REPORT ON PROCEEDINGS BEFORE

STAYSAFE (JOINT STANDING COMMITTEE ON ROAD SAFETY)

INQUIRY INTO DRIVERLESS VEHICLES AND ROAD SAFETY IN NEW SOUTH WALES

At Macquarie Room, Parliament House, Sydney on Friday, 17 June 2016

The Committee met at 9:30 am

PRESENT

Mr G. Aplin (Chair)

Legislative Council	**Legislative Assembly**
Dr M. Faruqi	Mr A. Crouch
Mr S. MacDonald	Mr N. Lalich
The Hon. D. Mookhey	Ms E. Petinos

WITNESSES—*continuing*

The CHAIR: Good morning and thank you for attending this public hearing of the Joint Standing Committee on Road Safety, also known as the Staysafe committee. I am the chair of the Committee and the member for Albury. With me today are my colleagues from the Legislative Council, Mr Scot MacDonald, who is the deputy chair, and Dr Mehreen Faruqi, as well as my colleagues from the Legislative Assembly, Ms Eleni Petinos, the member for Miranda; Mr Adam Crouch, the member for Terrigal; and Mr Nick Lalich, the member for Cabramatta. Unfortunately, Mr Adam Marshall is ill and is unable to join us.

Today the Committee will hear from a range of stakeholders on the issue of driverless vehicles and road safety in New South Wales. The evidence presented at today's hearing will allow the Committee to examine in detail the road safety benefits associated with the introduction of driverless vehicle technology and will make a contribution towards preparing New South Wales to maximise those benefits, and to meet the challenges presented by these technologies. I declare the meeting open. I welcome the witnesses and thank them for appearing before the Committee today to give evidence.

CLARE GARDINER-BARNES, Deputy Secretary, Freight, Strategy and Planning, Transport for NSW, affirmed and examined

BERNARD CARLON, Executive Director, Centre for Road Safety, Centre for Road Safety, sworn and examined

JOHN WALL, Manager, Road Safety Technology, Centre for Road Safety, sworn and examined

CRAIG MORAN, General Manager, Road Network Operations, Roads and Maritime Services, affirmed and examined

The CHAIR: Before we proceed, do you have any questions concerning the procedural information sent to you in relation to the witnesses and the hearing process?

Ms GARDINER-BARNES: No.

The CHAIR: Are you happy to provide written replies within 10 business days to any questions taken on notice and any supplementary questions the Committee may have?

Ms GARDINER-BARNES: Yes.

The CHAIR: Would you like to a make a brief opening statement?

Ms GARDINER-BARNES: This opening statement was prepared following the submission made on behalf of the New South Wales Government and relates to it. The New South Wales Government recognises and is committed to embracing the opportunities that technology offers to greatly improve traffic flows and a range of customer services. Improvements in connected vehicle technology are already playing a key role in congestion management in Transport for NSW through real-time data feeds that enable better congestion management along with supporting the systems that provide information to drivers on the network.

As the vision for driverless vehicles progresses, the innovations we are already seeing come into the market promise to improve significantly efficiencies in the use of road infrastructure by delivering less congestion, which will result in higher productivity and increased safety. The safety benefits of driverless vehicles will lead to significant reductions in crashes, which are a major cause of congestion on our roads. There is tremendous potential for increases in travel time, reliability and efficiency through better use of real-time data, including the automation of that information right down to the individual automated vehicle. As a strong market develops for shared driverless vehicles matched with real-time data, we could see significantly less congestion in peak times. This aligns with the national focus on applying technology to create productive, accessible and liveable cities which enable innovation and which create jobs and growth.

In April this year, Transport for NSW hosted the Future Transport Summit 2016. This marked the start of a journey to identify the new and emerging technologies, ideas and products that will revolutionise the way we plan, build and deliver transport infrastructure and services. At the summit, the Government announced the establishment of our Smart Innovation Centre, which will focus on emerging transport and road technologies. The centre will bring together thought leaders, industry, entrepreneurs, government and researchers in a partnership-based multi-campus hub for collaboration, research, demonstrations and technology pilots. One of the focus areas for the centre is connected and automated vehicles—a critical area from a safety perspective and also in terms of improving efficiency and accessibility of our broader transport system.

Unfortunately, our road toll has continued to increase this year. In response, we recently launched the Towards Zero campaign, which is designed to engage the community and to highlight the fact that no death on our roads is acceptable. We know that human factors are involved in about 90 per cent of road crashes. Connected and automated vehicle [CAV] technologies help to remove human error by supporting the driver, or even taking the driver out of the equation. The introduction of CAV technologies has already made a contribution to safety through features such as anti-locking braking, stability control, automatic emergency braking and lane departure warnings, which are either standard or becoming increasingly available in new cars sold in Australia. Fully automated driverless vehicles have the potential to take this further, and thereby significantly improve road safety. The introduction of CAVs is likely to escalate over the next five years, with driverless vehicles more likely to take off over the next 20 to 25 years.

There are a number of technical, operational, legal and human factor challenges to address before fully automated or driverless CAVs can be safely introduced on a large scale. This Government is laying the ground work for thorough programs like the Cooperative Intelligence Transport Initiative [CITI] project, which involves the only large-scale deployment of a heavy-vehicle cooperative intelligence transport system in the world. We are also working closely with industry and national and international jurisdictions to explore

approaches for CAVs to ensure that clear measures are in place for industry and manufacturers, who also wish to trial and innovate with new technology, and gain community confidence and acceptance of the safety, social, economic, and environmental benefits that CAVs have to offer. As the Deputy Secretary for Freight, Strategy and Planning in Transport for NSW, I am responsible for developing strategy, policy and planning for freight, public transport and road networks throughout the State and for leading the safe introduction of CAVs onto the New South Wales road network. With me today are Bernard Carlon, the Executive Director of the Centre for Road Safety, who is responsible for road safety in New South Wales, and John Wall, Manager, Road Safety Technology. From Roads and Maritime Services, we have Craig Moran, who is responsible for the road network operations, and Ray Duncan, who is responsible for customer and support services regarding safety and compliance. We are here collectively to answer questions from the Committee. Thank you.

The CHAIR: Thank you very much. I will begin with a general question building on your opening statement. I would like to explore the evidence that exists to suggest that driverless cars would lead to greater road safety benefits for New South Wales. Clearly that is one of the purposes of this Committee.

Ms GARDINER-BARNES: I indicated that 90 per cent of crashes are caused by behaviour. Over the years we have seen the introduction of many safety system improvements that have taken off in the commercial vehicle industry in Australia. We have some statistics showing how that take-up rate has improved and had a significant impact on crash reduction. Mr Carlon will provide more detail

Mr CARLON: We have seen, obviously, over the last 20 years the development of technologies within vehicles that have had a significant impact—from air bags through to electronic stability control and anti-lock braking system [ABS] braking. We are now starting to see the technologies come together to support a fully autonomous vehicle coming into the market in New South Wales. Some of those technologies, such as adaptive cruise control, are already in New South Wales. More than 52,000 vehicles are fitted as standard with that technology and around 154,000 with it offered as optional. In the last 10 years that has grown from 619 vehicles up to 21,000 vehicles in 2015 that were plated with that technology already standard in the vehicle. Some of the international studies around the contribution that those technologies make to reducing the total crashes have found it is around 6 per cent and, more specifically, a study done in Norway found it was up to 49 per cent for rear end crashes.

Similarly, there has been an increase in lane assist systems, which are critical to maintaining vehicle control—one of the factors in many of the fatigue related crashes. Currently there are around 54,000 registered vehicles in the New South Wales market that have lane assist systems fitted to them. There has been a change in the fleet over time with that as well. In 2005 there were no vehicles fitted with that technology and in 2015 there were 21,000 vehicles that were sold fitted with that technology. In the modelling for those crashes which are near side crashes and lane movement crashes, associated with both fatalities and serious injuries, we know that lane assist systems reduce them significantly.

We currently have 36,000 vehicles in New South Wales fitted with the technology of autonomous braking systems and 108,000 where it was offered as optional. We know that change in the fleet over time as well. In 2005 again that technology was not available in the fleet in New South Wales. Studies indicate that between a reduction of 35-41 per cent in rear end crashes. Our own data shows that 11 per cent of our serious injury crashes in urban areas where people are admitted to hospital are attributed to rear end crashes. So there is a significant body of international evidence that road safety benefits are already being derived by the introduction of those individual components and technologies which come into the market and into our fleet—and eventually the agglomeration of those will create the ability to have a fully autonomous vehicle and then a driverless vehicle.

In establishing a vision for driverless vehicles, we are committed to promoting and working with industry to continue to drive the uptake and offering of those technologies. That is why we are involved in the Australasian New Car Assessment Program [ANCAP] system and why we support the testing regimes to ensure that we incentivise the market to provide vehicles with those sorts of technologies that are proven to reduce the trauma and impact of crashes and that those automated functions continue to increase in the market here in New South Wales in order to protect the people of New South Wales.

The CHAIR: Thank you. That leads directly to a question I would like to pursue. The public will expect rigorous and transparent safety testing and certification processes for on-road testing and implementation of that technology in the longer term. Can you explain the mechanisms that were put in place in New South Wales to safeguard the trust and confidence of the public in road safety management relating to autonomous vehicles?

Ms GARDINER-BARNES: I start by referring back to the newly announced Smart Innovation Centre that Minister Constance and Minister Gay announced a couple of weeks ago. As part of that process we

have called for expressions of interest for industry partners to come forward. The starting point for that centre is the crash lab that is operated through Roads and Maritime Services. That crash lab is staffed by highly experienced specialists who understand the impact of crashes. The Smart Innovation Centre will extend its current core business to also looking at autonomous vehicles so that we have a facility specifically established within New South Wales to assure the public that we have mechanisms in place to test vehicles prior to them going on the road and allow manufacturers to partner with us to demonstrate such products. So there are mechanisms already in place and we are about to expand those and modernise them for the future of New South Wales road users.

The CHAIR: Thank you. Ms Petinos, would you like to ask some questions?

Ms ELENI PETINOS: Thank you, Chair. I return to some of the comments Mr Carlon made about the evidence of the improved safety benefits of the technological impacts. Mr Carlon, you mention that there is "evidence", but what you presented to us were, I suppose, summations of things which you may have read but I am not convinced that you have presented me with evidence of an improvement. I am not disputing whether the statements you have made are correct—I suppose I am asking where they have come from. Give me a source or sources, please.

Mr CARLON: Yes, certainly. In our submission we identify a series of research documents that have been done both internationally and here in Australia that provide that evidence where the actual technologies have been tested. Certainly some of this is around the reduction factors that have then been modelled. They are essentially modelling what the impact of the take-up of those technologies into the fleet would be, having done rigorous testing of the particular technology and whether or not it reduces the severity of a crash or the avoidance of a crash.

Specifically in terms of the testing that we currently do on these technologies for, let us say, the existing set of technologies that are in vehicles for safety, when we crash a vehicle we have a highly instrumented crash dummy that looks at the impacts of that crash on the individual, on the body. There is quite rigorous testing of the physical forces that the body is able to sustain. The tests, particularly in the crash testing, identify what the impacts on the individual body parts would be in terms of the outcome of a crash in a particular vehicle that either has a safety feature fitted to it or does not have that safety feature fitted to it. Then there is the modelling of what sort of impact the introduction of that into the market would have in the longer term.

There have been international testing regimes around, for example, automated emergency braking. That is currently part of the Euro New Car Assessment Program [NCAP] system. So there are testing regimes for the efficacy or the outcomes of reducing the number of crashes. We know what the outcomes of the crashes are at particular speeds. The evidence is clear around the injury and fatality rates. So we are applying that methodology in a way that has been tested robustly in other jurisdictions for automatic emergency braking systems. Certainly we will be adopting those protocols in the ANCAP for 2018 in order to update our systems. That is part of the innovation that we are talking about in the upgrading of the crash lab for the Smart Innovation Centre. We are happy to provide those research documents in full to the Committee. Any that you identify either in our submission or in our evidence in order to provide you with the detailed reports will link to the detailed reports that have been done internationally in terms of independent assessments of the benefits that are derived.

Ms ELENI PETINOS: I have one more question if I may, Mr Chair. Driverless technology obviously raises the issue of the legal definition of a driver in New South Wales law. As you are providing the Government submission on this matter, what is the position as to the definition of a "driver" with driverless technology?

Ms GARDINER-BARNES: Obviously, this is going to be a really critical question for all jurisdictions, as we start to move from human controlled vehicles to technology controlled vehicles. Right now, in New South Wales, the legislation requires that a human driver is in control of the vehicle. However, there are provisions' within the current legislative framework, to seek exemptions. So there are possibilities within the current legislative framework for new technologies—driverless-type vehicles—to be trialled within New South Wales. In fact, we are encouraging companies to come forward and put forward opportunities for New South Wales to embrace that and to trial new ways of doing business. But, in the early instance, they would be exemptions from the current regime for a trial purpose. So until we explore the exact technology and the implications on the road for the user and for others on the road then that is really a legislative framework that we need to work through individually and for different types of technology. John, would you like to add anything further to that?

Mr WALL: Not in terms of the legislation. We currently run the world's largest connected-vehicle project down in the Illawarra, in regard to heavy vehicles. Connectivity, I think, is a vital part of the puzzle

when we are looking at automated vehicles and their safety. We think we will get much larger road safety benefits if these vehicles are able to talk to each other and to talk to infrastructure rather than having individual autonomous vehicles running around doing their own thing.

So the work that we are doing in connected vehicles—the very large trial that we are running at the moment—will provide vital evidence for the discussion about what the effectiveness of these vehicles will be. At the moment I am a project manager with the Austroads project, which is specifically looking at the potential road safety benefits for these vehicles. That work is going on at the moment; it should be finished later this year. It will involve real-world modelling of the safety benefits, with a very large crash database derived from both Victoria and New South Wales.

Mr CARLON: With respect to the legislative framework, the National Transport Commission is engaged with the jurisdictions currently in a review process to ensure that we are looking at the issues to do with driverless vehicles in the future and reviewing the legislative framework that exists nationally and in each of the jurisdictions to manage that transition to driverless vehicles. As Clare Gardiner-Barnes has pointed out, we have provisions for trials already within New South Wales. Currently, though, a driver in a driver's seat, regardless of what technology they have engaged within their vehicle, is accountable for the safe operation of that vehicle under the law.

Mr SCOT MacDONALD: Which body was that?

Mr CARLON: The National Transport Commission, which is coordinating, with the jurisdictions, that review.

Mr WALL: I understand the National Transport Commission [NTC] will be providing evidence to the inquiry later today, as well.

The CHAIR: They will.

Mr ADAM CROUCH: Thank you for your time this morning. Obviously, we are seeing very rapid advances in technology, as has been outlined in the Government's reports of 2015. The Government's submission indicates that significant investment, planning and projects are underway or planned to ascertain whether New South Wales is adequately prepared to maximise the benefits of intelligent transport, including autonomous vehicles [AVs] . Do you consider, at this time, that the investments made so far are commensurate with the potential road safety benefits that autonomous vehicle technology may lead to in the future?

Ms GARDINER-BARNES: One of the key processes that we are engaging in through the Smart Innovation Centre is that government is not solely responsible for the investment in this space. There are many commercial opportunities here, and many that are going to gain from new technologies and new products on the market. The process that we are putting in place, through the Smart Innovation Centre, of linking with entrepreneurs, industry bodies, academics and other experts will mean that others are coming around the table to work in partnership with the New South Wales Government to ensure that we are looking at this issue holistically from a safety perspective, business perspective and from an economic growth perspective, and ensuring that all those players are contributing from very early on in the process.

We have already had 71 expressions of interest through that process from organisations wanting to partner with the New South Wales Government. So I think there is ample opportunity for Government seeding funding to be used in effective ways in partnership with many others to ensure that we embrace the opportunities here, but also to demonstrate that Government will address the risks appropriately using the expertise that we need to access from across the world.

Mr SCOT MacDONALD: That pre-empted a bit of what I was going to ask about—State versus national. When you look at what is happening in America do you think that there is a risk that we may go off and do our own thing? South Australia has introduced its own legislation. This inquiry is looking at regulation. Do you think there is a risk that we will have a bit of a piecemeal approach to this or do you think we will end up with good national oversight?

Ms GARDINER-BARNES: There is a risk, but that is being managed at the moment through a number of key mechanisms. Firstly, we have the National Transport Commission. That is providing some good policy overarching guidance to all jurisdictions and is keen to see a national approach to how we introduce any further regulatory environment into this space. We also have the Transport and Infrastructure Senior Officials Committee [TISOC], which is the executive committee for all chief executives that are heads of transport agencies across Australia and New Zealand. They come together three times a year. As well, there is the Ministerial Transport and Infrastructure Council. This item has been on the agenda for those meetings. We also

have Austroads, which all jurisdictions contribute to through funding arrangements, which decides on priority research projects.

As John indicated earlier, this issue, through Austroads, has been identified as a key area for investment by all jurisdictions to ensure that we have safety research highly prioritised, and to build confidence, through all layers of government, that we are doing our best to collaborate, develop standards for the future and cooperate in how we manage this. The last thing we want is for different jurisdictions to be doing their own thing. There are professional communities at all layers of government coming together on this issue, along with universities and industry, because we can all see the benefits, and that collaboration will be the key.

Mr SCOT MacDONALD: On that theme, is it more likely that the trucking fleet—the freight fleet—will be the leaders on this? Obviously, a lot of that fleet is moving across State borders. Are they worried about it? Are they engaged about it? We have a Queensland regulation and then something slightly different across the border but some of those trucks go from Brisbane to Adelaide.

Ms GARDINER-BARNES: There is a national heavy vehicle regulator that was established a couple of years ago and that oversees regulations nationally for heavy vehicles. It is through that regulator that will ensure that there is a systematic approach to new technology interventions. Because of what has happened in the mining industry with autonomous vehicles, it is likely that there will be a flow-on effect also through robotics in the freight industry. There will be that flow-on effect into other parts of transport. For New South Wales, we have already picked that up as an opportunity for our heavy vehicle fleet through the city project and we will continue to develop that that vehicle-to-infrastructure process to ensure that we are looking at new and safe ways for heavy vehicles. Obviously, all jurisdictions are keen to ensure that heavy vehicle fleets are the safest possible fleets across Australia. I think the National Heavy Vehicle Regulator will make sure that there are systematic processes to align how we roll out technology into the future.

Mr SCOT MacDONALD: Do you think that there will be a cost to the economy if we do not get that right, if we do not get correct national regulation?

Ms GARDINER-BARNES: It is hard to predict the extent to which that might occur. What I think is really important in these early stages is that different jurisdictions learn from each other through the trials that they embrace and start. New South Wales is doing a trial at the moment of our technology. Other jurisdictions are looking at other opportunities—for example, Western Australia has announced a trial for automated bus fleets. All of us need to learn from each other and to be open and transparent about the learnings and the benefits so that the financial impact and the cost impact to the consumer and to industry do not flow on in a detrimental way.

Mr CARLON: If I could add on that point, as Ms Gardiner-Barnes pointed out, it is really important that we are engaged nationally on the opportunities that exist within each jurisdiction. I am on the National Road Safety Taskforce under the Austroads banner. There are several projects that are happening in the connected and automated vehicles space, and we have a regular process for updating all of the jurisdictions on each of the projects that are happening in the different jurisdictions, sharing data and information so that across the country we have faith in our understanding of the benefits and the risks associated with the projects that are happening on the ground.

Really importantly, all the jurisdictions realise that we need to incentivise and provide opportunities for people to test out in the marketplace these technologies so that we continue to grow that market, because as I pointed out earlier in the evidence we know that the more we get these automated functions integrated into vehicles that are available to consumers then there are increased safety benefits that will be derived.

Mr SCOT MacDONALD: You talked about incentives. Is there an incentive for the freight industry to accelerate going towards automated vehicles?

Mr CARLON: I think opening up government systems to innovations that might come forward from the freight industry is one of the key things that the Smart Innovation Centre is about. We have had a number of approaches from the heavy vehicle industry around the Smart Innovation Centre as well in terms of trials and opportunities that exist for them to test systems within New South Wales and have that information available to share nationally.

Mr SCOT MacDONALD: As a regional member I am aware that a lot of mobile phone network is pretty ordinary. Obviously, much of this relies on satellite. Is there also reliance on the mobile network?

Mr CARLON: I might get Mr Wall to respond in the first instance about the standards that have been adopted internationally and the application of those standards here in Australia in our trial.

Mr WALL: One of the great things about the CITI project that we are running in the Illawarra at the moment is that it covers just over 2,300 kilometres of road network and models a number of different road environments, including rural and regional road environments. A major part of the route that our vehicles travel on is between south-western Sydney, the Hume Highway, and Wollongong, the Picton Road, which goes through a catchment area. It is very sparsely populated being a catchment area with very poor mobile phone coverage and some real challenges, and the topography is challenging for satellites as well.

