are to adapt.

Thought must be given as to how multi-storey car parks could be put to better use. While above ground car parks are relatively easy to repurpose into art galleries, office spaces, retail centres and, community and event spaces, Australia could follow the lead of countries such as Canada and France and develop extensive underground networks which will see below-ground car parking become places to live, work and shop. An example of a re-purposed car park is shown in Figure 1².



Figure 1: This building in New York City was once a parking garage, now a luxury apartment building*

With parking structures offering a service life of 80-100 years, consideration should be given as to the retrofitting of current parking infrastructure to accommodate future needs, and have mechanisms included in new developments to make them future-proof. Table 1 includes potential alternative land uses for parking space according to different parking types. Future building designs should consider issues such as floor heights, column spacing, and slab thicknesses.

A driver's choice as to where to park may eventually give way to decisions made by an autonomous vehicle, which would consider a number of pre-set factors by the user such as price or proximity to a location, and communicate directly with parking facilities to ensure that the user's requirements are met.

The vehicle will potentially act as a credential to access, exit and make automated payment at the car park – which means an end to tickets, access passes and queuing at pay machines.

² <http://observer.com/2014/02/condos-to-crave/>

*Approval of image pending

Table 1: Potential alternative parking space uses for each parking type

Parking Type	Potential Alternative Land Uses
Local Government residential street parking	Parking converted to other land uses, such as wider roads, nature strips and/or, pedestrian and cycle paths.
Large shopping complex parking	Parking converted to other land uses such as additional retail space, gardens, and/or public transport access direct to shopping entrances.
Privately owned and/or operated inner CBD parking lots (including at-grade and multi-storey)	Parking converted to other land uses such as art galleries, office space, tourist attractions and/or community gardens.
Parking garages for homeowners and building developers	Parking converted to other land uses such as a bedroom, garden, study and/or additional apartment levels/units.
Parking for buildings owned by businesses	Parking converted to other land uses such as building extensions, offices, and/or aesthetic entrances.
Airport parking	Parking converted to other land uses such as additional aircraft runways, tourist attractions, accommodation, golf courses and/or retail space.
Hospitals and university campus parking	Parking converted to other land uses such as additional lecture theatres, classrooms, patient or student accommodation, green parks and specialist consulting rooms.

Changes to Australian Standards and other requirements

While the objective of the Australian Standards relating to parking is to provide planners, designers and regulatory bodies with the requirements and recommendations for the design and layout of parking facilities, the current Standards are more than 10 years old and do not cater for emerging driverless vehicle and associated parking technologies.

To achieve a long-overdue revision of our Standards, it is crucial for the parking industry in Australia and New Zealand to come together to conduct a collaborative review. As part of that review, consideration must be given to how vehicles will interface with parking facilities in the future and how parking services will operate in this era including pickup-set down, traffic circulation, wayfinding, access and egress, vehicle manoeuvring, and the user experience - including for people with disabilities within a driverless vehicle context.

There can be no doubt that future Standards should be extensively influenced by technology, especially design aspects such as basic parking space dimensions, aisle widths, and the dimensions of circulation roadways and other manoeuvring areas.

The general impacts on parking across all parking types may include:

- Significantly reduced parking demand
- Greater space efficiency;
- Increased visual impact;
- Increased public safety (less opportunity for theft, crashes, assault);
- Money-saving advantages;

- Potential for less income generated from providing parking (parking fees, permits and infringements);
- Major road infrastructure investment.

Many other standards, policies and guidelines will also need to adapt to facilitate and reflect the emerging autonomous vehicle ecosystem. For example, Local Government policy and design guidelines will need to be reviewed.

Current guidelines prescribe a set number of parking spaces for dwellings regardless of whether the residents own a car or not. For example, in the ACT, a detached house requires one parking space for a single bedroom dwelling and two for 2 or more bedrooms. If autonomous vehicles become the dominant transport mode and car ownership drastically declines, these requirements would no longer be relevant. Where houses already have one, two or three-car garages, that area could be converted into other more useful space (e.g. bedroom), or reduced in space (in cases wherein AVs are owned) as self-parking AVs do not require open-door space for boarding/alighting passengers.

The following documents, guidelines and standards will also need to be reviewed and updated:

- Australian Standards, in particular the AS2890 set;
- Austroads Guide to Traffic Management: Parking, a review of this standard has just been completed by Austroads. However, as driverless vehicles become common place it is possible another review will be required;
- Legislation and policies on parking design, parking ratios, minimum parking provision requirements and zoning across Australia – for example, the ‘Parking and Vehicular Access General Code’ by the ACT Planning and Land Authority;
- Facility specific design guidelines – for example, airport and campus design guidelines.

Preparing the parking industry

The rapid evolution of autonomous and connected vehicle technologies will change the way operators engage with customers, as well as how parking facilities are utilised, operated and maximised.

The challenge facing parking providers is how infrastructure can adapt to accommodate highly and fully-automated vehicles. Parking technologies, systems and functions that support a gradual transition to full automation need to be put in place. Car park operators should consider how they will support wireless ad-hoc vehicular communication, whether it is vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I).