Mr SCOT MacDONALD: Really?

Mr WALL: Yes, especially on the descent down Mount Ousley, where the satellites bounce around all over the place—as far as the signals are concerned, not satellites. That provides some challenges for us. A lot of the research that is being done overseas today—and I am talking mainly in the connected vehicles space, not necessarily in the automated vehicles space—has been conducted in the areas like Michigan in the United States, which is very flat and open and has lots of satellite technology available for positioning. Positioning is going to be a bit of an issue for us in that area. Given that, we also in our own research vehicle have a lot of key automated features including collision avoidance, lane-keeping capability, even driver fatigue detection, which we would expect will be in all of the automated vehicles. Those systems work quite well independently and they work a lot better if they are connected. The system that we operate operates on a dedicated frequency, a radio frequency, and our vehicles, our connected trucks, talk to each other 10 times a second. We are finding that they can talk to each other up to a kilometre away, but more likely around 400 metres away. That technology does not rely on mobile phone transmission; it is a dedicated system, vehicle to vehicle and vehicle to infrastructure.

For regional road users the connected technology that we are working with, which is rolling out now around the world mainly in trials as there are no actual deployments at the moment, works very whether you are in the bush or in the major part of the city. I think there will be a lot of positives in terms of the connected side of automated vehicles going into the future for regional road users but also for the freight industry.

Mr ADAM CROUCH: Obviously, on the Central Coast we have a similar situation with roads. Is there a formal working group inside the department that is addressing the futureproofing of our road system, especially in regional areas such as the Illawarra or the Central Coast?

Mr WALL: That is probably a quick question for Mr Moran.

Mr MORAN: As has been said, a lot of work is going on nationally because clearly, as Ms Gardiner-Barnes, said it is important that all jurisdictions work together and get a better understanding from working with industry to start to ask what our road network needs to enable this type of technology into the future. To be frank, it is an evolving space at the moment because a lot of different industry players are evolving the technology very rapidly and we are seeing developments where technology providers are starting to look at how to get their technology to work with road networks as they exist today, recognising that there might be some things where industry wants greater standards. I will use one example: say, road worksites. Particularly across Australia there are different standards as to how road worksites are used.

Industry operators are saying they need greater consistency to allow them to get benefits early. They are also saying that they can evolve their technology to deal with these differences; they are not necessarily saying to us that we need to change things in the road network to enable these things to happen. They are rapidly moving their technology into space where it can work with different road environments. We have to recognise that it is not just New South Wales in Australia, but these vehicles will be coming in from an international market, so they are developing their technology to work in an international space, not just in an Australian or New South Wales space. We may need to make some refinements to road networks, which would be consistency across the country, but we are fairly consistent across New South Wales as a jurisdiction.

I think that gives industry a lot of confidence in terms of how to develop their technology without us needing to make a major investment in infrastructure to support this type of technology. It will be much more about where they go in a communications space—in satellite coverage, as Mr Wall mentioned—which is just as important, rather than the physical infrastructure of the road networks.

Ms GARDINER-BARNES: To respond to the question about governance, there is a committee that I sit on with the head of RMS that specifically looks at the road network across the whole State and priority projects and areas that need development. Anything like this can be put on the agenda and addressed through that governance committee.

Mr ADAM CROUCH: I will use the Central Coast as an example of the governance of roads. There are distinct differences in the quality of roads on the Central Coast depending on whose jurisdiction they fall under. Both Federal and State roads on the Central Coast are in very good condition, but unfortunately the regional roads, which come under the control of councils, are almost the opposite. Will you be engaging with

local councils as well, as part of that upgrade? Vehicles will be travelling from one road system to the next. State roads may well have been upgraded for this technology, but the council roads may not have been. How do we deal with the issue of going from one network, such as a State or Federal road, to a regional, council controlled road?

Ms GARDINER-BARNES: That is an ongoing issue that Roads and Maritime Services [RMS] deals with on a daily basis. One of the recent key initiatives undertaken by this Government is the Fixing Country Roads program. That program is specifically focused on local council roads in regional parts of New South Wales, particularly where there are pinch points that cause blockages for the freight sector. It is very much focused on freight. Staff from my part of the agency have worked collaboratively with local councils to put submissions together through stage 1 and stage 2 to access the funding that has been made available through that program. It is a very successful program. Lots of local councils have been able to secure funding for the first time for areas of high need, particularly to do with freight and trucking, to improve their road network. Collaboration between the different layers of government is key to that.

The CHAIR: Can we take that one step further and ask about the relevance of this technology on unsealed roads. Is it feasible?

Mr WALL: I can start answering that. Mr Moran might like to help as well. If we are talking about a fully automated vehicle that does not require a driver: currently, no. We need some level of infrastructure, such as the vehicle being able to read lane lines and that sort of thing, with vehicle based systems. Volvo will be appearing before the Committee later on today. It would be good to ask a vehicle manufacturer about that. Technology is evolving very fast. I mentioned to someone before the hearing began that our road safety technology section was established in 2008, so we have been going for eight years now. We are the only dedicated technology section within a road safety agency in Australia. We have seen huge changes in the technology.

When we first started to look at the ability of a vehicle to automatically brake and to use an adaptive form of cruise control, in 2008, the only vehicle we could buy was a BMW, at a price point of $160,000-plus. Move forward two years to 2010, and our second research vehicle had that technology and we purchased it for around $50,000. Move forward to today and we can buy vehicles in the early $20,000 range with that technology. That shows what has happened over eight years with autonomous emergency braking and adaptive cruise control. Many members may in fact have a vehicle that has that technology today. While it would be very difficult to use today's technology on a gravel road, tomorrow's technology is always open to having that ability. We are aware of projects that were run a couple of years ago, where a university drove a fully automated vehicle from Italy to China by land. It was retrofitted with this equipment and they were able to do that on unformed roads as well. Whether that was safe may be a different question, but it performed on gravel roads. It is a rapidly changing world.

Ms GARDINER-BARNES: Obviously it is happening already on gravel roads in controlled mining sites. The key will be how the different manufacturers allow for the technology to talk across vehicles into the future, and ensuring that there is a standard for different manufacturing groups to do that effectively, confidently and reliably.

Mr WALL: It is also about the potential for developing very detailed maps of roads as well. Look at the Tesla vehicle at the moment. It collects a lot of data about the routes that it travels on and it shares that with other Tesla vehicles. So every time a vehicle travels on a particular road it learns more about the right way to travel on that road and shares that information with other vehicles. One of the challenges in the future will be that if we only share that information between our own brand and model we are not sharing it for the greater good. It is very important that data is part of the conversation about automotive vehicles.

The CHAIR: Thank you.

Mr NICK LALICH: I am happy to see that we are talking to one another across the States and considering a national code for driverless vehicles. According to your submission, New South Wales has participated in interstate and international conferences on automotive vehicle technology and the emerging regulatory and policy issues. What has New South Wales learnt from these conferences to date? Would you outline the main points?

Mr CARLON: That is a really important issue. The things happening internationally allow us to advance our knowledge very quickly in our own road network and open up our system to trial that technology here. There will be differences. I know that some of the companies testing vehicles in very cold climates look to Australia to test their vehicle's capacity and ability to operate in a similar way, particularly with regard to safety technologies, in more temperate and hot climates. The interaction between our jurisdiction and international

research and programs is really important. It is critical for us to stay abreast of that and to encourage participation in our jurisdiction to validate the safety and productivity opportunities that exist in bringing those technologies to our market. It is the same process domestically. We need to share nationally what is happening in each jurisdiction. Clearly there are opportunities for both the economy and safety in staying abreast of what is happening internationally. Many of those vehicles and technologies will be imported here, rather than necessarily being manufactured here. It is about adapting our systems and creating opportunities within our systems to take those vehicle technologies into our fleet. It is important that we open and accelerate that process in New South Wales. John probably has specific examples of where we have been doing that.

Mr WALL: We, in the establishment of the connected vehicle initiative in the Illawarra, the Cooperative Intelligent Transport System Initiative [CITI], worked very closely with international colleagues, mainly from the University of Michigan Transport Research Institute [UMTRI] who had conducted similar projects in Ann Arbor. We very much modelled what we were doing, with the cooperation of UMTRI, on the Ann Arbor project. In fact, Dr Peter Sweatman, who was the director of UMTRI, visited us in September two years ago to provide advice to us about how we could establish our project. We are in reasonably regular contact with the team at UMTRI. When we strike a particular problem we will often contact them, mainly via email but occasionally via phone, to talk to them about how we resolve it and to ask whether they had the same issue in the United States.

We also regularly attend—at least, I spend a number of nights attending—webinars with the European Transport Safety Council [ETSC] on issues to do with automated and connected vehicles. I would also like to put in a bit of an advertisement for the Intelligent Transport Systems [ITS] World Congress, which will be held in Australia for the first time in at least a decade, I believe, in October this year. That will bring more than 7,000 of the world's experts in intelligent transport systems to Melbourne for a one-week conference and event. Transport for NSW is actively involved in the organisation of a congress. I sit on two committees—a program committee and a demonstration and exhibitions committee—and I am sure we have to learn a lot from those experts when they come here. But importantly I think we can also teach some of the experts from overseas about what we are doing, especially in the heavy vehicle connected space.

Mr NICK LALICH: I read some time ago that satellite tracking can tell you within a metre of where you are on this earth. That is all very nice if I am just sitting in the middle of a desert somewhere and I wanted someone to find me when a metre here or there does not matter but when I am driving down a road, or in mountainous country, one metre the wrong way could be over a cliff. I will support my regional colleagues. I know we have lane-controlling devices within the vehicle to keep you within a lane but in the country there are no line markings. The satellite could be out by one metre, which could cause a problem. On some country roads where there is plenty of room a metre may not matter but in the city it may matter a lot. Is technology to use sensors in the road available in city circumstances? They could be installed on telegraph poles or in the line on the road to guide motorists in the city areas which may be a lot more accurate. We know that in time satellite tracking will become more precise than a metre.

Mr WALL: The member has hit on one of the biggest challenges that we have with this technology at the moment and certainly I think it underlines the importance of running real-world trials. An analysis of the first 370 million records that we have collected from the city project has actually led us to a conclusion that we have some major issues around that positioning technology. We have found that our satellite technology in some of the more mountainous and challenging areas can be out by 10 metres. So positioning is a really big technical issue, but in saying that there is a commitment not just at a State level but also at a Federal level to look at solutions for this.

We were a participant in an ARC linkage grant with the University of New South Wales Centre for Space Engineering Research to look specifically at this issue. Unfortunately, we did not get the funding for that but we are now putting up for another project as well. We are working with the space engineers here in New South Wales to see how we can get better positioning. It may be around being able to add infrastructure to better perform that. It may be around using onboard cameras and things where the vehicle can recognise certain landmarks and then understand where it is on the network as well. So it is not just about satellite; it is about all those sorts of things but it is certainly a challenge.

If we have taken the results directly from Michigan where it is open and flat and where there is full coverage of the American GPS system we would not have seen it as an issue but once we started to run our own on-road Australian trials that is where it became highlighted as a major issue for us. I know that people like Geoscience Australia, which is in charge of the Australian space program, is looking at those sorts of issues of better positioning. We already do have that. Our surveyors use this system, which is an augmented positioning system, and they can get to centimetre-level accuracy. The issue is that it costs you about $2,000 for that little black box that can get you to that, and you have to add that to the cost of the vehicle as well.

We know that at the world congress the cooperative ITS radio manufacturer Cohda Wireless from South Australia we understand will announce a system add-on to its existing system that we currently use that will get us sub-metre accuracy. We are really waiting to find out what that technology will be.

Mr NICK LALICH: I think you are right when you said it will be somewhere between 20 and 25 years before this comes to fruition and we would have fully automated vehicles. I think in that time that little black box may be worth $1 or something. Technology is increasing exponentially and five years will be six months. A computer or a phone is useless after six months today and you have to get a new one.

Mr WALL: It is also about volume. Whilst ever we are conducting trials with small numbers of vehicles it costs us a lot but when we starting putting that into millions of vehicles around the world the price point drops dramatically as well.

Mr CARLON: I think the other technology that is being used currently in terms of lidar is a much more refined technology. So there are different technologies that will come onto the market that will potentially just change the system and the costs. I think we need to be flexible and open to the fact that there is significant change in the technology area constantly happening and the driverless vehicles, particularly in using lidar, have a much higher level of accuracy, again at a slightly increased cost.

Mr WALL: Yes, so the vehicles do not necessarily have to depend on satellites to get their position on the network. They can use all of these other vision radar and lidar-based sensors as well that will certainly help in those areas which are more challenging for GPS.

Mr MORAN: I was just going to add I think you are absolutely right that there are certain technologies that work better with a map and a positioning sort of approach in probably the more rural areas but when you get into urban areas that ability to sense the road environment and other road users becomes really important. Just as technology will grow and the price point will come down, I think you will find those technologies will converge because it will not just be New South Wales and Australia, the market will be saying "How do I bring this to customers to meet all of their requirements?"

Dr MEHREEN FARUQI: It is all very exciting that vehicle technology is advancing so rapidly as well as intelligent design systems. I can envisage the whole roadwork having driverless cars in the near future, or the not far away future. In your planning what sort of time horizons are you using to predict that the whole road network will become driverless?

Ms GARDINER-BARNES: The $6 million question.

Dr MEHREEN FARUQI: You would have to pick a time frame to be able to adjust to it.

Ms GARDINER-BARNES: We think in the next 25 years there will be a significant shift in traffic mix in the market. To get to the point of fully automated only fleet might occur in some locations sooner than others. I think, for example, in the Bays Precinct, where there is a development opportunity, we have put through the application process that that be a driverless precinct as a way of testing in a new environment and quite a significant size development, what it might look like and feel like so you could then engage the public in that process as well. So people can become familiar and get the experience of a driverless vehicle and how it might manoeuvre around in a fairly normal type environment but that is well structured and built for purpose.

Clearly there will be lots of flow-on effects of this type of technology as we move to automated bus fleets and what that means for our freeways and highways and our road networks and our capacity to improve congestion and efficiencies. I think once commercially there is a shift for the price and the cost of providing that sort of technology enabler there will be a point where there is a really quick shift across infrastructure to pick up shared cars and shared vehicles and buses into this form and slowly we will see a decline of personal vehicle ownership. But that will be a cost factor and will require all of us to be able to be satisfied that the reliability of safety mechanisms are clearly in place.

Dr MEHREEN FARUQI: What will be the impact on public transport once level four driverless cars are on the road? According to industry research, if everybody drives a driverless car the roads will be much safer. At the moment obviously public transport is much safer than driving your own vehicle. Has any research been done on that? Has a cost-benefit analysis been done? How much has been invested in public transport versus improving infrastructure for driverless cars?

Ms GARDINER-BARNES: We have just commenced the process of refreshing the long-term master plan for all transport across New South Wales. Technology will be a key driver for how we relook at our investments across the road and rail networks, not only for passenger transport but also freight. There are many opportunities because of the data linkages between public transport usage and driverless vehicle technology that we are putting into our metropolitan system. For example, we are capturing for the first time individual travel

patterns in a way that we have never been able to capture them before. As a result, new businesses will emerge like the ride-sharing services that have been established in many parts of the world. That will be a benefit and will provide much more customised transport systems.

The key will be how we shift that to a mass-transit system. I think part of it will be the opportunity for people to interchange across different transport modes, and they will have a much quicker trip from their front door to their destination than is possible now. The interchange technology and the big data will be the key in ensuring that it is integrated into public transport network planning.

Dr MEHREEN FARUQI: Are you aware of any studies being done anywhere in the world on the impact on public transport of the introduction of driverless cars?

Ms GARDINER-BARNES: Not off the top of my head.

Mr CARLON: No, I have not seen that modelling done in any other jurisdiction.

Dr MEHREEN FARUQI: The Committee has had a number of submissions highlighting the impact of driverless cars on vulnerable road users; that is, pedestrians, cyclists and motorcyclists. I am concerned about what that impact might be. There are still many blind spot monitors in cars that do not detect humans, cyclists and motorcyclists. What is your view on that and how can it be overcome?

Mr CARLON: Again, that relates to the uptake of blind spot monitoring systems in vehicles in the real world experience in New South Wales. In 2005 there was no data available for any vehicles that had blind spot monitoring systems, but in 2015, 30,000 vehicles had them. A significant amount of research and testing is being undertaken in other jurisdictions and here. I understand that work is being done here with the recognition of kangaroos to avoid animal strikes on rural roads. That technology is continually improving. Some advances have also been made with reversing cameras in terms of recognition of pedestrians in automated systems.

Significant industry investment is happening in that area. We continue to encourage and to promote those technologies within fleets so there is more consumer take-up. A significant amount of work is also being done internationally in relation to cyclist and pedestrian recognition. As the OECD nations continue to reduce our road tolls over time, the proportion of the vulnerable road user groups that are subject to fatalities has been increasing. There has been a refreshed investment in attempting to design better technologies for the recognition of pedestrians, cyclists and motorcyclists.

Mr WALL: We have three safety research vehicles, two of which are light vehicles—a Subaru Outback and a Volkswagen Amarok utility—with retrofitted pedestrian, vision-based detection systems. They appear to be very effective at detecting pedestrians, but the pedestrian must be in the view of the cameras. They must be a little way in front of the vehicle to be detected and to warn the driver. One would imagine that in the future the technology will allow the vehicle's brakes to be applied. Some vehicles on the market have that capability, so we are already able to detect pedestrians, cyclists and motorcyclists quite effectively with that camera-based system. However, that will not prevent the scenario where a person walks into the path of a vehicle, for example, while using a mobile phone or something similar. At least we have come part way in terms of being able to do that. I think we will be able to detect those pedestrians and, as long as we have enough time with the technology, to cause the vehicle to brake and so on.

We have one heavy vehicle that has a detection system running down the side that will detect pedestrians walking into the path of the vehicle. We have put three different systems on that vehicle over time, and the first two failed miserably. Therefore, it is not a given that the information being provided by the manufacturer of a vehicle or a person trying to sell it about what it will do is accurate. It comes back to the importance of having on-road trials and demonstrations in real world conditions so we can pick that up, but that technology is looking promising. The question to ask is whether in the future those technologies will be better than a human driver. I cannot answer that at the moment because I do not have the evidence.

Dr MEHREEN FARUQI: People have raised the issue of human drivers having eye-to-eye contact with people and those cues might be missing in driverless cars. As I understand it, designers prioritise the safety of the occupants of the car and not the safety of the road users in situations where there could be an accident. Do you see it as your role to talk to designers about those issues once you go into trials?

Mr CARLON: Absolutely. We have identified a shift in that market. Mention was made of that earlier with regard to the number of vulnerable road users increasing as a proportion of the road toll in other jurisdictions. The vehicle manufacturers and designers are looking at new technologies, and we can see them coming into the market. It is about how we continue to provide incentives and market-based ratings systems that encourage that behaviour in terms of bringing those technologies to the consumer. Australasian New Car Assessment Program and the international rating systems are moving in that direction and are starting to

incorporate pedestrian protection safety mechanisms in vehicle designs. They are now giving them some precedence in terms of adding them to vehicle star ratings. That process is happening now.

Mr NICK LALICH: I am not concerned about vehicles not being able to recognise humans or bikes. I have been in a police car that had numberplate recognition technology. We drove not even one block before the technology detected six or seven vehicles on side streets. It can detect them at the side, behind, and in front. If it can detect numberplates like that, it could be used to detect humans, telegraph poles and so on. That technology already exists and it works very well. There is no chance of getting away from a police car.

Dr MEHREEN FARUQI: But you have a person driving the police car.

Mr NICK LALICH: It could be incorporated in cars.

Mr WALL: I was just saying that I understand that Volvo Car Australia will be here giving evidence later today. Certainly some of their vehicles are equipped with pedestrian detection, so they should be able to tell you a little bit more from the manufacturer side about the advances in that technology.

The CHAIR: I would like to pick up on some of themes we have just touched on—themes that have been developed by Dr Faruqi and Ms Gardiner-Barnes. One of the major themes of the Government submission was the need to consider the safety implications of the mixed fleet. Do you consider that there is merit in perhaps doing a cost-benefit analysis for skipping the transition period and delaying the introduction of AVs until there is a robust body of evidence that level 4 AVs—those that do not require driver involvement other than to designate a destination—are available, safely developed and on the market? Obviously that is a devil's advocate question there.

Ms GARDINER-BARNES: Yes, it is. I think it would be a mistake not to continue to engage in new technologies and test them as they emerge. One of the things that we are going to do through the Long Term Transport Master Plan process is develop some technology that allows us to do some scenario planning based on changes in policy and traffic mix. Through some back-end modelling we will be able to see for the first time what the flow-on effect might be of introducing new type technologies into the traffic mix in different regions and, potentially, what the flow-on effect might be for safety. There are real benefits from doing that modelling and, from that, seeing where the real benefits are from different types of technology. But there will come a point when we need to do some cost-benefit analysis around significant government investment in a new technology if that is what is required, particularly where it relates to vehicle to infrastructure communications. If that is some of the technology that we need to invest in then certainly there will be a cost-benefit analysis done for that purpose.

Mr CARLON: One of the key issues in answering that question is that through the vision of fully autonomous vehicles or driverless vehicles we have seen the market take up the particular attributes within vehicles. Whether it has a lane assist system or an adaptive cruise control really is driven in the market by the future benefits that might be derived from having those technologies in your vehicle now. So we would not want to put in place anything that discourages the adoption of those or the testing and bringing to the market of those technologies that get proven as having a safety benefit in reducing the trauma on our roads. From our point of view and from a road safety perspective, the sooner we are able to get more of the fleet with these technologies that can protect drivers, passengers and other road users, the better.

The CHAIR: Thank you. That leads directly to a quote from one of the speakers at the Future Transport forum. They said:

> … vehicles [can] arrive on demand complete with a double shot latte to blow away those morning cobwebs.

I think most of us have received inquiries from interested parties as to whether this means that in the future if you are over the prescribed range of alcohol you can still sit in your vehicle and be driven home. In your submission you approached that particular subject—the loss of skill that can occur if drivers become over-reliant on technological assistance and the need for alertness. What further action would you anticipate will be taken to re-educate drivers in New South Wales to maintain those skill levels in the position that they might face driving an automated vehicle?

Ms GARDINER-BARNES: That is actually a big issue already in the freight industry where drivers are doing long-haul journeys and they are relying on lots of technology in their vehicle already. We have got some camera technology to pick up fatigue, for example, which is really critical in those contexts. Some of those technologies will be very important as we start to better automate what is going on in the vehicle and the flow-on effect for the human behaviour. We cannot afford for a person who is in control of a vehicle to start to get so comfortable that they are fatigued and in fact not focused on the task and responsibility that they have on that road network. It is an important issue that we need to continue to address. Some of the fatigue technology will help draw that out.

The CHAIR: Thank you. That is exactly what I was after.

Mr SCOT MacDONALD: Just on that theme of coffee, this leads to equity. I do about 40,000-50,000 kilometres a year and I pay the same green slip as our Greens friends who drive down to the café and get a skim milk latte.

Dr MEHREEN FARUQI: That is a cheap shot.

Mr SCOT MacDONALD: It is a very cheap shot. My point is I pay the same green slip with my high number of kilometres as someone who might be doing 5,000 kilometres a year. Do you see this technology and the data maybe assisting us with equity in terms of a user pays system and where that might go for someone who is having an impact on the road network like the heavy vehicle versus someone who is not drawing down on the system much?

Mr CARLON: In the submission we reference information from the State Insurance Regulatory Authority on that issue in particular. In terms of the costs associated with road trauma in New South Wales and in particular those that are more susceptible to doing a lot more kilometres and being on the road more often potentially involved more in crashes, their view is that we would clearly identify that there is potential for crash reductions, even with current technologies such as automatic emergency braking systems, reducing the costs overall and then being able to deliver a much more efficient green slip and compulsory third party [CTP] system. Their view is that there are substantial benefits into the future in the reduction of crashes and the reduction in costs being delivered to the community.

Mr SCOT MacDONALD: Is there any international experience where through tracking of vehicles road toll costs are ascribed in relation to usage?

Ms GARDINER-BARNES: Yes. The notion of user based charging for the hypothecation of revenue back into paying for our road infrastructure, for example, is something that is and has been on the agenda for governments for a long time. Our fuel excise tax is not going to be a long-term solution with the evolution of electronic vehicles. The current mechanism is not future focused around the infrastructure investment requirements. There are countries like New Zealand that use user pays systems—user charged systems hypothecated back to investment in road infrastructure. Australia is a long way from moving to that point and there is a lot of work as we move into improved technology and electric vehicles around how we will collect revenue from road users to pay for future road infrastructure.

Mr SCOT MacDONALD: And be fair about it.

Ms GARDINER-BARNES: Yes—and create a sustainable model that is much fairer and more just.

Mr CARLON: I think the other issue that we need to bring to the attention of the Committee is that in the current system for pricing your insurance, the CTP insurers actually do have a variety of prices.

Mr SCOT MacDONALD: Levels—yes.

Mr CARLON: And many of them are currently factoring in the risks associated with the vehicle type, the type of protection that is within the vehicle and the vehicle use.

Mr SCOT MacDONALD: So there is a signal there now.

Mr CARLON: There is already a signal and already some of the providers give incentives to people who have safer vehicles or safer travel patterns by reducing their premiums. On this journey towards more automated functions within vehicles that improve safety, that is one of the systems that will incentivise people.

Mr SCOT MacDONALD: That is a good point.

Dr MEHREEN FARUQI: I would like to ask a quick follow-on question. You mentioned electrically charged vehicles. I think in your submission you also pointed out that more and more of the autonomous vehicles will be electric vehicles. What sort of plan have you put in place for investment over the next few years to have charging stations and infrastructure for those sorts of vehicles?

Ms GARDINER-BARNES: Government is not investing, as such, in those sorts of opportunities but is certainly working with industry to ensure that, as the market evolves, we are planning our road network to better cater for those sorts of shifts in usage and take-up rates. It will be very interesting to watch how it evolves, and there are lots of innovative ideas around how that can be catered for in workplaces and in homes and in between journeys. Potentially it will have a huge impact on our road network into the future, depending on how long it takes to charge a vehicle and how sustainable that electric charge is. It will be very interesting to see how that evolves, over time.

Mr ADAM CROUCH: Mr Wall, I think it was you who stated earlier that the Government has two vehicles which were retrofitted to be autonomous. I think it was a Subaru and a Volkswagen Amarok. From the Government's submission we know that there is a massive market for technology to modify vehicles around the country. Will there be regulations about retrofitting vehicles with driverless technology and will this be raised at a national level by New South Wales? Secondary to that, what sort of risk mitigation will we be putting into that? Where someone retrofits their own car with automated systems—which, by the sound of it, we have done already—will the Government be looking at that, and will there be a discussion about that at a national level?

Mr WALL: Mr Crouch, I will have to pull you up.

Mr ADAM CROUCH: That is all right.

Mr WALL: We have not retrofitted an automated system to our vehicles.

Mr ADAM CROUCH: We did not do the retrofitting? That is all right. Did those vehicles already have the systems on them?

Mr WALL: They have advisory systems. A lot of the work that we are doing on connected vehicles, and in testing road safety technology involves retrofitted devices that provide advice. They do not interact with the vehicle's systems. With the things that you were probably referring to, vehicle manufacturers spend a lot of time and a lot of money building their vehicle management systems—their fuel and braking systems. Those systems have to meet Australian design rules [ADRs]. The development of the ADRs is a Federal Government responsibility, with input from the states.

There are experts within New South Wales–our vehicle engineers and others. At the moment, anything that was retrofitted to a vehicle—in terms of taking over some controls like braking and acceleration—would have to meet the Australian design rules. If they do not meet the Australian design rules they would have to be signed off under our engineering signatory scheme. They would have to be certified by a fully qualified and accredited mechanical engineer under the certification scheme. That is a potential challenge but we would always say that, in the first place, we would like manufacturers to bring in these automated features rather than having individual owners retrofitting those.

Ms GARDINER-BARNES: As part of that another question needs to be asked. In many instances in future there may not be a retrofit but as soon as you get into a car with your mobile phone it could connect, based on data that sits in that phone, to take over the vehicle in some aspect. So there is a potential for your own personal mobile device to hold technology and applications to talk directly to whatever vehicle you get into and customise it for your purpose. There are many different ways in which technology can be applied that do not require any mechanical or engineering fitting device. So we will need to be careful about how those are applied in vehicles.

Mr WALL: We have already seen at least Tesla update their vehicles a number of times with different software and change some of the functionality of the vehicle with that software update. It is actually sent over the air to the vehicle. The vehicle has its own SIM card and it is connected. It receives those software updates. The traditional method of certifying changes will have to change in the future because a lot of those changes will be software related, and physical inspection of the vehicle may not be able to see any of those changes that are made.

Mr ADAM CROUCH: Is the Tesla upgrade unique to the Tesla vehicle?

Mr WALL: Yes, that is right. It is sent out by the manufacturer—that is the key point—unless someone has hacked the system. I guess there is always a potential for that.

The CHAIR: Professor Toby Walsh from the University of New South Wales suggested that automated vehicles should be visually distinctive and easily identifiable. He suggested that the plates could be similar to those displayed by learners, for instance. Do you consider that that would enhance road safety? In particular, would it benefit vulnerable road users? Perhaps, there should be markings that are even more distinctive than those suggested in the early stages.

Mr CARLON: Right now we have registered vehicles that are operating on the network that can be driven in fully automated mode whilst the driver is still in control of the vehicle. I do not think they need, necessarily, to be differentiated because the driver is still in control of the vehicle and responsible for the operation of that vehicle on the road. I think there is a consideration, as we have seen, in terms of the outcomes of some of the driverless vehicle technologies tested in the United States. There are some issues about the way in which human factors determine the relationship between a driverless vehicle and a vehicle controlled by a human driver.

There needs to be some consideration about the whole system of how those two modes of transport interact and operate together on a network. The whole system of how a driverless vehicle operates in a shared mode with operators of vehicles on the road is something that is under consideration. We should consider all of the safety risks associated with the mixed operation of driverless and human-controlled vehicles. We are not at that point yet, but that is happening. So we need to consider how that system would operate safely.

Dr MEHREEN FARUQI: Am I right in assuming that much of the safety benefits from improving technology can be achieved through vehicle-to-vehicle communication and vehicle-to-infrastructure communication—by building infrastructure and the technology—rather than just considering moving to level 4? Can that offer the best increase in safety? Can those benefits be achieved—I guess this is my question—more quickly if we do not think about the whole network being level 4? It could still be driver controlled but it would have all these safety benefits.

Mr CARLON: I think I made a statement earlier that we do not want to impede the technologies that would deliver safety benefits today. So, my answer to that question would be yes, we want to improve the safety and quality of those vehicles incrementally in order to get those benefits to the market. When we think that there are more than five million registered vehicles in New South Wales and we are talking in 50s and 100s of thousands that have these current technologies actually operating on a network, there is significant advantage in increasing the volume of vehicles.

Dr MEHREEN FARUQI: That would also mean improving infrastructure, would it not? I read a research paper from the United Kingdom which spoke about wi-fi roads, for instance. Would it still need investment in infrastructure to be compatible and to allow those vehicles to achieve the optimum safety levels?

Mr CARLON: Depending on the technology. I would say on autonomous emergency braking, probably not because it is operating relative to the vehicle in front of it. Potentially on adaptive cruise control, but probably not significantly. Potentially on the lane assist systems in terms of being able to determine that you are actually leaving the lane, having quality lane markings would certainly have a benefit. In the majority of the current systems that can be integrated into vehicles, significant safety benefits will be derived just by having more of them in more of our vehicles on the market.

Mr WALL: What we found with our connected vehicle space is that the sensors that are currently used in autonomous emergency braking and lane keeping are visual lidar and radar-based sensors. They have the capacity to look ahead about 200 metres or so. Connected vehicles look ahead 400 metres and up to a kilometre. I think we will get significant safety advantages for these vehicle-based sensor systems and for autonomous emergency braking with a 25 per cent to 35 per cent reduction in serious casualties, I think.

Mr CARLON: Around 35 per cent, yes.

Mr WALL: It does not require infrastructure to do that, but it would enhance it. The current systems are line-of-sight systems, so effectively they see what humans can see. The advantage with connected systems is they can see beyond what a human can see. They can see in the dark; they can see through fog; they can see over the crest of hills and between buildings. That gives them the extra benefit. But the two are not mutually exclusive; they both build on each other to build the best possible system for the future.

Mr MORAN: If I can just add to that and say that enhancements in digital infrastructure are probably going to be more related to the congestion benefits of connected vehicles rather than the road safety benefits purely because of the access to data to understand how networks are working and that can be provided back to customers in their vehicles and what have you. It is probably more on the congestion side rather than on the road safety side.

Dr MEHREEN FARUQI: That would lead to road safety in the end because of fatigue and all of that.

Mr MORAN: Absolutely.

The CHAIR: I have a final question. The New South Wales Government's submission stated that the Government plans to produce green and white papers and a future transport roadmap further to the future transport summit that was held in April this year. Will the papers address or incorporate automated vehicles, and if so to what extent?

Ms GARDINER-BARNES: Yes, that work is underway at the moment and it will include new vehicle technology, the full range of vehicle technologies that we need to consider for our long-term planning processes.

The CHAIR: I thank our government representatives for their appearance today and for their extensive submission.

(The witnesses withdrew)

(Short adjournment)

DAVID PICKETT, Technical Manager, Volvo Car Australia, sworn and examined

The CHAIR: Mr Pickett is accompanied by Mr Greg Bosnich, who is appearing not as a witness but as an adviser to Mr Pickett. Welcome. Thank you for appearing before the Staysafe Committee today to give evidence. Do you have any questions concerning the procedural information that was sent to you in relation to witnesses and the hearing process?

Mr PICKETT: No.

The CHAIR: Before the Committee proceeds to questions, may I confirm that you would be happy to provide a written reply within 10 business days to any questions that are taken on notice or any supplementary questions the Committee may ask?

Mr PICKETT: Yes.

The CHAIR: Thank you very much. Would you like to make a brief opening statement?

Mr PICKETT: I would, Chair.

The CHAIR: Please go ahead.

Mr PICKETT: On behalf of Volvo Car Australia, I thank the Chair and fellow Committee members for the opportunity to appear today at the inquiry into driverless vehicles and road safety in New South Wales. Greg Bosnich will be assisting me today. I would like to make some opening remarks about Volvo's submission. Afterwards we will be very happy to take questions. In Australia and around the world there is a great deal of interest in the development of autonomous driving technology, which is commonly referred to in the media as driverless cars. As a global leader in the development of autonomous driving technology, we believe this description is somewhat misleading and could be counterproductive in the debate on the introduction of this technology into Australia.

As stated in its submission, Volvo believes that a more accurate description of this technology is autonomous driven cars or self-driving cars. An autonomous or self-driving car is one that can accelerate, brake and steer itself without intervention by the driver. Last November Volvo demonstrated this technology in action in Adelaide in the first Australian trial, using Volvo XC90s. This trial was conducted, with the full cooperation of the South Australian Government, as part of ARRB Group's Australian driverless vehicle initiative, which is researching the requirements and benefits of introducing autonomous driving technology into Australia. The trial attracted major national media coverage and captured the imagination of the Australian public, who are renowned as early adopters of the latest technologies. Following the trial, there is now growing interest in conducting similar trials from State and Territory governments across the country.

Why is there so much interest in this technology? As we stated in our submission, self-driving cars will be the biggest challenge to personal transport since the invention of the car 130 years ago. At the macro level, Volvo believes that self-driving cars will boost economies and productivity by transforming the way people manage their time. At a local level, self-driving cars will benefit New South Wales drivers and society alike through reduced congestion, improved traffic safety and sustainability. Imagine beginning your work in your Volvo car on the M5 or the M7, watching the morning news whilst making notes in preparation for a 9.00 a.m. meeting. Your car follows a preset route. It automatically changes lanes safely to avoid slower vehicles. It communicates with other vehicles and electronic road signs to receive updates about traffic conditions ahead. At the end of the day your Volvo can pull out of the car park ready for your return journey home.

Modern car technology has finally caught up with the cartoons of 40 years ago. By 2021 Volvo could have a fully autonomous car commercially available in New South Wales to drive on selected roads such as the M7 or the M5. But, as we point out in our submission, this can occur only with the political will of the New South Wales Parliament and State transport bodies to adapt and change existing road rules to accommodate this technology within acceptable safety boundaries. Volvo has built its brand and reputation on developing some of the safest cars in the world, so public safety must always be paramount.

Volvo has been at the forefront of advanced driver assistance systems, the first of which was an autonomous emergency braking system in 2007, followed by the introduction of Volvo City Safety, which reduced rear end collisions by up to 40 per cent, with a significant reduction in injury at the same time. Volvo has continuously developed world-leading safety technology to create semi-autonomous cars that make journeys safer and easier whilst leaving the driver fully in control, in accordance with the local road rules. Later this year Volvo Car Australia will launch the all new XC90 in Australia, with Pilot Assist function. Pilot Assist permits the car to accelerate, brake and steer, maintain a set distance from the vehicle in front, and centre within the

lane, up to speeds of 130 kilometres an hour. If New South Wales road rules are changed by Parliament to allow fully autonomous cars, proven technologies like Pilot Assist will underpin Volvo cars on New South Wales roads.

Before I conclude my opening remarks, I draw the Committee's attention to a major autonomous driving initiative that Volvo is undertaking in Sweden next year. In 2017 Volvo cars will play a leading role in the Drive Me project, the world's first large-scale autonomous driving project, involving up to a hundred Volvo XC90s. The cars will be driven on public roads in everyday driving conditions by selected members of the public around the city of Gothenburg. These roads are used for typical commuter trips and include motorway conditions and frequent queues. The aim of the trial is to establish the benefits of autonomous driving and position Volvo in Sweden as a leader in future mobility. The Drive Me project is a joint initiative between Volvo Car Group, the Swedish Transport Administration, the Swedish Transport Agency, Lindholmen Science Park and the City of Gothenburg. It is endorsed by the Swedish Government. Chair, Volvo extends an invitation to you and your fellow Staysafe Committee members to visit Gothenburg during 2017 to observe the trial firsthand. That concludes my opening remarks. I am happy to take questions.

The CHAIR: I am sure that many members will be interested in taking up that offer. You mentioned the trials. Could you share the role that the Swedish Government has had in this program? What are the goals of that testing?

Mr PICKETT: The goals of the testing are to see how other people will react with the cars and how well the project works. The Swedish Government's role I think would be described almost as a facilitator. It is not something that Volvo can do by itself and it is not something that the City of Gothenburg can do by itself. There is quite a collaboration between all the different peoples involved in this which is why the project has taken a few years to get started. It would be the same as attempting to do it here. There would have to be a lot of road rules that would have to be looked at, permits, requirements and things like that to allow the project to go ahead.

Mr NICK LALICH: Would the Government have to put in a lot of infrastructure so that Volvo can do that test preparing the roads for the vehicles or does it just have to allow you to use the roads?

Mr PICKETT: You are correct in both ways. Some infrastructure has to be addressed. It could even be something as simple as making sure that when roads are maintained that the markings on the road are clear and nothing has changed on the road without prior acknowledgement. You imagine if we are developing cars that are trying to maintain themselves in a fixed position in a lane on a road, if all of a sudden you get somewhere and there is no road lanes any more we will have a little bit of an issue. That is part of the collaboration that needs to be done.

The CHAIR: Therefore, there are different types of roads being utilised in these trials?

Mr PICKETT: It is mainly what you call arterial roads. It would probably be the equivalent of say the M2 and M7, M5 loop road around Sydney but we are coming into the city with lower speeds.

The CHAIR: It is primarily an urban environment testing?

Mr PICKETT: Yes.

Mr NICK LALICH: If I am in the lane on the side of the road and there is a centre line can your detector keep you in that lane even though you do not have the second line running down the side of the road or up against the middle of the road, if you want to call it that?

Mr PICKETT: No, not at this point. We need a contrasting line to determine the lane itself, yes.

The CHAIR: The Government's submission indicates that Transport for NSW will be reshaping itself with a much sharper focus on technology and partnership through the new Smart Innovation Centre. What do you consider the NSW Government should focus on to adequately prepare for the introduction of AVs and the associated technology?

Mr PICKETT: I think the main thing is consultation with industry to ensure that any changes that are made is something that works sort of globally because this is what we really need to look at. The percentage of cars sold in Australia globally is very small so we need to make sure that anything we are putting in place either in New South Wales or in Australia is actually in context with what is happening globally so that we do not end up with a unique rule here which may prevent technology coming in.

Dr MEHREEN FARUQI: Do the trials also encompass some driving in a fully autonomous mode where the car driver will have nothing to do with the driving of the car?

Mr PICKETT: "Drive me" will be in a fully autonomous mode. What will happen is the driver will reach a section of road where he will be indicated a message on the dash similar to a GPS notification to say that autonomous driving is available. He then has paddles on the steering wheel, engages those, hold for a time and then the car will actually acknowledge that the car has been taken over for the responsibility and control. During that stage Volvo has announced that whilst the car is in a fully autonomous mode Volvo will be responsible for the car and the driver is then free to sit back and read, or do something else in that time.

Dr MEHREEN FARUQI: What will be the biggest risks involved in the trial? They would be similar to when you transition to driverless cars, or as you call them, self-driving cars? What risk management strategies have you in place?