Parking providers should develop fail safe operational systems and understand what degree of reliability and robustness is required in the data and information processing spaces. Importantly too, they should work to develop adaptation schemes (including maintenance and durability considerations) for existing parking infrastructure. City planners, landlords, regulators, and lessors will have to investigate planning mechanisms for newly-constructed car parking structures to ensure they can be adapted for new uses, if needed, at a future point.

City planners will need to revisit zoning laws and parking requirements, while local governments and other operators that receive substantial revenue from parking, must re-evaluate revenue forecasts as a result of declining demand and reduced infringements.

Presently, the parking industry is not well prepared and operators must be more agile in changing their business models if they want to maximise new opportunities and limit disruptive effects. Companies like Wilson Parking, arguably Australia's most experienced and largest carpark operator, are already working to accommodate connected and automated vehicles through technology integration.

The parking sector is not alone when considering how to address the disruption autonomous vehicles will bring. A key ally will be city planners as outlined in ADVI's Integrated Transport Planning Thought Leadership Paper, as together these key partners can help influence and better prepare Australian cities for autonomous vehicles.

The ADVI position

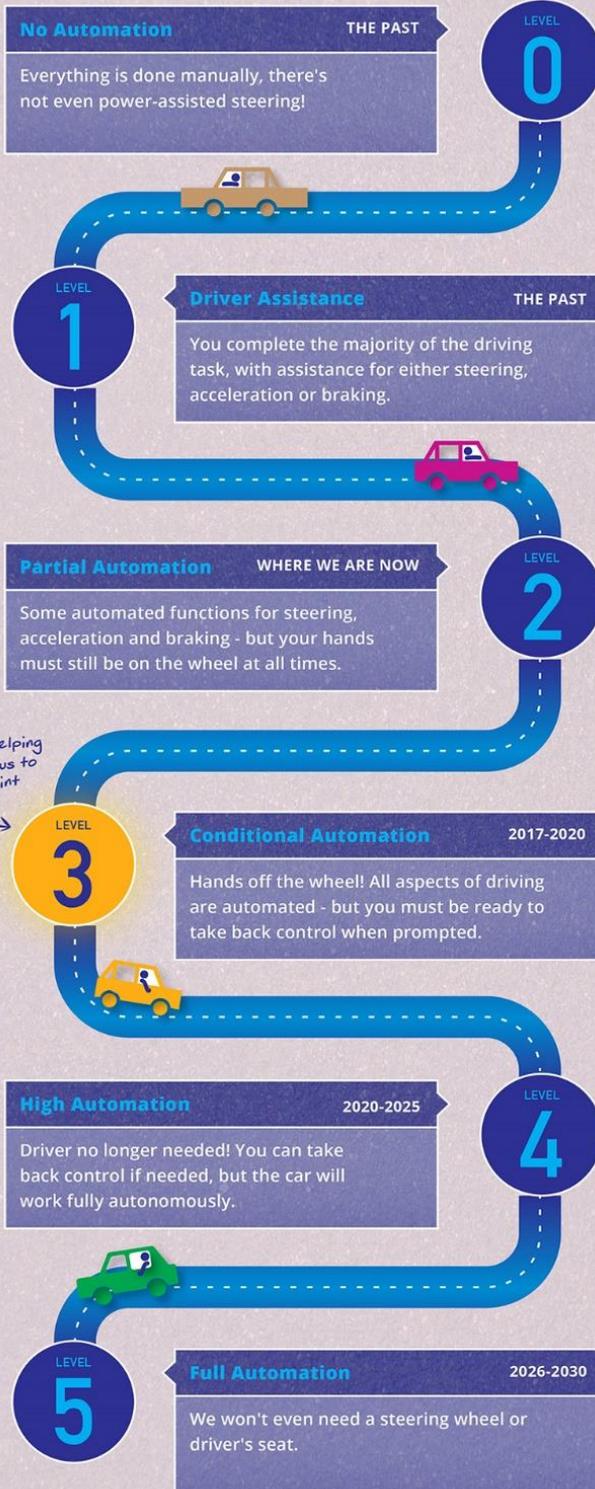
ADVI's position is that parking providers should investigate the issues and opportunities associated with the introduction of highly and fully automated vehicles, and then move rapidly to:

- Expand their scope of business to include all aspects of automated vehicle technologies and data requirements, including holistic solutions for connectivity, security and privacy, data processing, management and analytics;
- Restructure aftermarket business models to address new retail competition that may spawn from driverless vehicle deployments;
- Design and incorporate designated parking areas/floors within facilities dedicated to self-park technology;
- Evaluate investment opportunities that support the adoption of highly and fully automated vehicles and establish a presence in these areas;
- Collaborate with vehicle manufacturers and technology providers to guide the development of new autonomous vehicle fleet and commuter services that deliver value-add and business growth in the new ecosystem; and
- Partner with integrated mobility providers to incorporate parking industry offerings into their respective business models, infrastructure and operating networks.

Appendix A

Journey to Driverless Cars

The Australian Driverless Vehicle Initiative



Sources:
 ERTRAC Automated Driving Roadmap, 21 July 2015 http://www.ertrac.org/uploads/documentsearch/438/ERTRAC_Automated_Driving_2015.pdf
 SAE International's J3016 Levels of Driving Automation, 2014 http://www.sae.org/misc/pdfs/automated_driving.pdf