Mr PICKETT: Most of the technologies in place we are using. I drove here this morning without using the brake or the accelerator and I had my hand on the steering wheel but the vehicle was steering itself. I live at Camden so I had a 1½ hour drive in here this morning and apart from resting my hand on the steering wheel most of the time I was driving autonomously. So the risks are probably not as great at this point. I think for the trial it is probably more of an education aspect of seeing what happens to other people. One question is, you are driving along in the traffic and you see the person next to you reading a book and it will be quite distracting for the person next to you.

Dr MEHREEN FARUQI: In the case of a collision when the vehicle is in a fully autonomous mode, what is your view of liability? Is the car manufacturer liable for those sorts of situations?

Mr PICKETT: From the point of view of Volvo, if the car is in a fully autonomous mode Volvo is responsible for the vehicle.

Dr MEHREEN FARUQI: A few vulnerable user groups have made submissions, including the Motorcycle Council of NSW, and cyclist and pedestrian groups. They are concerned about their vulnerability, especially with regard to vehicles being operated in the fully autonomous mode. Someone pointed out that the blind spot technology is not accurate enough to acknowledge pedestrians, cyclists or motorcyclists. What is your view on that, and how have you catered for it in your cars?

Mr PICKETT: At present we have pedestrian and cyclist detection in front of the vehicle. The cars used for the trial will have a 360-degree radar and laser; that is, they will have another layer of technology as opposed to that used now. Europe is set up slightly differently in regard to cyclists; cyclists have their own cycleways, they are not on the roads. The roads we are using are not likely to have pedestrians.

Dr MEHREEN FARUQI: So the trials do not accommodate for that at the moment? Do you envisage another trial that might do that after you have honed the technology? Normal road conditions would include pedestrians, cyclists and motorcyclists.

Mr PICKETT: We are probably testing a different type of technology. For six years we have had technology in the car where if a pedestrian steps out the car will automatically brake. That is probably not such an issue in this trial because we already know we have the proven technology.

Mr NICK LALICH: Your submission recommends urban freeways as the early testing tracks for driverless vehicles because there are no traffic lights, pedestrians or other impediments. If New South Wales wants to go that way, where would be the best place to do the testing? Would it be best tested in Newcastle, Wollongong, Sydney or Camden?

Mr PICKETT: We can look at the Adelaide trial. We need a highly maintained, good piece of road. We would talk to the Centre for Road Safety and look at the best roads in cooperation with the centre. I do not want to say that I want to use the M5 because it would be easier for me to get home. We should look at where we can get benefits from the trial. Other trials are underway for different technologies, and I would like to see us encompass them as part of the trial.

Mr NICK LALICH: Professor Toby Walsh says that driverless vehicles probably should be marked like cars being driven by people with L-plates and P-plates. Perhaps they could have an E-plate indicating that it is an electronic vehicle. That would indicate to other road users that it is a special test vehicle. Do you agree that these vehicles should be marked?

Mr PICKETT: There could be. There might be a reason to do that more from a law enforcement point of view so officers will know why a person is not paying attention. I do not see a big benefit for other road users.

Mr NICK LALICH: Someone might see a driver reading a newspaper and be distracted. If it were marked other people would know that it was a self-driving vehicle.

Mr PICKETT: I do not think it would bother us, but I do not see a definite need. You would probably do it more from a marketing point of view rather than for any other reason.

Mr NICK LALICH: It is an awareness thing, and letting people know it is a different vehicle.

Mr PICKETT: It could be done with a sign similar to those on LPG-operated vehicles. There is no reason for not doing it.

Mr ADAM CROUCH: Government representatives earlier discussed software download updates being done automatically by the company that manufactured the vehicle. We discussed that when we visited Volvo.

Mr PICKETT: Yes.

Mr ADAM CROUCH: Given the rapid advances being made, how serious a risk is hacking of that technology? Does Volvo use a similar system where it regularly updates the software and then the vehicle? Is there a forum or a responsible group getting together to develop and monitor the measures to ensure the security of those systems? We are talking about extremely advanced technology.

Mr PICKETT: Volvo believes that vehicle hacking should be a criminal offence. I will answer the question in two parts. What we call "over-the-air" software downloading can be done on certain functions. However, we do not do it on anything we class as vehicle safety or vehicle critical. We can do a software download to upgrade apps or the navigation system, and customers can update their own navigation and maps. However, if something affects a vehicle system it must be done using the proprietary equipment used for downloading into cars.

Mr ADAM CROUCH: You would get a message from Volvo asking you to bring in your car to be updated; Volvo would take responsibility?

Mr PICKETT: Yes. There are two types of upgrade. If the upgrade improves the product performance, we would do that as a normal part of servicing the vehicle. If it related to vehicle safety, it would be covered under a recall.

Ms ELENI PETINOS: Your submission notes that the Government and industry will need to plan for a range of scenarios in which vehicle technology might fail. Should backup solutions be made mandatory or prerequisite elements to the introduction of driverless vehicles in New South Wales?

Mr PICKETT: It is up to the manufacturer to prove that the vehicle is safe to use. Volvo Drive Me cars have double redundancy for everything. There is a secondary system for the brakes, steering control and so on. That is how the safety aspect can be achieved: If you have a failure there is another system that will enable the car to be pulled over or to continue the journey with warning messages or something like that. The safety aspect should be built in at the start.

Ms ELENI PETINOS: What do you see as the biggest risks during the introduction and transition phase for driverless vehicles? What should the Government do to address those risks?

Mr PICKETT: The Australian design rules and motor vehicle standards legislation cover that. It is up to us as a manufacturer to provide a safe vehicle. Whether that is a safe vehicle now or in 20 years as an autonomous vehicle, the onus is still on us to produce a safe car. During the implementation it probably has more to do with the education of drivers and knowing the vehicle's limitations. During the transition from no autonomous aspects to semi-autonomous and then fully autonomous vehicles it is about understanding the type of vehicle they are driving.

Mr SCOT MacDONALD: I have a couple of questions. Regarding your point about extra urban space, do you have any comments about the sharing revolution that is coming? In your submission you talk about things like car parks, but is Volvo turning its mind to Uber share and all those sorts of things and how that might impact?

Mr PICKETT: No. I do not think so. At this point we are mainly concentrating on the idea that I will still own my own car. It will be able to go off and park somewhere and come back, but I think we are still looking at a vehicle—

Mr SCOT MacDONALD: Largely private ownership?

Mr PICKETT: Yes. In 20 to 30 years down the track I am not sure where that will end up.

Mr SCOT MacDONALD: Okay. I think almost your entire submission is about small vehicles. Is there anything you would like to talk about in terms of trucks and heavy vehicles?

Mr PICKETT: Actually, Volvo Car group is a separate company entirely from Volvo Trucks, so I cannot really comment on them. But I can make the general comment that historically a lot of the technology that rolls out in cars does start rolling out in trucks.

Mr SCOT MacDONALD: This is my last question and I also asked it of the government witnesses who appeared earlier. You touched a little on new revenue streams, but do you have any views about what the revenue might mean for the Government in terms of insurance, road tolling, user pays and all those sorts of things?

Mr PICKETT: I am sorry—I do not know.

The CHAIR: You touched on ride sharing. The New South Wales Government submission suggested that driverless vehicles may actually not bring a road safety benefit if they add to traffic congestion, yet other inquiry participants noted that vehicle automation may free up road space due to greater efficiency of car movements. The Committee is aware that driverless technology, if it is combined with vehicle sharing systems, could lead to a significant decrease in the volume of cars on roads. Do you consider that vehicle sharing systems are one key way of maximising the potential road safety benefits of this technology?

Mr PICKETT: I do not know that sharing will change the safety benefits so much. From Volvo's point of view we are looking at the vehicle having the safety benefits. I suppose vehicles being able to travel closer together will give a reduction in congestion and accidents. As to whether sharing will make a difference, I cannot really comment.

The CHAIR: One of the themes that came through in the government submission was the need to consider the safety implications of a mixed fleet. That is obviously something that Volvo would also be concerned about and preparing for. In a strange way we could suggest that there may be merit in doing a cost-benefit analysis—and we put this to the government witnesses—for skipping the transition period and delaying the introduction of AVs until there is a robust body of evidence on the level 4 AVs, which do not require driver involvement other than to designate the destination, and until they are safe and available on the road. Do you have any comments on that particular position?

Mr PICKETT: I think there are a lot of benefits to road safety in implementing the technologies rather rapidly. If we look at the technologies in cars today, to delay pedestrian detection as one of these technologies is not going to be a good thing. This is why we are not looking at a driverless car scenario—a vehicle with no steering wheel and no pedals. We think that there is a lot to be gained by having the technologies in the car and working our way to that goal of maybe having a driverless car in 50 years, because the benefits that we can get from emergency braking systems, driver fatigue systems and things like that are there now. That has a definite impact.

The CHAIR: We have read a lot of submissions. The Motorcycle Council of NSW's submission quoted the RAND Corporation, which is a global policy think tank. It said:

> … the RAND Corporation has calculated that to verify self-driving cars are as safe as human drivers, 275 million miles—

—or 442.5 million kilometres—

> —must be driven fatality free.

Are you aware of any internationally recognised benchmarks which would be used to clearly verify that these self-driving vehicles are at least as safe as human drivers?

Mr PICKETT: No. In relation to reductions in crashes and the road toll and differences the technology we are using now is making already, the autonomous braking system gives a 40 per cent reduction in nose to tail accidents. We are starting to see data because we have had these cars on the road for 10 years now. We are starting to see reductions in crashes and injuries—that is already proven and tested. As this technology is out and being used, we are seeing reductions in insurance claims. I think that is proving its worth.

The CHAIR: Do members have any more questions?

Mr NICK LALICH: I will ask one on international experience. What do you consider to be the key lessons from overseas experience so far and how would New South Wales learn from those in managing the introduction of driverless vehicles? To follow on, do you consider that proximity sensors and automatic braking should be mandatory for all vehicles—so they can at least stop and sense—before automatic vehicles are introduced in New South Wales?

Mr PICKETT: From an international point of view, the fact that the discussion has started is the most important thing. Our real learning about driverless cars will come from the Drive Me project. We have announced that Drive Me will be in Gothenburg in 2017. It has now been expanded to London through 2017-2018 and a large city in China. This is where we will learn our lessons and we will be more than happy to share those when the time comes. Regarding an autonomous emergency braking system, Volvo has fitted it as soon as it possibly could to its vehicles. We see benefits and reductions in that. Whether it should be fitted standard to all cars is probably a different discussion. We believe it is something that makes a big difference.

Mr NICK LALICH: I think your sensors will be really tested in China.

Mr PICKETT: Yes.

Mr NICK LALICH: I have been there and they come within an inch of your car before they stop.

Mr PICKETT: Yes. In relation to the comment in regard to autonomous driving and an alert driver, I have been asked in the past, "Is autonomous driving as good as a driver?" It really comes down to the fact that a driver of an automobile that is 100 per cent focused, aware and concentrating on what is happening is probably as good as an autonomous drive system, but you cannot maintain that level of alertness and concentration for the whole time of the car trip. Something will distract you.

Mr NICK LALICH: Thank you.

The CHAIR: Thank you very much for your appearance before the Committee today. We found that very valuable. I thank Volvo for the opportunity afforded to the Committee to participate in the physical experience of your vehicles and gain a bit more understanding of the development. Thank you for your submission and thank you for appearing before the Committee today.

Mr PICKETT: Thank you for the opportunity, Mr Chair.

(The witness withdrew)

GERARD WALDRON, Managing Director, ARRB Group Limited, sworn and examined

ARJAN RENSEN, Regional Manager, NSW/ACT ARRB Group Limited, affirmed and examined

MICHAEL REGAN, Chief Scientist, Human Factors, ARRB Group Limited, affirmed and examined

The CHAIR: Good morning, and thank you for appearing before the Joint Standing Committee on Road Safety today, in our inquiry into driverless vehicles and road safety in New South Wales. Before we proceed, do you have any questions concerning the procedural information which was sent to you in relation to witnesses and the hearing process?

Mr WALDRON: No. Today, I am here representing the Australian Driverless Vehicle Initiative [ADVI].

The CHAIR: Before we proceed with any questions may I just confirm that you would be happy to provide a written reply within 10 business days to any questions taken on notice and on any supplementary questions which the committee may have.

Mr WALDRON: Yes.

The CHAIR: Thank you. Would you like to make brief opening statement?

Mr WALDRON: Firstly, on behalf of the Australian Driverless Vehicle Initiative I would like to thank Mr Aplin and the Staysafe Committee for the invitation to represent evidence today, along with my colleagues. Many of you will have already met Mike and Arjan at the Volvo demonstration on 14 March. I think the Staysafe Committee should be congratulated for its leadership and foresight in pursuing an understanding of driverless vehicle technology and for taking a thorough and collaborative approach to obtaining the information about what I think is probably the most important transport innovation of the century.

The Australian Driverless Vehicle Initiative [ADVI]is a cooperative partnership of more than 60 government, industry and academic organisations, of which ARRB is a founding partner. Since our first roundtable in October 2014, the ADVI partners, including Transport for NSW have worked collaboratively to research and inform the development of a robust State and national policy, legislation, regulation and operational procedures and processes to accelerate the safe and successful introduction of driverless vehicles into Australia. That last statement is the vision of the Australian Driverless Vehicle Initiative.

At ARRB and ADVI we share the vision of a future where vehicle crashes will become a rare exception and where communities can be spared the tremendous physical and emotional trauma associated with road crashes. We see the vision coming to life through a combination of smarter and safer road infrastructure and through the safe and efficient introduction of highly automated and driverless vehicles.

ADVI operates and supports its vision with three key activity areas. The first of these looks into policy and risk areas. It works through engaging in social research, identifying the risks and concerns, and helping to inform policy makers. It has a major advocacy role and, as such, it does a fair bit of industry engagement, government relations and public awareness. Committee members will have seen that we have had a fair bit of press over recent times.

Finally, and quite importantly for this submission, we do scientific research, including the facilitation of road trials and we conduct human-factors research and scientific-knowledge transfer. As you have heard from our partner Volvo, ADVI led the first-ever demonstration of driverless vehicles on Australian roads last November, in South Australia. It has also been instrumental in assisting the South Australian Government to develop driverless vehicle legislation—the first of its kind in Australia . Despite these initial achievements and early progress there is still a great deal of work to be done at a policy and road infrastructure level by Government. We think it should be done in partnership with academia and industry to ensure that Australia reaps the benefits—particularly the safety benefits—of this technology.

Initial research suggests that safety benefits could be significant because 90 per cent of crashes, deaths and injuries relate to human error. We believe that this technology has the capacity to diminish that enormously. It is potentially worth $24.3 billion a year in the reduction of the national road trauma bill. In addition, there are significant economic benefits from driverless vehicles, which is important for a country that spends twice as much per dollar of GDP on transport as the average OECD country. Driverless vehicles will help alleviate road congestion, which currently costs the Australian economy about $20 billion a year. There are also positive environmental impacts from less greenhouse gas emissions, and increased freedom and mobility for the elderly and those with disabilities.

I will now cover some facts that were not included in the submission. Just last week the global automotive industry analyst IHS Automotive released its latest driverless vehicle forecast, predicting a substantial increase on previous estimates to say that nearly 76 million vehicles with some level of autonomy to be sold globally between now and 2035. However, it is unlikely that the future move towards driverless vehicles will be only smooth. New risks for drivers during this transition over the next two or three decades will require some careful investigation. I know the committee is already asking questions in this area. Professor Regan is a leading expert in this area. He has already begun investigating with ARRB and ADVI partners and colleagues.

Some of the potential new risks that may undermine the predicted safety benefits for autonomous technology include human factors in relation to driver skill, engagement and ability to take back control of vehicles. There are issues around trust and overreliance on, and misuse of, the technology, and also the much-publicised interaction of driverless vehicles and highly automated vehicles with traditional vehicles, all of which share our roads with vulnerable road users.

For this transition, while connecting with international research, Australia has a unique opportunity to deliver Australian-conducted research to inform the training, testing, licensing and vehicle design for the global context. Through industry, academia and Government working closely together we can ensure the key research needs are defined and this important research is quickly applied and adopted in the real world, leading to the manufacture and introduction of safer vehicles onto our roads as quickly as possible. This collaboration has an important role, which is at the heart of the ADVI mission and belief that research is there to inform the adoption of best practice.

There is also considerable work to be done in the realm of community education and understanding of the future safety benefits of autonomous vehicles. Otherwise there is very real danger that some isolated incidents involving driverless vehicles could result in some reactionary legislation and policy-making that could severely disrupt progress.

The reality is, however, that driverless and connected vehicles remain a highly complex technology and require a flexible approach to legislation, policy and infrastructure changes unlike anything we have ever seen before. I think the Committee is already recognising the pace of change in technology. It is going to be very hard for governments to stay on top of it. Broad and considered consultation with industry is required to deliver the forward-thinking legislation at a national level not only for road safety and risk management but also for telecommunications, insurance, mobility and transport issues. Legislation, in our view, needs to be centred on performance-based outcomes rather than what has traditionally been an overly prescriptive reference to specific technologies, which would lead us to becoming redundant quite quickly and stifling innovation while delaying road safety benefits from being rolled out for the community.

ADVI has already had some success in facilitating supporting strategic partnerships that yield significant national benefits to Australia. A recent example of this is the Australian Research Council that is now co-funding several ADVI partners to undertake a large program of human factors research: firstly, to understand the transfer of control between drivers and automated vehicles; next, to look at how drivers of non-automated vehicles react to having automated vehicles around them; and thirdly, to look at how drivers react to automated vehicle failures. The project would not have eventuated without the collaborative arrangements of ADVI support. The code of practice developed by ADVI to run the automated vehicle trials in Adelaide last year will also inform the development of the national code of practice for running trials across the country. I know that Austroads, for example, has taken that work on board immediately.

The ADVI partnership has displayed a strong involvement from industry with seven of the eight core partners representing industry and only one government core partner, the South Australian Government. The interaction and messaging we have received from this collaboration over the last 12 months has been strongly in the direction that government should be interacting early and working to support the industry rather than providing a hindrance through the traditional means of regulation. We have seen some areas internationally where some attempts to regulate or create rules are already causing some difficulties with implementing the technology. The industry view is that early State government discussion papers, expressions of interest, tender documents and conceptual discussions regarding the technology in its infancy show poor understanding of the concept of mobility and will really provide minimal assistance, and will not deliver what is required to support this industry in Australia.

The ability currently exists for the New South Wales Government to show some strong support for industry-led technology innovations and provide a flexible working relationship to encourage industry to innovate and deploy the new technology in New South Wales. This will enable benefits such as road safety to flow as early as possible and provide a business development opportunity for the State Government to support current and new industry in the space. From my interactions and ADVI members' interactions with overseas

partners and organisations, we strongly believe that there is a role for Australia to take a lead position in enabling the development and deployment of transport innovations, and to provide those learnings to the rest of the world. New South Wales has a strong history in supporting consumer advocacy for road safety, such as the ANCAP [The Australasian New Car Assessment Program] crash testing since the early 1990s. Moving to a world where cars are designed not to crash will require a different level of thinking and moving far beyond the traditional crash test protocols and Australian design rule requirements for vehicle safety systems.

I encourage the New South Wales Government to take more of a lead role in this space and I welcome the opportunity for the New South Wales Government to progress to a role as a core partner of ADVI. The Government is already one of the 60 industry partners in ADVI and it now has the opportunity to lead the required work being developed by industry and to support industry innovations. I thank the Committee for the opportunity to discuss the driverless future for New South Wales. We welcome your questions and I give you the hint that I would be delighted to answer some questions about heavy vehicles that were not really covered in our submission.

The CHAIR: Your submission describes driverless vehicle technology as "the biggest road safety opportunity in history" and today you have predicted a reduction of up to 90 per cent of accidents combined with significant savings in road trauma. Are there any preconditions for achieving that level of reduction of accidents?

Mr WALDRON: That is the reduction that you would expect when cars do not have steering wheels and pedals and humans do not drive them at all. We will have a phase-in period in between when we will get some percentage of those reductions. As our colleagues from Volvo have mentioned, some of the technologies that support driverless technology can already be implemented with great safety advantage.

The CHAIR: You also cited some predictions in the Netherlands indicating the deployment of vehicle automation systems would result in quite a significant decline in the number of fatalities and injuries over the years. Is it realistic to translate such predictions to the context of New South Wales, where obviously the terrain, driving culture and traffic management systems are so vastly different?

Mr WALDRON: It is fair to do that based on the type of road and the type of application. You will get the advantages firstly in urban environments, urban freeways and those sorts of things. As the technology becomes more mature and is deployed more widely, you will get to the stage where vehicles should be able to cope quite well with our road network beyond our cities and the higher standard roads that we have. That is the journey over the next couple of decades.

Ms ELENI PETINOS: Please clarify one of your introductory remarks around the fact that legislation should be on performance-based outcomes. What did you mean by that?

Mr WALDRON: If I take the example of the Tesla that was mentioned in earlier discussions, that car was introduced onto Australian roads without any automated driving capability. There is no Australian design rule to cope with that in any case, and then overnight last November, it was updated over the internet and it got a self-driving automated driving capability. I can see that it is going to be impossible for regulators and legislators to stay on top of something that can be updated as quickly as the apps on your mobile phone. Really we have to be working towards creating a framework where the people providing that technology take some responsibility for the outcomes and there is a proper risk management framework in place so that the updates that are going to happen are done by responsible organisations making sure that what they are delivering, as Volvo says, is a safe vehicle that is safe for that application, rather than trying to regulate how wide its rear bumper bar should be and those sorts of things.

Ms ELENI PETINOS: What about legislation impacting the enforcement of road rules and road safety? Do you have views on the direction required?

Mr WALDRON: So much of our road rules would become redundant, obviously, when we do not drive cars. Road rules are there to regulate human behaviour in that space, so there will have to be at thorough rethink of that area.

Ms ELENI PETINOS: This question is based on the New South Wales Government's position. Driverless vehicles may not actually bring a road safety benefit if they add to traffic congestion, yet other inquiry participants noted that vehicle automation may free up the road fleet due to greater efficiency of car movements. The Committee is aware that if driverless technology is combined with vehicle-sharing systems it could lead to a significant decrease in the volumes of cars on roads. Do you consider that vehicle-sharing systems are a key way to maximise potential road safety benefits of driverless vehicle technology?

Mr WALDRON: The short answer is yes, but I am going to give you a longer answer. I would agree with others that you will see a convergence of at least three technologies here: firstly, automated driving; secondly, electric vehicles; and then thirdly, some sort of Uber-esque sharing of the fleet. I think there is a huge economic advantage in that. We think that Australia will need only about one-third the number of cars that it currently has in order to meet our mobility requirements. Those vehicles will not need parking spaces at the curb in cities, so that will free up urban space for people rather than cars. A huge change is upon us in that regard. Obviously we would want to see this done nationally, but government generally has a one-off golden opportunity. The Committee asked questions of Transport for NSW earlier today about vehicle pricing. That sort of thing really comes home when you start to consider what would be in the best interests of the community in terms of interaction between this technology and the traditional public transport system, for example.

You could use driverless vehicles in the worst possible way. Instead of using the driverless vehicle to get to a railway station and then using a mass transit system to get to town, someone might say, "Since the car has arrived, it can take me to town," and it will join the backlog of cars waiting to be processed on an already crowded freeway. Pricing will be a major part of getting the outcome that you are looking for. It behoves government to start thinking a couple of moves down the chess board about this. It will be a whole lot harder, when there are already 100,000 vehicles on the road, to start to then try to change the rules of engagement so that those vehicles pay their way and people have the incentive to use them in a sensible, economic way.

Mr ADAM CROUCH: The Committee heard earlier today from Transport for NSW about how it is looking to reshape that agency. We have had information about the Smart Innovation Centre it is working on and how it is engaging with industry. What should the New South Wales Government should focus on to adequately prepare for the introduction of automated vehicles and all the associated technology?

Mr WALDRON: There are a few areas where we think there is some immediately beneficial work to be done. Transport for NSW has answered that question for you, in that there is a national program looking at regulation. The National Transport Commission [NTC] already has a program to investigate what national legislation would be needed. New South Wales needs to participate actively in that. There are also some really good opportunities to do some work in the human factors area. Professor Regan has a few words to say on that.

Professor REGAN: Thank you for the opportunity to speak to the Committee. As Mr Waldron said, I am Chief Scientist, Human Factors, at the ARRB Group and the co-technical leader for human factors for the Australian Driverless Vehicle Initiative [ADVI]. One of the things that has become very clear to me in my reading of all of the literature in this area—because I am working on a number of projects in human factors at the moment, including one for Austroads looking at the impact of autonomous vehicles on vehicle registration, licensing and compulsory third party insurance—is that the success of these technologies will depend very much on the human factor, much more so than in the past.

The reason for that is that we are getting into an area similar to what happened in aviation 20 or 30 years ago, when pilots were exposed to automation. The first generation of automated aircraft had the capacity to provide them with all sorts of automation. It provided them with glass cockpit displays of instrumentation that was presented in new ways that could benefit their performance and safety. They did not want to have anything to do with it. When the glass cockpits came in, pilots wanted the glass cockpits to simply mimic the instruments that used to be in the instrument clusters in the aircraft. It took them a long time to accept that the automation could help them. There was a lot of resistance to automation because it meant that fewer pilots needed to be in the cockpit.

What I am saying is that public acceptance is very important to understand when we talk about increasingly automated vehicles. At the moment a lot of the discussion is pure conjecture. Within the Australian Driverless Vehicle Initiative we are about to release to the public—to about 10,000 people, we hope—a public opinion survey so that we can try to understand how people feel about these technologies at the moment. It is very important to do that sort of research so that we can get a handle on it. The trials that we are planning within ADVI and that other people are planning—and this goes back to the question about the Innovation Centre—are very important because they provide an early opportunity to expose the public to these technologies, to bring people on board and get them used to technologies. My experience, having worked in this area for about 15 years, is that if you explain to people the capabilities and limitations of technologies and they understand what they are, and if you expose them to those technologies over time, generally they become accepting of the technologies, unless they contain repeated faults and malfunctions that erode that acceptance.

From the human factors point of view there are three messages I would like to get across today. I have alluded to them in the report. One is that human factors are critical to the success of automated vehicles, from the aspect of acceptance and understanding how people will use and possibly abuse them. Particularly when we are talking about level 3 vehicles, where there is a requirement for people to take back control, it is important to

understand the conditions under which that is likely to occur and the extent to which they are ready and able to do that, based on the way in which the vehicle is designed.

People talk about level 5 vehicles as if they are inevitable and that at level 5 no-one will have to do any driving. I was not here for the Volvo presentation, but I know from speaking to other vehicle manufacturers that they are not ready to give people vehicles which they hop into as passengers if people still demand to be able to drive. We need to be thinking that level 5 vehicles in the future may very well be vehicles that allow people still to drive. The fundamental issue at that level and with level 3 automated vehicles, where the car is not capable of driving autonomously all the time, is that if people are exposed to technology for long periods they can lose the ability to drive safely. I have experienced that. As someone who recently sold the car and rides his bike to work every day, when I hop back into a car, even after three months, my hazard perception skills are not as good as they used to be.

The second point to make is that research is critical to underpin our understanding of human interaction with autonomous vehicles and automated vehicles. In the submission I have set out what I think are some of the key research priorities based on the fact that I sit on a number of international committees, I have read a lot of literature and I understand that if we do not do this research we could end up with cars that are not acceptable to users, that compromise their safety and that may not yield the ultimate safety benefits that we would like to have. Much of the research we can do in Australia. One of the unique things about this development in automation is that it is now within the realm of not just the vehicle manufacturers; start-up companies and all sorts of groups are working on this. So, as a consequence, the start-up companies in particular might not be as aware of human factors guidelines, standards and other resource documents that are needed to make sure we design the automation appropriately. There is a lot we can be doing in Australia to support local businesses and start-ups, for example, that want to develop vehicles and technologies. They are the key messages that I wanted to get across. Thank you.

The CHAIR: Thank you.

Mr ADAM CROUCH: Professor, you mentioned aircraft travel. Obviously there are collision avoidance mechanisms in aircraft. There was a push back from the industry originally, when automation began to take control away from pilots. Day-to-day travel by car en masse is very different. It is a different skill set. The concern has been raised about the degradation of human skills. The more automation we put in the car, the less the driver becomes aware, whether deliberately or over time. What is your professional opinion on how we tackle that? How do we tackle the skill degradation that we could see in drivers as automation becomes the norm?

Professor REGAN: I was thinking about that at about midnight last night as I was finalising a section of a report on exactly that topic. There are a couple of ways in which you can probably deal with that. One would be that you could put in place a regime, and I have not thought exactly how it would work, within the licensing system that requires people to periodically drive the car manually. This is exactly what they do in aviation—

Mr SCOT MacDONALD: CPD.

Professor REGAN: Yes, exactly. Basically there is a requirement, a schedule that they have, that they take control of the vehicle at certain stages of flight, typically in the stages that are safest. The second thing that you can do, of course, is that asin aviation you can bring in people and test their ability to perform driving manually. They do that in aviation and bring them into simulators. So you have got another mechanism by which you can access their ability to drive manually. Thirdly, you could have log books and things like that, that will not be so particularly effective but it could be a requirement that people log the number of hours that they drive manually over a certain period to maintain currency. I think there are different ways of skinning the cat, and I have not really thought deeply about the complexities of them, but I think they are probably the main ways.

Mr ADAM CROUCH: Are you aware of any of those sorts of studies or applications being applied outside this country or in other States in Australia apparently where people are looking at exactly what you just said?

Professor REGAN: I know the Department of Motor Vehicles in California has been grappling a bit with this issue. I am not sure where they are at in terms of deciding how they are going to deal with it. The aviation industry is probably the industry that I think is the one that we can look to in this area. The contact I have is Dr Simon Henderson, who is currently the Fleet Manager for Virgin Airlines. He was one of the experts that we consulted on this project that we are working on for Austroads so he has some ideas in that area.

Mr SCOT MacDONALD: Do you have some general comments about heavy vehicles?

Mr WALDRON: Starting off with the safety performance of heavy vehicles in Australia, it does not often get talked about as bluntly as I am about to put it, but we have here 5.3 per cent of the national fleet, and 18.8 per cent of the deaths and injuries. When you come to articulated trucks you have got 0.5 per cent of the national fleet and 10 per cent of the deaths and injuries. If you divided that into the $30 billion a year cost of not having road safety in Australia you would come to the conclusion, talking about user-pays, that each one of those articulated vehicles ought to be charged on average $30,000 a year for their share of road trauma.

One of the things that concerns me is that the technologies that we are talking about to go into light vehicles are already available, particularly from the European heavy vehicles. But I am told by the companies that supply these vehicles that it is somewhere between 10 per cent and 20 per cent of new trucks get any of these systems—I am talking about the autonomous braking, lane departure, those sorts of things, even stability control. There is a huge opportunity just to implement the technologies that lead towards automated driving.

Mr SCOT MacDONALD: What is the difference in cost between a new Volvo heavy vehicles with those aspects and small vehicles?

Mr WALDRON: You should ask Volvo. My guess would be it is in tens of thousands of dollars, not in hundreds of thousands of dollars, if you like. But I can tell you in terms of the trailer, a trailer with stability control on it costs about $2,000 more than one without. One of the biggest trailer manufacturers told me recently that less than 20 per cent of the new trailers that they are supplying at the moment are being specified with stability control. We have approximately 365 or 368 truck rollovers nationally a year and, of course, with some consequent deaths and injuries associated with those and that is mostly the rear trailer is turning the truck over. So it is falling over and then it turns the whole rig over. Fundamentally, $2,000 worth of technology on the trailer could prevent a lot of crashes.

Mr SCOT MacDONALD: To be fair to the B-doubles and the triples, they might do 800,000 kilometres a year. So without getting into an argy-bargy over heavy vehicles and their fair user-pays, do you think we will be able to finesse it to be equitable and fair?

Mr WALDRON: It depends on what is fair. If an industry is contributing that much to the cost on the community, that would be the price, would it not? I am not greatly impressed with anyone from the heavy vehicle industry saying "But the crash was not our fault", "The car driver got in the way" and that type of thing and "It was not our driver's fault". The reality is that when a heavy vehicle crashes and is involved in a fatal crash, about 75 per cent of the time it is not the heavy vehicle driver who dies, and there is usually more than one fatality—I think it is 1.3 or 1.4 fatalities in a heavy vehicle crash the outcome is related to the heavy vehicle being in the crash, and that is the place to treat it.

Mr SCOT MacDONALD: Is your message that there is a lot of discussion around the small passenger vehicles but we need to be very mindful and put a lot of thinking into heavy vehicles and all this technology?

Mr WALDRON: Indeed. I think you will get a disproportionate benefit the more heavy vehicles that are equipped with these technologies. I would then go on to point out—and I pointed this out in my opening remarks—that Australia spends twice as much per dollar of gross domestic product [GDP] on transport as the average OECD country. So we are already internationally uncompetitive. I heard the other day from a freight forwarding association that about three-quarters of the cost of transport for an exporter is land transport costs in Australia. So the shipping and the land transport at the destination are only one-quarter or one-third of the total, and land transport in Australia is largely done by truck.

Mr SCOT MacDONALD: So there is role for these technologies we are talking about to address some of that competitiveness.

Mr WALDRON: Indeed, and if you could go completely driverless you would get about a 40 per cent saving in the cost of running a truck. There would be other savings as well because you would also get improvements in load factor because obviously a truck that does not have a driver does not need a cab. You can put a tonne of payload on the front axle where the cab was and the truck can run 24/7 so you actually need less vehicles. All those sorts of issues come to play that would build some efficiency back into that system.

The CHAIR: Yes, that takes us into another realm beyond our Committee's terms of reference.

Mr NICK LALICH: In relation to the cost of freighting in Australia compared with OECD or European countries, three-quarters of Europe could fit into Australia. If you added the cost for every country you go through and you paid their costs it would probably far outweigh what is paid in Australia. I am wondering whether it is because of our distance—we could travel from one end of Europe to the other just to get to another State in Australia.

Mr WALDRON: The tyranny of distance and the nature of the things that we export are both major factors in that. However, for our international customers that does not matter. It is the price they pay.

Mr NICK LALICH: One of you advised the Committee that the New South Wales Government needs to eliminate barriers and create an agile legislative framework to introduce driverless vehicle technology. What are the key features of an agile legislative framework? Do you suggest that, apart from the certifying and safety of automatic vehicles and the safety or road users, the State Government should keep right out of it and let the car industry let its hair down and do what it has to do to get this technology up and going?

Professor REGAN: I think I will go back to where I started. We should have a risk-based framework and invite industry to participate in the development of the rules that govern it, and to ensure that the technology providers—the vehicle manufacturers and so on—are acting responsibly, rather than try to regulate what the technology is, how it does it, and so on. We are not at a landing yet on what will be the optimum technology; it will keep evolving. As soon as we lock into something we will be locked in for a long time.

Mr NICK LALICH: You do not want to hamstring industry?

Professor REGAN: It is not just the industry, it is also the benefits that we get from it.

Dr MEHREEN FARUQI: When we look at driverless heavy vehicles we must also look at rail freight and do a cost-benefit analysis because that also has safety benefits. I refer to the impact of driverless cars on public transport. A few people have said that as cars become easier to drive more and more people will leave public transport. Has any research been done on the impacts on public transport?

Professor REGAN: They are the sorts of issues we are looking as part of the national public opinion survey. We are trying to get a handle on how people feel about precisely that issue, among others. I am not aware of any Australian research looking specifically at that issue. One of my major frustrations—but conversely it is a source of excitement—with this issue is that much of what we are talking about is pure conjecture. We have no idea how this technology will unfold; we cannot make predictions about a reduction of 70 per cent in the number of vehicles on the road. We cannot be sure that will happen; much of it is speculation.

Dr MEHREEN FARUQI: It makes for interesting research.

Professor REGAN: Yes. However, if you did the reality test you would have to ask yourselves what you would do if you could catch a train from point A to point B or have a car with a nice, quiet cabin pick you up. What would you do?

Mr WALDRON: For a lot of our commuters a train is a driverless vehicle. It confers most of the advantages of being in a driverless car, although you might not have a seat for part of your journey or you might be cramped compared with a car. It comes back to that economic framework. As I said, the Government should be a couple of moves down the chess board in looking at what we want to achieve. Achieving the best economic outcome—and I use "economic" in the broadest sense—is what we are here to do. How can we achieve behaviour and consumer decisions that will achieve the best outcome?

Dr MEHREEN FARUQI: But surely we must look at economic outcomes as well as societal and environmental outcomes.

Professor REGAN: There is also the human factor. If you have a driverless car that can get you to where you want to go but the train is 10 times faster, you would probably want to take the train. I used Uber last night. People say that one of the reasons they do not use Uber for business travel is that an Uber vehicle cannot use the bus lane during peak periods but a taxi can. They are the human decisions that people make when choosing modes of transport.

Dr MEHREEN FARUQI: Some reports suggest that autonomous vehicles get confused around cyclists and that cyclists and pedestrians are sometimes not recognised as vehicles. The Motorcycle Council of NSW raised the issue of the technology used in driverless cars not being able to detect motorcycles as well as other vehicles. What is your view and should there be more research on safety for vulnerable users?

Professor REGAN: I do have a view on that. I am a psychologist not an engineer, but I have read some of this literature. I recently spoke to Dr Steven Schladover in the United States, who is probably one of the world experts in vehicle automation. He does not believe that an autonomous car will be able to operate as safely as a human driver possibly for 60 years. Of course, there will be shuttle buses and other level five vehicles that will be able to operate much earlier than that; we already have them on the roads. One of the problems with automated vehicles is that they are driven by algorithms and they are only as good as the people programming them. They cannot predict the intentions of road users such as motorcyclists and pedestrians as

well as a human can. Their sensors are able to detect that road users are out there, but not always their intentions.

If a car cannot anticipate what will happen in the future, it makes it very difficult. Of course, they can react to potential conflicts, but the smarts in an autonomous vehicle are in their ability to anticipate. If you are driving a car on the road and you see a mother on one side and a child on the other, what do you do? Your instinct is to slow down because you think that the child could run across the road to the mother. That is anticipation. These are very subtle, perceptual cues that people use to avoid conflict. They are the sorts of things that have to be built into cars; they must make those decisions. I mentioned in the submission that the Google car was not able to predict the intentions of a bus; it thought that the bus would yield. Everyone knows that buses do not yield to anyone; they do not have to. They are not in the danger that we are as vulnerable road users.

Dr MEHREEN FARUQI: That ties into the issue of liability and insurance. A few submissions have raised the issue of who is liable at levels three and four and how CTP insurance works. Do you have any views on that?

Professor REGAN: One part of the report we are writing at the moment is dealing with exactly that topic. I am not an insurance expert, so we had to talk to a number of people about that. The insurers would like to change the scheme ultimately to what they call a first-party scheme. That means that it will not be up to someone who injures a person in an autonomous vehicle to go to court to prove that it was or was not their fault. The insurers are hoping that an ordinary person will be able to go to their insurance company and all the work involved in sorting out who is liable will go on behind the scenes. It will be a more seamless structure than it is at the moment.

Of course, the big issue with driverless vehicles is being able to determine when the automation was activated at any point in time because you need to be able to do that to assess issues of liability. However, even that is not enough. We are told that one of the big problems in aviation is that people often could have resumed control of a situation manually but did not do so because they trusted the system. In the end, the automation fails, but it might not have failed if they had resumed control and if they had not had so much trust in the system. That raises other issues of liability because that person could see a situation unfolding and from experience they could probably have controlled it, but they let the automation do its job. Many accidents have occurred in aviation for precisely that reason. It is a very complicated area, and it is probably best that is sorted out behind the scenes.

Mr WALDRON: Tesla had a recent example of that. It has an automated driving system and one of its customers in the United States was driving a car on autopilot and ended up running into the car in front and blamed the car. When Tesla looked at the records, it was established that seconds before the accident the driver had touched the brakes. Of course, as happens with cruise control, the system put the car back into the hands of the driver. The car was no longer doing the driving; it was no longer an automated vehicle. However, the driver did not realise that they had disengaged the automated features. That really goes to the heart of the question of who is driving this car now. You can figure out the liability with the facts after the event, but that misunderstanding between man and machine is definitely a problem.

Professor REGAN: I think the other major problem we are going to find—and they have found this in aviation too—is that people can conversely take back control of automated vehicles in this case when in fact the vehicle is better capable of dealing with a situation. In psychology we call this calibration. There is a lack of calibration there, for whatever reason. I suspect that maybe younger drivers are going to be less calibrated in understanding the conditions under which they should and should not take control of a vehicle, if they have that option. It is a line of research I will be doing in Boston in the United States in a few months' time.

Dr MEHREEN FARUQI: When is your report coming out?

Professor REGAN: It will be delivered to Austroads at the end of July and then it goes out for peer review within the Austroads community. I think it will be available a couple of months after that.

Dr MEHREEN FARUQI: Thank you.

The CHAIR: I want to explore a little the issue of cooperative intelligent transport systems and the infrastructure requirements. We recognise that connectivity with other vehicles and infrastructure is critical to the success of automated vehicles. Australian Driverless Vehicle Initiative proposed that existing infrastructure will have to be prepared for partly automated vehicles so that there are roads which can be read. Can you give us an indication of the upgrades that you might consider necessary for the physical infrastructure?

Mr WALDRON: Similarly to Volvo we would expect that the first implementation is likely to be on motorways. They are generally built to a standard that is quite suitable for that sort of operation anyway—maintenance to ensure things like line marking and those sorts of things are managed at a reasonable level so the vehicle can see. One of the other things you would be looking for is some form of interaction between the operator of that road and the vehicles. I know with the trials in Sweden that the driver will not have an automated driving experience available to them if it is snowing, for example. The road manager will effectively disable the cars from operating autonomously because the conditions—it might be maintenance on the road or whatever—indicate that that is not a good idea. That sort of communication would be valuable even in those early or introductory phases of market development.

The majority, however, of the technology that will be worthwhile putting into the infrastructure—and it is predominantly the electronic variety rather than the physical structure—is more to do with the opportunities to get better performance in terms of congestion. So that would be where the road actually helped the vehicles platoon so that they could close up the gaps between them and operate more or less like a continuous train with communication between the vehicles but with the infrastructure brokering that sort of arrangement. And so for that purpose or certainly for congestion there is a good reason for doing it, but the vehicles will have enough sensors of their own to operate safely without the infrastructure having that investment if it is not worthwhile from an economic point of view to put it there.

The CHAIR: Thank you. You mentioned disabling of the systems. That takes us back to a question that was asked earlier about the skill level—I think it was Professor Regan talking about some form of reinforcement that might have to be imposed. That particular statement you made would suggest that it would be possible to disable systems on a regular basis—perhaps every quarter or half year—so everybody has to take control of their vehicle in order to reinforce their skills.

Mr WALDRON: Interesting thought.

The CHAIR: That could well be built into the system.

Mr WALDRON: Yes, it could be.

The CHAIR: If there are no more questions, I thank the witnesses for appearing before the Staysafe Committee today. Thank you for your submission.

(The witnesses withdrew)

(Luncheon adjournment)

MICHELE HUEY, Group General Manager—Strategy, Transurban, affirmed and examined

The CHAIR: Good afternoon and welcome to this afternoon's session of our inquiry into driverless vehicles and road safety in New South Wales. I would like to welcome the witness Michele Huey and her associates. Thank you for appearing before the Staysafe Committee to give evidence today. Before we proceed, do you have any questions concerning the procedural information sent to you in relation to witnesses and the hearing process?

Ms HUEY: No.

The CHAIR: Before we proceed with any questions may I confirm that you would be happy to provide a written reply within 10 business days to any questions taken on notice, and to any further questions that the committee may have.

Ms HUEY: Yes.

The CHAIR: Thank you very much. I understand that you wish to make a PowerPoint presentation so we will relocate and allow you to do that.

Ms HUEY: Thank you for giving us the opportunity to share some of our perspectives on this very important topic. Before we get into the main body of the presentation I would like to spend a couple of moments providing a brief introduction about Transurban for those of you who may not be familiar with our organisation.

Transurban is an Australian-owned, publicly-listed Australian Securities Exchange [ASX] organisation—part of the top 15 listed entities. We started as a special-purpose vehicle in the 1990s for the purpose of CityLink in Melbourne. Since then we have expanded our footprint and our operations across jurisdictions, mainly in Australia—Sydney, Melbourne and Brisbane—and also in the Northern Virginia area in the United States. We have the privilege of serving five million customers globally, most of them in Australia. We do that by providing tolled motorway services to these customers—consumers, road users and corporate freight logistics companies.

To provide you with a sense of the contribution that toll roads or motorways provide to the economy, KPMG recently released a study that estimated that the economic contribution directly from tolled motorways was around $52 billion, of which $14 billion was contributed to the New South Wales economy. In Sydney specifically we are involved in the ownership and operations of six motorways. Some of them we wholly own and operate—such as the Hills Motorway or M2 and the Lane Cove Tunnel. For others we cooperate with other investors and other operators, such as the Westlink M7 and the M5. All of our motorways form a part of the Sydney orbital network. In addition to some of the management activities we are also collaborating with the New South Wales Government to deliver some enhancements and extensions to that network. One of the major projects that we are focused on at the moment is NorthConnex, which is a nine-kilometre twin tunnel that will join the M2 at Pennant Hills, Wahroonga M1 Pacific Motorway.

Going to the main topic of the presentation this afternoon, I would like to share some of our perspectives on automated cars as well as the benefits that we believe advances in technology will bring to roads and transportation more broadly. When we think about advancements in technology in the sector we typically think about progress along three dimensions: technology, social changes and the policy evolution that enables some of this progress to be made. For the bulk of the presentation we will be focusing on the first two of these dimensions—technology and social adoption of these technologies.

Progress in the road transportation technology space is taking shape in many forms. Perhaps the most commonly reported or talked about form is in-vehicle technology. Functional automation such as cruise control, auto braking and parking assistance is becoming more and more commonplace in the modern models of vehicles that we see on the roads. All of those things are helping human drivers to make decisions and to have a better experience on the roads. More recently we have been involved in dialogues about the potential for mass deployment of self-driving vehicles, where the machine or the vehicle takes complete control of the vehicle that the passengers travel in. That promises to completely disrupt and transform the way that we think about transportation today.

Achieving these outcomes requires the adoption, testing and preparation of a whole range of different technologies. We are very familiar with some of these, such as cameras, computer vision, radar, lidar and global positioning [GPS] that help us with communication and navigation. But beyond the in-vehicle technology advancement that a lot of us are seeing, there is an understanding—as a road service provider we are investing a lot of time and effort in this—of what technology advancements need to occur in infrastructure for us to get the maximum input and maximum benefits. The roads that we operate are getting smarter, and with that smartness

comes better customer or road-user experience, better productivity or efficiency when it comes to how we use the physical assets—roads in this case—and, more importantly, safety outcomes.

Some of the examples that are becoming more commonplace when it comes to the capability that we are inputting into the infrastructure that we operate day today include things like real-time road condition responses, so variable messaging signs, variable speed management—all those things are being implemented a cross roads, not just our roads but the entire network. They promise to help with improving the use of those roads as well as the safety outcomes of the drivers on the road. The next challenge is for us to connect the two—in-vehicle connectivity and infrastructure. An example that Transport for NSW announced in April was a trial involving just over 100 heavy vehicles or trucks and their connectivity with traffic signals at about 100 of the city's busiest intersections, effectively using wireless technology for the heavy vehicles to connect and synchronise with the traffic lights in a way to see if we can reduce the number of truck stops, which would hopefully improve the overall traffic flow not just for the trucks but also for all road users. These kinds of trials will help us to explore where the opportunities lie for us to leverage the technology.

While we explore the technology and it is very fascinating, we believe the more important focus is on understanding the benefits of these technologies. Perhaps the most important and most relevant one for this Committee is in the space of road safety. Every year, 1.3 million people die and more than 50 million people are seriously injured across the world on roads. In Australia for the 12 months leading up to February 2015 over 1,200 fatalities were experienced on our roads; in New South Wales over 350. The number of seriously injured is considerably more than those figures. The cost of road incidents—whether in the direct form of health care, rehabilitation, property damage repair or emergency service deployment or in the indirect form of lost productivity, lost output, disruption to traffic—sums up to hundreds of millions or billions of dollars.

An estimate was provided in Australia of an annual number around $27 billion being the indirect and direct cost of road crashes. Sadly, the majority of these incidents involve some form of human error. In this submission that we provided to the Committee there was a very conservative reference that around 75 per cent of road crashes are attributed to human beings. In other research and studies in the UK and the United States, we see that number being closer to 90 per cent or even 94 per cent. That means that a significant amount of impact would be addressed by improving safety on our roads and the performance of drivers. The introduction of connected and autonomous vehicles promises the potential to do that by significantly removing the risk involved in human decisions while driving. All of us are aware of some of the challenges of putting humans behind the wheels of cars because of factors such as driving under the influence of alcohol or drugs or being in a hurried state of mind when bad decisions get made. More recently what is becoming more concerning is distraction of phones and messaging while driving.

Early research by the Virginia Tech Transportation Institute, based on Google's self-driving car, which has recently completed 1.5 million miles of driving in various locations in the US with mixed real-life traffic, has indicated that connected and autonomous vehicles have the potential to significantly reduce the frequency of crashes and, if crashes do happen, the severity of these crashes. Taking away some of the human factors I highlighted is one form of doing that; obviously, technology needs to learn a lot about the different combinations and permutations of road conditions and there is work in progress to do that. But the promise is quite vast. A recent report by PricewaterhouseCoopers indicated that connected and autonomous vehicles could reduce road crash incidents by a factor of 10.

Beyond the safety impact of vehicles, technology progressing infrastructure is also helping us to address some of the road safety risks on our roadways. Incident prevention measures like over-height vehicle detection that stops an over-height vehicle from entering a tunnel, variable messaging and variable speed signs that control and respond to incidents on the roads and real-time road conditions are things that we are progressively deploying in our roads. They help road users and drivers to respond in real time to changing conditions. The next challenge for us as an infrastructure provider is to work out how to send these signals and messages to connected and autonomous vehicles not in the way that a human driver visually receives and responds to these signals traditionally.

In the United States 15 states have over the past years made autonomous driving legal. I am sure the Committee would be aware that in Australia various neighbouring states—South Australia, Queensland and Victoria—have also progressively explored opportunities to make preparations for the introduction of these technologies, whether through legislative change or physical trials that the States are involved in conducting. In the United States in November 2015 Transurban partnered with the Virginia Department of Transportation, Virginia Tech university, as well as mapping specialist HERE, to conduct the Virginia Automated Corridors initiative. It was the first test of automated and connected vehicles on the northern Virginia roadways. As a bit of background, the 95 express lane, which is a managed motorway that we operate in the United States, was chosen as a safe environment in which to conduct the trial. The express lane is a controlled environment with a

high quality of road surface, good quality lane markings and a free-flowing motorway condition that potentially presents vehicles under trial conditions with fewer complex factors, such as pedestrians and cyclists, than they would otherwise have to negotiate.

The demonstration of the trial features an autonomous vehicle performing specific driving functions, such as lane change, detecting different driving conditions and automated braking in response to changing road conditions. I will now show a segment of the video footage of the autonomous vehicle undertaking the trial. You will notice that the vehicle is a Cadillac. The trial starts with the driver assuming control under manual driving conditions. You then see the driver activating the automated vehicle control. The vehicle effectively now controls the speed and the lane position, as well as monitoring the environment that it is driving in. That includes approaching safely and changing lanes in response to vehicles that are driving at different speeds or responding to a law enforcement vehicle that has pulled up on the side of the motorway and choosing to safely change lanes, allowing a greater distance from the law enforcement vehicle.

The next situation that you will see is a simulated work zone. The vehicle executes emergency braking when it senses that a worker is approaching live traffic. This allows the worker to be let safely through. It brakes at an emergency in an automated way to ensure that the environment is safe for both the worker in the construction zone as well as the vehicle passengers. Undertaking these kinds of initiatives gives autonomous vehicle manufacturers as well as infrastructure providers real-life conditions under which to test these technologies and work to refine them before they can be safely and adopted introduced into day-to-day use.

Beyond the safety elements of autonomous vehicles, we believe that technological advances promise to reshape the way that we think about capacity on our roads. Without taking too much time to talk about the technical aspects of motorway operations, we typically think about the capacity of the road network as being how many vehicles can pass through per lane per hour. On a free-flowing motorway 2,000 vehicles per lane per hour is the maximum or the capacity with human driving conditions. That limit is usually reached during morning and afternoon peaks, when there is congestion. Usually it is worse when there are incidents or breakdowns or accidents on the road. Autonomous vehicles, including platooning vehicles that are connected using technology so that they can travel at much higher speeds, with a shorter distance in between vehicles and without compromising safety, promise to significantly lift that capacity. In a dedicated lane autonomous connected vehicles can travel at a much higher speed, up to 4,000 vehicles per lane per hour. That significantly increases the capacity, reduces congestion and improves the experience of road users. The capacity increase is certainly relevant for our urban developing economies, including Sydney.

Another area that we believe could be significantly improved is the environmental and material usage. Recently the European Truck Platooning Championship was held. Cross-country platoons of trucks travelled from Germany and Sweden to the Netherlands. That trialled various types of truck platoons. Reportedly with slipstream effects and an improvement in labour and logistics planning, they experienced a 10 per cent to 12 per cent fuel efficiency improvement. That is not counting the labour and logistics improvements that you could expect to see from making these technologies work.

We believe it is very important to also understand human reaction and human preparedness to adopt the technology. As the population grows and ages, demand on travel and mobility will increase. That puts pressure on us as a society to come up with innovative solutions to meet those needs. One of the things that we are observing beyond population growth and the expansion in the absolute level of need is the type of travel used and the attitude of travellers, especially the younger population. We believe that the younger population are demonstrating a social shift away from the need to own a vehicle or to have ownership of an asset or to hold a driver's licence. They are moving towards being able to access mobility services. That includes taxis, public transport and potentially newer forms of personalised transport such as Uber and other things that the advancement of technology could afford.

We have seen evidence of this in the number of people obtaining a driver's licence, which has been steadily declining. The trend is not as stark in New South Wales as in Victoria. It may be partly explained by social attitudes towards other forms of transport such as public transport, walking and cycling. We believe the trend is there. We need to be prepared for that. We find that younger drivers, rather than having the ability to drive and needing to own a car, are happy to access mobility services and to share them with fellow travellers if it is economically better for them to do so. Extending the time horizon and thinking about what technology can do, we can see a future where there are robo taxis. These would be autonomous vehicles without a human driver. They could be driving around and responding to the demands of travellers. They could serve unmet travel needs of the younger population who do not have a driver's licence, the older generation who are no longer able to drive, and the visually impaired or physically challenged segments of our population. The potential is huge.

Many different views have been presented on how quick the pace of change will be, what form it will take and what it means for travellers on our roads and the network that we need to provide. The presentation provides a very small sample of the differences and opinions on the uptake, the pace of change, how quickly it will penetrate our existing fleet of manual vehicles but also the form it will take. Smaller scale personalised transport like the robo taxi would solve the last mile issue that passengers are presented with when they reach the end of a bus or train line and have to find their way to their door. The truck platoons that I mentioned could significantly change the efficiency of the freight industry and the logistics sector.

When we combine these different trends—some working for and some working against—we need to think about the potential outcomes in overall vehicle miles travelled. On the sharing side, collaborative economy would be likely to improve the utilisation of vehicles. That is great for the environment and for the economics of the traveller. At the same time, offering autonomous vehicles as a solution for people who cannot currently access transport may drive up demand from unserved travellers with unmet travel needs. We are open to the outcome and we are very excited about what technology can potentially offer us.

These changes need to be enabled by the right legislation and policy. We appreciate that all levels of government are working actively to ensure that we leverage technology to get the right productivity improvement the right outcome and the right experience for the community. We are very excited to be part of that. We will look for any opportunities we can to support and contribute to further studies on that. We believe motorways are a prime candidate for the facilitation of the trials that need to be undertaken before the mass adoption of the technology. On a free-flowing motorway there are good quality lane markings and a good quality road surface that allows for autonomous and connected vehicles to be tested in a controlled environment. The future of transport is disruptive yet very exciting. Very considered and very proactive planning needs to be in place to ensure that we are prepared for the changes, and Transurban will welcome the opportunity to be a part of that planning.

The CHAIR: You recommended that haulage vehicles are used for the introduction of driverless vehicles on Australian roads. What are the benefits of that over other types of vehicles? Can you identify any disadvantages if haulage vehicles were not used first?

Ms HUEY: Let me work through that question in sequence. From our perspective we believe that there are a lot of opportunities—and I covered some of those in the presentation—that autonomous vehicles and a platooning format of travelling could bring from being able to leverage the physical roads that we have in a much higher capacity through platooning, travelling at higher speeds with smaller distance in between them, some of that—the recent European truck platooning challenge proved it can be worth that. The other opportunities would be in the fuel efficiencies phase, labour saving, productivity and logistics planning improvements that give flexibility to when a platoon travels, let us say interstate or at great distance, and when it approaches where it needs to do drops and delivery it can actually break up into smaller parcels. That gives us flexibility in terms of improved response times as well as the delivery destination.

It is not the only area where we believe we can get benefits out of autonomous vehicles and the technology that we can leverage but it is certainly an area that in a controlled environment, with a smaller number of logistics companies, it will be easier to make sure that the technology is adopted. Some of the disadvantages when we think about that, obviously in the transition stage—and it is very important in the road safety phases— is thinking about how platoons such as truck platoons get introduced into mixed traffic. That is exactly why we believe we need to do more tests. We need to do more controlled environment studies before we can actually mass adopt the technology. Some of the examples that we are seeing in other geographies that are being tested is how they introduce some of these haulage or other platoons into dedicated lanes. So rather than having the mix in live traffic with human drivers, who we know behave in a different way to what a machine would algorithmically make decisions on, it is to protect it and separate it through a dedicated lane solution.

The CHAIR: That is where I wanted to head next. Was the trial in Europe in April under those conditions with dedicated lanes?

Ms HUEY: It was not. Most of the trials involved six different trucking companies in live traffic. In Germany they used the autobahn. Obviously there is significant planning around making sure that it is not done during heavy peak traffic, making sure that there is enough communication to the broader road user community so they know that it is a championship and a test that is being trialled. We are even more conservative than that in thinking that the first study we would do is we would not introduce it into live traffic. We would look for opportunities where it is off peak, it is a weekend, so we are minimising the disruption to normal road travellers before we introduce the kinds of trials that we are thinking about, similar to the way that we have undertaken the trial in the United States with the express lane.

Dr MEHREEN FARUQI: You have recommended that regulation be put in place for dedicated lanes when we introduce driverless cars. How will dedicated lanes for autonomous cars simulate the real world? It would not really get other road users used to them. What is your thinking behind that?

Ms HUEY: Ultimately, depending on what study or what research we refer to, the penetration of autonomous and connected vehicles is going to get to the stage where it reaches critical mass, it reaches the majority, so it will be mixed into mixed traffic. Our view, taking a very conservative and moderated approach, is let us test out the technology and test out how humans behave in that technology before we open up the technology and expose it to mixed traffic. When we think about proposing changes, legislative or policy—we are certainly not policymakers—to allow for dedicated lane testing, it is a transition state that we have in mind.

Dr MEHREEN FARUQI: Do you think you will propose that for New South Wales if we went ahead with the trials?

Ms HUEY: We would very much welcome the opportunity to partake. We know that we are not the only ones who need to be involved in thinking about that. It is an idea that we would offer as something to consider but we would also be very happy if there are other ideas that we would like to explore in collaboration with our government as well as our industry partners and stakeholders.

Dr MEHREEN FARUQI: One of your graphs referred to the drop in the number of licences. I have two unlicensed young adults at home who rely on public transport. I think one of the reasons Melbourne has fewer licences is because of its better public transport. I have asked this question of other witnesses. I know that your vested interest is in roads obviously but have you thought of the impact of driverless cars on public transport? What are your views about that?

Ms HUEY: From the perspective of Transurban, we know we operate roads and we certainly hope that roads offer a value proposition to users, but we would never think that road is the only solution. It is not the only solution that needs to be part of the system of transportation. So we absolutely welcome investing in other forms of transportation and infrastructure. When we think about autonomous vehicles we think of them as a complement to other types of transportation. So the example that is commonly talked about is the last-mile solution, which is as urban areas grow, as residential areas get developed, sometimes trains, buses and those kinds of transportation take time to get to where the development is. So very often we face the last-mile challenge, which is when the train or bus stops people still need to find their way to their home doorstep.

Autonomous vehicles, in a smaller scale pod-type environment, could be a potential solution to that. One of our neighbouring States, Western Australia, has announced that later this year it is going to trial an autonomous vehicle pod, which is actually a pod that has been manufactured and is being trialled in other places in Europe as well, to see if they can run a last-mile type solution for some of their more regional or residential areas.

Dr MEHREEN FARUQI: Would that pod be a big, automated, no-driver vehicle?

Ms HUEY: That is our belief and understanding of what the trial will be. Obviously they will be monitoring through a control centre, no different from the way that we monitor our traffic on our motorways as well.

Mr NICK LALICH: Transurban owns most of our highways. Volvo and other submissions have indicated they would like to have a dedicated place to be able to trial these vehicles. As the owner who knows the roads from back to front, do you have in mind a place that would be appropriate for the Government to direct these tests?

Ms HUEY: It is certainly a very welcome opportunity. From a concept perspective, we absolutely agree that motorways, by simplicity, by the quality of the conditions of the road, is the ideal candidate for trailing that. We would need to work with our Government, partners and other industry partners on working out what is the right place to provide for that. Obviously it depends on the kind of trial that we need to run, the distance we need to have, as well as the time and the day conditions that we need to have. We have a few ideas around the motorways. You are familiar with the motorways that we have, but the examples that we have obviously would include open roads like the M7 and the M2, and potentially also tunnel environments such as the Cross City Tunnel or the Lane Cove Tunnel, where, for example, global positioning satellite systems may not work as well. It is important for us to test all those environments before some of these technologies are mass adopted.

Mr SCOT MacDONALD: I refer to the Transurban express lane. Is there a means to give an economic signal to automated vehicles so if on your network it works, sharing vehicles, heavy vehicles or

whatever they might be, offering some sort of economic incentive to adopt AV and reduce congestion and to do more sharing and things like that?

Ms HUEY: In our express lanes in the United States—without dragging you into too much detail—how the equivalent of the concession arrangements are is that high-occupancy vehicles, in this case defined as having three or more passengers, travel for free. The Virginia Department of Transport's policy is to encourage car sharing. The arrangement we have with it is that three-plus, high occupancy vehicles can use the express lane. That provides reliability and, although it would not be zero, a managed congestion experience for free. If it is the right incentive—economic or otherwise—we would work with the Government find the right solution.

Mr SCOT MacDONALD: In some respects Uber would be a bit of a risk to your business. There would be fewer cars on the road and fewer vehicles going through the tolls.

Ms HUEY: It is an ongoing discussion. From a Transurban perspective, the reality is that if this is a technology and a change that addresses a community need, we will support it. If the impact on the road is adverse or positive, Transurban will prepare for it. It is not something that we can control.

Mr SCOT MacDONALD: It will be disruptive anyway.

Ms HUEY: We want to be part of preparing for that. We believe that if we do the right thing by offering the right infrastructure for the community, the population will grow, economic prosperity will follow, and overall demand will grow. It may be offset by better sharing and utilisation, and that is great for the environment. However, if we are meeting the need, we should also be able to translate that into better long-term economic growth.

Mr SCOT MacDONALD: It is a win-win.

Mr ADAM CROUCH: Thank very much for your presentation. Obviously the video was made in North Virginia. Can you elaborate on what Transurban gained from the trials? What things were effective and what will need to be addressed in the future? How would you tailor that to road conditions in New South Wales? Are they similar?

Ms HUEY: The trial is continuing, so we showed footage only from the initial trial. We are hoping to continue that partnership. Most of the insights we gained as an infrastructure provider working with autonomous vehicle providers and other partners focused on the infrastructure we need to provide for manufacturers to make autonomous vehicles work. We are not Volvo and we are not planning to manufacture vehicles. We gleaned information about the quality of the lane marking, the clarity of what we call "roadside furniture—that is, lamp posts, signals, light boxes and so on—and being able to predictively communicate that or having the autonomous vehicle or the mapping technology to keep it in the library for the machine to recognise and react to it. They are the kinds of insights we have gleaned.

We have done a similar type of virtual reality study with another asset we have with CityLink in Melbourne. We have tried to map in a three-dimensional way what an autonomous vehicle would see on the road. We are already incorporating many of these insights. The conditions here are very different from those in North Virginia. The good thing is that we do not have snow and frost. Given a few different weather conditions and complexities, New South Wales will be in a better position to undertake the trial. At the same time, we also have very different conditions with the sun and other things. We would love to do more trials and practical studies in the environment in which we are looking to adopt the technology.

Mr ADAM CROUCH: You mentioned the furniture on expressways and motorways. Obviously you have extensive existing motorway connections orbiting the central business district and the M1 connection on the Central Coast, which I am particularly pleased about. Will it be an expensive exercise to upgrade or to change the existing furniture on motorways so that it meets the standards required by autonomous vehicles? Will it require a great deal of reworking, or does the existing network need only minor adjustments to meet those standards?

Ms HUEY: I probably need to take that question on notice to provide an accurate quantitative answer. However, at a conceptual level we would like to think that motorways are relatively simple and much less difficult in terms of complicating factors like pedestrians, traffic signals and so on. From a roadside furniture perspective, we are at a good starting point. Obviously there will be adjustments. Practical examples would be trees and branches. They are the things that a human driver will be able to spot and it will be easier for them to distinguish them. We will need to properly map and survey these things to understand their impact. We will need to make adjustments, but the expectation is that motorways will be relatively easier as candidates on which to deploy some of the testing and technology systems.

Ms ELENI PETINOS: Thank you for the presentation; it was wonderful. Your submission mentioned the safety benefits from automation in the aviation sector. Can you expand on that and explain how it is relevant to this inquiry?

Ms HUEY: I am not involved in the aviation industry, so I am sure there are much better experts to discuss this issue. However, in talking about autonomous and connected vehicles and what technology could bring to road transport, we looked to other sectors and industries to understand what insights and what knowledge they have gained. The aviation industry has undergone huge transformation in adopting new technology and safety standards. In fact, it probably started heavy automation and functional investments back in the 1960s. A recent survey was undertaken involving pilots across the globe. It estimated that a pilot in a Boeing 777 manually flies the aircraft—as opposed to it flying autonomously—for about seven minutes during a flight. It is roughly half of that time in an Airbus. When you think about the technology adopted by commercial aviation and the ability for it to complement, if not replace, human piloting, you realise the huge advances made in just a few decades. The number of human errors made in the aviation space before the heavy adoption of technology interestingly—and I am sure coincidentally—is in the ninetieth percentile. We hope that a similar investigation—obviously it would involve different technologies and different circumstances—into automated vehicles could lead to better connecting infrastructure and result in similar improvements in terms of safety on our roads.

The CHAIR: You referred to studies undertaken in North Virginia. The Committee is aware that the United States is approaching the introduction and management of driverless vehicles on a state-by-state basis. What issues have arisen as a result of that approach? What are your views on a national approach as opposed to a state-based approach in Australia?

Ms HUEY: We draw on a lot of insights and the history of other industries and sectors, whether it be rail or telecommunications, where a great deal of innovation has taken place in the geography in certain States. For us to have synergy, economies and consistency in the way we think about setting standards, eventually we need to look at these topics, and certainly at a state or regional level. The National Transport Commission and other government stakeholders are actively pursuing these questions. We are not in the policymaking space, but we would be keen to contribute to some of the discussion about how to ensure that we strike the right balance between finding a solution that is scalable and consistent across the nation, while at the same time recognising there will be different needs and conditions that must be catered for across States or within States around different geographies.

The CHAIR: Are you aware of any issues that have arisen as a result of perhaps a different approach to lane marking or the provision of street furniture in the United States?

Ms HUEY: I will probably need to take that question on notice and come back to you.

The CHAIR: Okay. If you would, it would be interesting to reinforce that desire to have a common approach if there is an element of confusion that has been recorded as a result of trials.

Ms HUEY: We will come back to you on that.

The CHAIR: Thank you very much for your wonderful presentation, for answering our questions and for your submission. Thank you for your appearance before the Committee today.

Ms HUEY: Thank you very much for the opportunity.

(The witness withdrew)

GEOFF ALLAN, Chief Operating Officer, National Transport Commission, affirmed and examined

MARCUS BURKE, Project Director, Heavy Vehicle Compliance and Technology, National Transport Commission, affirmed and examined

The CHAIR: Good afternoon and welcome, witnesses, to our inquiry into driverless vehicles and road safety in New South Wales. Thank you for appearing before the Staysafe Committee this afternoon to give evidence. Before we proceed, do you have any questions concerning the procedural information sent to you in relation to witnesses and the hearing process?

Dr ALLAN: No.

The CHAIR: Thank you very much. Before we proceed with any questions, may I confirm that you would be happy to provide a written reply within 10 business days to any questions that might be taken on notice or that the Committee might send you following this hearing?

Dr ALLAN: Yes, certainly.

The CHAIR: Would you like to make a brief opening statement?

Dr ALLAN: Yes, we would. Thank you very much, Chair and Committee members. This is a very important topic, obviously, for the National Transport Commission [NTC] and for this Committee. We are very pleased that the Committee extended the invitation to us. Given the role of the NTC and this Committee's terms of reference, I would like very much to focus today on reference 3—that is the preparedness of road safety regulators to meet the challenges extended by driverless vehicle technology.

To that end, I would like to talk very briefly about the role of the NTC—given it has been mentioned in a number of submissions and certainly by the previous witnesses appearing before the Committee—and how we work with States and Territories such as New South Wales to keep transport laws contemporary and up to date; secondly, how we work with international agencies to translate changes that are occurring overseas and work again with States and Territories to turn them into proposed reforms back here in Australia; and, thirdly, the process that led us to do work on driverless vehicle regulations and how we are working with jurisdictions in this area. I will then hand over to Mr Burke to talk about the reforms we are proposing related to automated vehicles.

Firstly, the NTC was established in the early 90s as the National Road Transport Commission—that is the NRTC—after a series of special Premiers' conferences. Our role was and continues to be national uniform consistent regulation of road transport. The role of the NRTC was expanded in 2003 to take account of a broader array of land transport issues and hence we became the NTC. The NTC is responsible for proposing national land transport reforms and legislative change. We propose reforms to the Ministerial Council on Transport and Infrastructure, specifically on ways to improve land transport productivity, safety, regulatory efficiency, heavy vehicle charges and on ways to improve national consistency.

The council is obviously a Council of Australian Governments [COAG] forum, comprising Ministers from States, Territories, the Commonwealth and also the chair of the Australian Local Government Association. States, Territories and, to a lesser degree, local governments have constitutional responsibility for land transport matters and for most of the land transport reforms. Once those proposed national laws, model laws, codes, guidelines et cetera are agreed by Ministers and implemented by jurisdictions, we work with States and Territories to maintain them—that is, we work to keep them contemporary and consistent with their policy intent in light of changing technological, market and community circumstances and expectations.

In relation to laws, regulations and other instruments that are influenced by international developments, we have a process to monitor what is occurring internationally and bring back those changes to Australia and apply them in appropriate circumstances. For example, when the United Nations updates its model regulations on the transport of dangerous goods, as it does every two years, we work with States and Territories to incorporate those changes in the Australian model law and in the Australian dangerous goods codes and adapt them to the Australian context if needed. In doing so we work with transport officials and other officials involved in the regulation of dangerous goods. For example, in New South Wales we work with Roads and Maritime Services and Transport for NSW as well as WorkCover, the Environment Protection Authority [EPA] and the Australasian Fire and Emergency Service Authorities Council, which includes Fire and Rescue NSW.

The process we use to bring laws back to Australia and adopt them in a timely manner we like to call "timely incrementalism"—that is, tracking what is going on overseas and bringing it back to Australia. These incremental but timely changes allow Australia to keep pace with but not go ahead of the rest of the world—in

effect, to position Australia as a very fast follower on law reform. For automated vehicles, obviously, if Australia goes ahead of the rest of the world on laws, we could be compromising safety and potentially restricting markets, given we are now for the most part automotive technology takers. However, if we go too slowly we could also delay and miss out on some of the safety, mobility and productivity benefits that could be gained from automated vehicles.

I expect that in relation to driverless or automated vehicles the NTC would play a similar role of timely instrumentalism to ensure Australia receives the benefits of automotive vehicle laws through routine, periodic incremental updates of appropriate laws and regulations. To that end, my colleague Marcus Burke has been nominated by the Commonwealth to be an observer on the legal subcommittee on the EU-US-Japan Automation in Road Transport Working Group. Marcus can then work on the developments that are occurring in the rest of the world and bring them back to Australia to work with States and Territories and ask ministers to apply changes in Australia in a timely manner.

Finally, before I hand over to Marcus I would like to say that, as was noted in the submission by the New South Wales Government to this inquiry, and in an answer to a question on notice to Minister Duncan Gay in November last year, we were asked by the Ministerial Council to undertake a review to prepare for more automated road and rail vehicles and focus on identifying any legislative obstacles that might limit the uptake of automated vehicles in the future. To this end we released an issues paper in February, which we attached to our submission. Subsequently, after submissions closed in April, we released a discussion paper in May on options to improve regulations for automated vehicles. I would seek permission to table the report but I can see that a number of you already have it.

The CHAIR: Thank you very much; we have it.

Dr ALLAN: With that done, I will hand over to Marcus to talk about the detail of the report and the detail of what we are proposing.

Mr BURKE: Thank you for the opportunity to appear today. As Geoff mentioned, ministers asked us in November to examine the regulatory barriers to having more automated vehicles. There are a couple of key elements to note. We have used the term "automated vehicles" rather than "driverless vehicles" or "autonomous vehicles". That is intended to recognise that there is a spectrum of automation in vehicle technology, which we are already on today and which will likely lead to fully driverless vehicles in the future. There are different regulatory issues that arise as we move along that spectrum of automation.

The second element is that we are examining regulatory barriers—that is, we are looking at the emerging vehicle technology and how it would fit within Australia's legal framework, and how it would be supported. We have examined what areas of the legislation would potentially prevent the use of technology which can have significant benefits for the Australian community.

As Geoff mentioned, the NTC released an issues paper in February in order to outline the issues and gain feedback on them. We had 32 submissions from governments, automotive manufacturers, insurers, law societies and others. As Geoff mentioned, that was an appendix to our submission. I would like to mention a couple of issues that came out of that feedback. The first is the key issue of who is in control of the vehicle. I will come back to that a little later. The second is national consistency. There was concern expressed to ensure that there was a nationally consistent approach—in particular from vehicle manufacturers who wanted to ensure that there were not different requirements for products in different states within Australia, which could be a major barrier to the commercial deployment of this technology. We note that this issue has been raised in other submissions to your inquiry.

The third issue was the concern about international consistency—again, that was particularly from manufacturers in relation to vehicle standards. Specific requirements in Australia could act as a barrier. Other issues that were raised included safety, liability and privacy. I will come back to the issue of safety. As part of this reform we have also established an automated vehicles advisory group—a government advisory group, of which Transport NSW and Roads and Maritime Services are members.

Based on the feedback to the issues paper and further research that we conducted we published, in May this year, a discussion paper, which you have before you—*Regulatory options for automated vehicles*. The paper sets out 10 key issues or barriers, with options to address each of those issues. We have divided the issues into what we see as the necessary sequence and timing into "near term", "medium term", "long term", and a further category of "clarify and refine"—issues that we believe will require some ongoing monitoring.

We have also set out a proposed option to address each issue based on our research and feedback to date. However, these will be updated based on the submissions and feedback that we receive as part of the current consultation process. The issues, proposed options and timing are summarised on figure A of page 9 in

the discussion paper. That is flagged in the copies you have just received. That summarises the key issues of the proposed approach and the timing.

I will run through those very briefly. We believe that the key near-term issue to resolve is to ensure support for on-road trials, including national consistency where that is required. The second issue is to clarify the concepts of "control" and "proper control" in the Australian road rules. As an outcome this would allow Australia to support on-road trials for any level of automation and support the commercial deployment of conditional and highly automated vehicles on public roads.

We then identified a further set of medium-term issues. These include: the safety assurance framework for automated vehicles, to which I will return; clarifying the definition of "driver" and the obligations on drivers; and identifying responsibility for a vehicle at a particular point in time and associated enforcement issues. We believe that addressing these issues will allow the commercial deployment of highly-automated and fully-automated vehicles. Longer term, we believe that vehicle standards will need to be updated; however, we suggest that this should be done in step with emerging international standards as there may be requirements today—such as for steering wheels or rear-view mirrors—which may be redundant in the future. New standards around things like security might be required.

We then have a set of issues which we have described as "clarify then refine". These include changes to standards and processes for vehicle modification of more highly automated vehicles, liability in the event of a crash and privacy. A number of these issues revolve around data and access to data and how it might be used. We are seeking feedback from a wide range of stakeholders on the issues, including on whether the proposed approach for each issue is correct and whether we have the proposed timing and sequencing right. The discussion paper also describes the different levels of automation that are likely to be released. I assume that this has been discussed at length today so I will not go into detail.

From a regulatory perspective, the key point in terms of levels of automation is moving from relying on the human driver as a fall-back to taking the human driver completely out of the loop. Those two scenarios raise completely different sets of issues. As part of our consultation process we have held Government and industry forums in Brisbane, Sydney, Melbourne, Hobart and Perth, with further forums planned in Canberra and Adelaide. Based on submissions and the feedback we receive we will be making recommendations to Ministers in November, as Geoff mentioned.

I would like to highlight two particular issues—the issue of vehicle control and safety assurance. A key question is to determine who is in control of the vehicle, and hence who is responsible for the vehicle. Currently it is clear that the human driver is in control, but this will increasingly be in question as we move up through the levels of automation. The concept is illustrated on figure 3 on page 46 of the report. That sets out the different levels of automation, moving from partial to conditional, high and fully automated—and who would be likely to be considered in control at each of those levels. There are particular challenges there—in particular at the level of conditional automation, where the driver may continue to monitor but not have active engagement with the driving task. There are also challenges with respect to highly automated vehicles, where control may switch between the driving system and the human driver.

The second issue is safety assurance. Here there is a key decision for governments about what is the role for governments in this area and this technology—either to allow the technology to be rolled out based on current regulations or to more actively manage the deployment of that technology. A simple way to think about this is illustrated in figure 4 on page 55. We currently have certification of the vehicle, and then the vehicle's registration. We also currently license the human driver. There is a question about whether we need an equivalent licensing regime for the automated driving system, and if so what sort of test this would involve and what this would look like from a regulatory perspective.

One approach may be to require entities proposing to run highly or fully automated vehicles to demonstrate a safety case, as they do in other sectors. Some of the elements that would potentially need to be satisfied as part of such a safety case are set out in figure 5 of page 62 of the discussion paper. I will not go through all of them, but they include the potential for a provider to demonstrate that it can meet safety requirements, compliance with relevant laws, security and that it has appropriate insurance. This list has been generated for discussion and would obviously need further development.

Finally, a word on timing. Submissions on the report close on 4 July. We will then prepare recommendations, initially for the Transport and Infrastructure Senior Officials' Committee, in September, and then the Transport and Infrastructure Council, in November. As is set out in the discussion paper, there is very likely going to be the need for further work beyond November on a variety of issues. As noted earlier, the key issues we see as needing to be immediately addressed in the short term are to support trials and to clarify control. I thank you again for your time and look forward to answering any questions.

The CHAIR: The Australian Driverless Vehicle Initiative described driverless vehicle technology as "the biggest road safety opportunity in history" and predicted a reduction of up to 90 per cent of accidents combined with significant saving in reducing road trauma. To simplify what you have described to us through your discussion paper and introductory words, what are the preconditions for achieving that? Please pick a few examples to highlight.

Mr BURKE: The important precondition that we are looking at is the legal framework. We need a legal framework that allows that technology to be rolled out and used on public roads. As part of our work we did an audit of existing Australian laws to identify specific barriers in individual provisions. We published that as an annex to the discussion paper. We found 716 provisions, I think, across the country in different laws which would potentially present barriers particularly to the higher levels of automation. I will summarise some of the issues. There are the basic requirements around safety and ensuring that you drive safely, but there is a variety of other obligations that we currently put on drivers, which include things like obligations around the vehicle such as ensuring the kids in the back seat have seatbelts on and loads are tied down securely.

There is a variety of obligations around interacting with enforcement officers, such as handing documents to and following directions of enforcement officers. There are obligations around interactions with other road users, such as an obligation to stop and assist at a crash, for example. How would these work with highly or fully automated vehicles, where there may be no human driver present? We feel that there are changes required as a precondition to the regulatory framework to ensure that the intent of these provisions is retained, but they are potentially reframed in a more performance-based way to allow greater levels of automation.

Ms ELENI PETINOS: My question is around nationally consistent laws, which you touched on in your opening remarks. What safety benefits would nationally consistent laws offer? What are the risks of having a State and Territory-based approach? How can the Federal and State governments manage autonomous vehicles to ensure and maintain the best outcomes?

Mr BURKE: Was the first part of your question about the safety risks of inconsistency?

Ms ELENI PETINOS: Yes, what are the benefits from a safety perspective?

Mr BURKE: One that has been identified is that inconsistent approaches may prevent the rollout of this technology or delay its deployment, and hence we may miss out on some of the safety benefits including significant reductions in lives lost and serious injuries on the road. There may be specific risks that are created by inconsistent legislation. If the vehicle needs to know a different set of road rules in Victoria to New South Wales, that may create a source of error or of crashes through needing to manage different sets of rules in different parts of the country. There is a strong push from manufacturers to ensure that the manufacturers can develop systems that meet all obligations through a nationally consistent approach. One of the challenges is determining exactly what needs to be nationally consistent. We are obviously not going to make every law across the country exactly the same, so part of the challenge is identifying key elements that need to be nationally consistent and what could stay at a State level and be done in different ways.

Ms ELENI PETINOS: Do you have any views on what those elements might be that need to be nationally consistent?

Mr BURKE: In the short term we are starting to have some discussions around that, in particular for trials and the elements that may be different for trials. One of the two that need to be raised in particular is vehicle standards. We currently have a largely national approach to vehicle standards, but there may be exemptions in different States. If there are decisions through, say, new licensing regimes that are put in place that create different requirements for the vehicles themselves, that would be an issue from a manufacturer's perspective. The second area is the road rules themselves, which are largely consistent. The National Transport Commission develops the model Australian road rules and they are largely adopted in the same way in different States, but there are some minor differences. Those could create a challenge for manufacturers as increasingly it is the car that needs to understand and apply the road rules, not the human driver.

Ms ELENI PETINOS: Your submission notes that the level of involvement of the human driver can vary from brand to brand by manufacturer. Would you recommend consistency? If so, from a government perspective, can it be regulated and if so how? Would you suggest training, testing and licensing if there were to be different levels of human involvement in different car brands?

Mr BURKE: That is a really difficult question, because different brands have different mixes of technology that they use. They have different abilities and different limitations to what they do. They can sometimes be described in the same way, so you might have two brands using the term "autopilot" but what the function actually does and the expectations of the driver can be quite different. It would be a significant challenge to try to regulate that and to have consistent terminology and regulation around the technology itself,

because the technology is still evolving and we do not know the exact mix of different technologies being used in higher levels of automation.

That would be a significant challenge, and maybe some of these approaches looking at a performance or outcomes-based approach, where potentially a manufacturer and operator has to demonstrate safety levels and how they go about achieving that safety, may be done in different ways. That could be a better approach, but there are some significant challenges for manufacturers in how they communicate with and train drivers they sell vehicles to, to ensure that the drivers understand the limitations of the technology. For governments, in terms of licensing requirements, there are challenges as these could change in future as expectations of drivers change. I do not have a solution for that at the moment as it is a really challenging problem.

Mr ADAM CROUCH: Thank you for your expansive report and the discussion paper you have supplied today. Some of our questions are covered in the discussion paper, especially with regard to licensing. One of the Committee's concerns is drivers' training and experience, or lack thereof, as automation becomes more and more accessible. I was going to ask about driver training legislation and what we may need to put in place to ensure that drivers have the necessary skill sets moving forward. What would be your advice on that?

Mr BURKE: It is something that we are still trying to form a view on and gain feedback from stakeholders on. It may be in the future that, as well as having the option to obtain a manual or an automatic licence, there may be other levels that you allow drivers to have for higher levels of automation. The aviation sector was mentioned earlier. This is a challenge that it has faced. As you increase the levels of automation you are relying on the driver to be a fall-back. When you are going to fall back on that driver is in the most challenging, tricky situations, where the technology is not able to drive itself. That might be due to heavy rain or snow or bad roads or a variety of conditions. In that sense, even for the higher levels of automation you still may want the same training for drivers because when they are called upon as a fallback they still need all the skills that they have today.

That is a challenge as we move up those levels of automation and as driving becomes more of a monitoring task for the driver, rather than them being actively engaged. There are challenges for manufacturers as to how they deal with that. We know that some are looking at what they describe as driver vigilance controls. How does the manufacturer know, when they go to hand control back to the human driver, that the driver is in the driver's seat, awake and alert? Some are looking at different sensors to detect that the driver has their hands on the wheel or at cameras to monitor fatigue and whether the driver might be nodding off in order to satisfy themselves that they are managing the safety risks appropriately.

Mr ADAM CROUCH: There was a conversation earlier today about the option of having a mandatory driving time in a vehicle. Say it is an automated or semi-automated vehicle. As the driver, you have to spend a certain amount of time in unautomated mode. Do you have an opinion on that?

Mr BURKE: That is an interesting idea. It is effectively what is done in aviation. It is a challenge in aviation. Even though pilots are professional and highly trained—which is quite different from the situation with drivers out on the road—pilots still have a challenge to keep up skills over time, as they do not need to engage as much in the flying task. I imagine that it would be a challenge to manage and monitor those requirements. If a driver has access at home only to a highly automated vehicle, how do they go about finding a more manual vehicle to get up the number of required hours? That is not something we have looked at in detail. I imagine there would be a number of practical challenges. Certainly, it is the approach that is taken in aviation.

Mr ADAM CROUCH: Thank you very much.

Mr NICK LALICH: When vehicles reach level 5, which is fully automated, with no human interference, I take it that there will be no steering wheel, clutch or brakes. It will all be done by the vehicle. It will be a cabin to hop into. If I want to send my little grandson to see his grandmother down the road—he would probably know this better than me, because he knows how to operate a mobile phone—he will put in the number of where he wants to go and the car will take him. There is no human intervention if the car breaks down. It pulls up on the side of the road and little Johnny has to wait until grandma comes to pick him up. Do you envisage that that will be the case?

Will level 5 be like the $160,000 Tesla of today? Next year they are bringing out their $35,000 and $50,000 cars, which will be semi-automated, probably around level 2 or 3. Do you envisage that, when it gets to that point, you will be pushing all the motor vehicle manufacturers to make level 5 vehicles? Today you can buy an automatic car or a manual. I would never buy a manual car—I drove one when I was young and that was enough—but some people still love them. Would you force them to go to level 5 and build all level 5 vehicles? You envisage that or do you envisage allowing a point of sale and costs to build different levels?

Mr BURKE: They are both good questions. The first question, about children, is a specific area of policy that needs to be looked at. Some States already have offences for leaving a child in a car unattended, to prevent, for example, someone leaving a child in a car outside a shopping centre on a hot day, resulting in injury or death of the child. I do not know whether from a government policy perspective we would want to allow children to be driven around on their own. There would be challenges. For example, what happens if the car breaks down? How do you ensure that the child puts on their seatbelt? How do you ensure that they do not hit the big red stop button that might be at the front of the vehicle? That is probably a specific area that needs further thought. It is not one that we have focused on in our work.

As to the availability of vehicles and whether you would still allow manual vehicles to be released, I have not heard it proposed anywhere that we remove the ability to still have manual vehicles in the short term. There are issues of human freedom and providing the ability for people to choose. The safety benefits of a driverless vehicle significantly outweigh those of a manual vehicle. Does that create an argument for compelling people to use only a driverless car? I think we are some way away from doing that. One option could be that you then raise the standards associated with the licensing of manual vehicles and raise the skill level, to try to improve that. Answers to those questions are still fairly far into the future. In terms of what manufacturers produce, yes, we would expect to see this technology in higher end vehicles and then flowing down. We see this coming through from competitive pressure between manufacturers rather than any sort of government compulsion at this stage. I would expect that to continue.

Dr MEHREEN FARUQI: Good afternoon. Thank you very much for your fabulous report. The New South Wales Government submission has noted that the safety benefits of driverless vehicles and the technology have yet to be fully proven, especially because the on-road trials have not been done in real-world scenarios. We just heard from Transurban their suggestion about trialling driverless cars in a dedicated lane on a motorway. What are your views on how they should be tested on the road? If they are tested in a dedicated lane it does not really show us how safe they could be in actual traffic. What would be your suggestions if New South Wales went ahead with a trial?

Mr BURKE: There is definitely further work that needs to be done to demonstrate the safety benefits. There is work being done by another government organisation, Austroads, that currently has a project looking at the safety benefits of both connected and automated vehicles. It is looking to produce a report on that later this year and has engaged Monash University Accident Research Centre to assist with that work. As to what trials may best demonstrate the safety benefits, I do not have a strong view at the moment. I have not turned my mind to that. I imagine there will be a need for a variety of different trials in different situations. Transurban mentioned earlier the Western Australian trial, which is a passenger pod travelling at low speed, not on a public road but initially around a pedestrian area. Those kinds of niche deployments and trials would need to take place. Ultimately you would need something out on a public road, in mixed traffic, to really test the safety benefits.

Dr MEHREEN FARUQI: Absolutely. What do you think would be the minimum infrastructure requirement to carry out that trial?

Mr BURKE: That is an interesting question. It depends to a degree on the path that the technology takes. Some manufacturers are developing technology that presumes some level of connection or information being passed from the infrastructure. I note the work going on in New South Wales at Port Kembla, looking at vehicle to infrastructure communication, which would potentially be a key enabler of automated vehicles. Other manufacturers are, however, focused on the sensors in the vehicle itself, along with things like GPS and mapping data that would go into it, without necessarily relying on the infrastructure. As noted earlier though there can be some challenges with either inconsistencies in things like line markings and road signs and some of today's sensors, as I understand it, are not able to read certain types of road signs. So there would potentially be need for great standardisation, and for those lane markings and road signs to conform in a way that can support this technology. I would see that as probably being the key area.

Dr MEHREEN FARUQI: This question has been posed by the Institute of Public Works and Engineering Australia which I find quite interesting: What liability might road authorities carry in the event of vehicle accidents resulting from poor or failed infrastructure elements? What are you views on that?

Mr BURKE: That is also a good question. We actually discussed that in the discussion paper. Currently today there are different standards in different jurisdictions. Some jurisdictions in Australia legislate away their liability entirely. Say today a crash was caused by a pothole in the road by some infrastructure issue. Other States have to ensure that they meet a certain guideline and if they meet that then there is no liability. I think in New South Wales—I would need to double check—there is a requirement to be liable the road agency has to be aware of the specific issue that caused the crash.

As we are moving more from physical infrastructure to digital infrastructure there is a question about whether those rules should remain the same and whether they would even potentially be a barrier to deployment so operators and manufactures may not be willing to employ the technology if they cannot rely on some of the data coming through from infrastructure providers and if there is no ability to take action if there is some deficiency there.

The CHAIR: I refer to the implications for traffic congestion and flowing from that the possible implications for public transport and the potential end of public transport as we now know it with a switch to on-demand public transport. Some inquiry participants have expressed concern that the deployment of driverless vehicles will negatively impact on traditional public transport and that it may, in fact, lead to a greater number of vehicles, cars, on the roads. Do you consider that the convenience therefore of driverless technology may result in that scenario? What do you deduce from that?

Mr BURKE: I think this is another one of the unknowns because it depends significantly on consumer take up and consumer use of the technology and we do not know exactly how that will play out today. I have read very different estimates on automated vehicles either significantly increasing congestion or significantly reducing it, depending on your starting assumptions and how it might play out. So if there is a lot of trips with no driver in the vehicle, for example, which we do not have today, it could significantly increase congestion. But if we have a much more efficient system then that could reduce congestion, so ultimately we do not know at this point.

In terms of the impact on public transport, again there is no certainty around that. It may be an enabler for public transport, for example, by enabling more efficient driverless buses or more automated buses that could be used around the network. It may also help, for example, with ferrying people to and from train stations in catchment areas. It may actually help increase public transport use. But I do not have a strong opinion because I do not know, and the research that I have seen comes to varying conclusions.

The CHAIR: There are various views, as I indicated.

Ms ELENI PETINOS: You have touched a lot on technology. You mentioned connectivity. If you have a view on this, what do you believe are the impediments to data sharing in this space?

Mr BURKE: Data is a key issue for a number of the topics that we look at in the report. We hear it particularly through recent conversations. One is on vehicle modification and how you ensure that the vehicle is maintained at the right standard over time so manufacturers have an interest in the data coming from the vehicle to ensure that. It is also an issue around liability so in a crash how do insurers and Coroners actually know what may have happened, and access to the data is critical there. And then also from a privacy perspective, who has access to the data? You have vehicles that could potentially be used as a surveillance device effectively.

Data, rules around access to data, are a critical issue and we are hearing very different views from manufacturers, technology providers, insurers, police and privacy experts and, of course, the interests of consumers. Data is a key issue but we have not proposed any changes at this stage but we have noted some potential approaches particularly around the liability issue as to how data might be accessed or shared between interested parties.

(The witnesses withdrew)

(Short adjournment)

GARY ELLEM, private citizen, affirmed and examined

The CHAIR: Welcome. Thank you for appearing before the Staysafe Committee inquiry into driverless vehicles and road safety in New South Wales. Before we proceed, do you have any questions concerning the procedural information sent to you in relation to witnesses and the hearing process?

Dr ELLEM: No.

The CHAIR: Would you be happy to provide written answers within 10 business days to any questions taken on notice or any supplementary questions the Committee may have?

Dr ELLEM: As long as the scope of the questions does not entail more than 10 days' worth of work to address.

The CHAIR: Certainly. Would you like to make a brief opening statement ?

Dr ELLEM: Hopefully members have had time to read my submission. I apologise for the stream of consciousness; I had a relatively short period in which to produce something. I assume that witnesses appearing before the Committee today would have spoken a great deal about autonomy itself and where things are going on that front. If I were to think about what new information I might bring to the conversation, it is possibly around three points. The first of those points is that often when we think about transport we think of transport by itself. Therefore, when we think about transport safety we are often thinking simply about how we manage risk. We are not thinking about the scale of the opportunity. It is important when you talk about any risk and its management to think about the scale of the opportunity coming your way. That gives you the appetite with regard to how you manage risk.

All things entail risk. The question is what risk you want to take on and what would be the strategic advantage. When we talk about autonomous cars and legislation and changes to that legislation, in some ways we are talking about the risk involved in that legislation. If you did not think there was a huge opportunity, you would be happy to be a follower or a slow follower of other people's legislation. You would let them do all the work and then adopt the legislation in the longer term. However, if you thought there were enormous opportunities associated with it, you might take a quite different strategic position and want to be a leader in terms of developing the legislation. You might then take on a higher legislative or regulatory risk as part of that process. Talking about the opportunity and the scale of that opportunity is important when we think about the framework of our approach to the legislative and regulatory process.

Part of my submission deals with the scale of that opportunity and helping the Committee to understand more clearly the scale of the opportunity in the Australian and New South Wales contexts in particular. One of the things I want to highlight is that while we talk a lot about driverless vehicles in terms of safety, and maybe in terms of congestion, the big strategic issues are not in the transport system but in how it impacts on the balance of trade. That is something transport planners do not talk about much. It turns out that transport planners are not normally high level economists.

If we think about balance of trade issues and the goods imported into New South Wales, we have a system that is dependent on the private passenger car—80 per cent of trips involve the use of a private passenger car as a ballpark number. That is fantastic in terms of enabling us to have suburban communities and people being able to get around the State. The problem is that we do not make cars and we do not have oil. That means that to keep the transport system running each year we import around $16 billion worth of cars and oil. It is about half and half. That is about 20 per cent of goods imported into the State. In terms of impact on the economy, in current numbers it is worth about two coal sectors. I ask members to think about the importance of the coal sector to the New South Wales economy—it is our largest export. This is worth about two of them. In the opposite direction, the economy is leaking out that much money.

The autonomous vehicle stuff is not necessarily just about safety but about how we might reconfigure our transport system away from car dependency. This is the first technology suite starting to head our way that looks like it might be able to break car dependence. That will mean we will be able to access the transport system in suburban Sydney and suburban Australian without having to own a private passenger car. The same transport job could be done with perhaps 90 per cent fewer vehicles. There could also be a change in the way vehicles are used. It is obvious that that would involve electric cars. That means you have reduced both the car import bill and the fuel import bill in one fell swoop if you can make this work. That is the strategic opportunity, and it is worth billions of dollars in economic leakage to the Australian economy. If you get the sharing part of it right, you will reduce road congestion, which will probably pull out billions of dollars from the State's infrastructure budget and the requirement for infrastructure spending.

That is the scale of the opportunity we are looking at. This is a multibillion-dollar opportunity for New South Wales if we get the legislation right and if we can bring these vehicles on earlier still—a billion dollars every single year. So even just bringing it on one year earlier will be a State saving of several billion dollars. That is just to set the scene of why you would think it would be a big opportunity. So I think that means it is a big strategic opportunity for New South Wales. It is one of the biggest ones that has come our way for quite a while. It is worth thinking about the legislative framework in that context. It is worth saying, "How do we take a position of legislative leader rather than a slow follower?" Because there is an upside and we want to capture as much of that upside as possible and get that legislation right. So the first thing is to understand the risk and what the opportunities are and why you might position yourself in one space or another.

The next thing I want to highlight is that there are actually two pathways to the autonomous vehicle. At the moment most people are very comfortable with one pathway. That is the driven car—a passenger car with a driver and slowly inserted autonomous features, starting with cruise control, adaptive cruise control, automated parking, braking assist, lane following technology and eventually you can take your hands off the steering wheel for a little bit of time while the car is on the freeway, then the car gets better at doing stuff and slowly you hand over the driver activities to the car and eventually the car is completely autonomous. That is the one that we are quite happy with. The reason for that graduation is what you are trying to do is have the AI system in the vehicle keep up with what is happening in the environment. That means there are two ways to solve the problem. One way is to get the AI better and better to cope with the environment. The other is to make the environment simpler and start at full autonomy to begin with.

There are some other approaches. At this point in time if you go to Heathrow Airport and get off the plane and go to the business car park, you will get into an autonomous shuttle. What have they done there? The shuttle was completely autonomous. It has always been autonomous. It was designed to be autonomous. The way they made that work was by simplifying the environment around the vehicle so that the vehicle could operate autonomously. That is the second pathway that starts with a completely autonomous vehicle and slowly allows the environment to be more and more complex until it ends up being able to operate on road and in traffic with all those considerations.

I want to point out both of those pathways because when you are thinking about the legislation you want to make sure that you enable both of those pathways and do not prevent one from happening. Legislation from a number of other jurisdictions limits that second pathway—that fully autonomous vehicle. The reason we want to do that is because we want that fully autonomous vehicle as quickly as possible because it is that vehicle that actually changes the business case of the vehicle. It is that one that actually lets you think about transport as a service—for instance, the robot taxi or the robot bus. We also need to think about the fact that this legislation and regulatory environment interacts with couple of other regulatory environments that are quite important. If we are thinking about the digital disruption of transport, autonomous vehicles is one of those but ride sharing is the second one. Most of us have a phone. It knows where we are. We can tell it where we want to go and an AI system at the back end can organise a transport system to work that out for us. That is the critical part in transport as a service.

At the moment you would all be aware that the New South Wales Government has been doing quite a lot of work to get the ride sharing industry up and running and legislating for the ride sharing industry, but we are only halfway there on that, because step two has not happened. At the moment the hire car legislation still says that you can actually only have one individual or organisation hire a car at a time. You cannot do multi-hire. You cannot share it. You cannot do pooled transport. It is that pooled transport which is the other half of the problem—that is to get more people into the same vehicle if they are travelling in the same direction and so reduce the number of vehicles travelling on the road to do the same transport job. It is those two things together that create this new form of transport, which is multimodal transport as a service. That is the first thing we have seen since the invention of the private motor car that can actually compete with private car dependence. This is a multibillion-dollar problem for New South Wales and we should think it through in that context.

The CHAIR: Thank you very much. Some of the positive predictions you made in your submission were certainly reflected in that opening statement. You touched on something I want to explore a little further—the way in which you saw we could reduce the frequency and severity of accidents but also break that commuter car dependence in urban and suburban environments. You talked a little about that. Can the same safety improvements be assumed in regional centres where transport modes and conditions can be very different to those of the urban environment you have been discussing?

Dr ELLEM: What I am talking about there is really allowing a new business case to operate. That new business case really is reliant on reducing waste. At the moment the ownership of a private passenger car is essential to access the network because it is hard to share but it turns out that is a waste because most of us only use our vehicle 4 per cent or 5 per cent of the time. For the other 95 per cent of the time it is taking up an extra

room of your house or an extra two parking spots on the road somewhere and doubling our road widths and a whole bunch of other infrastructure issues. So the question is really: is that business case going to be allowed in regional Australia? And that depends a little bit on how frequently you can use the car and how easy that car is to share.

That is why it is a little bit dependent on a multimodal system. That might be that you have vehicles that operate within a regional town, so to speak, but the regional towns might actually be connected with a mass transit backbone. You might transition from a number of modes and that will make it cheaper. If you are in a rural block all by yourself it might be quite hard to service with that multimodal service model, so you might have to still own your own private passenger car. Then the questions when you talk about a legislative framework are: what kind of autonomy might you let operate in that particular condition and how soon will that autonomy be available for that particular condition?

The CHAIR: We are not heading to the city-regional divide, are we?

Dr ELLEM: There are some things where numbers actually help.

The CHAIR: Point taken and made. Thank you very much.

Dr MEHREEN FARUQI: Good afternoon, Dr Ellem. The concept of breaking dependence on private vehicles is really interesting. As you said, compared to other similar cities Sydney has a much higher private car dependence. Part of the reason for that could be that London, for instance, has an excellent public transport system which is integrated, efficient and convenient. I am interested in your thoughts. Are you suggesting that we should make a leap straight to driverless cars? You say, I think, that the number of people could be transported with as little as 10 per cent to 30 per cent of the vehicles currently on the road—this is with taxis and buses. What would be the balance between investing in better public transport compared to investing in moving our State towards driverless cars?

Dr ELLEM: I suppose I want to talk about that in a slightly different way, if that is possible, and that is to think about how you define public transport. We can define public transport in two basic ways. Is it publicly owned and operated transport or is it publicly accessible transport? Publicly accessible transport would include the taxi network, the hire car network, your bicycle—all those things are publicly accessible.

Dr MEHREEN FARUQI: Trains, buses, trams.

Dr ELLEM: Trains, buses, trams. At the moment often what we think about when we talk about public transport is really mass transport. We are getting to the point where we can think of multimodal transport. That is transport which is publicly accessible that might include a personalised fraction and a mass transport fraction. I think it is actually a little unhelpful to think about this divide between public and private transport. What we really have is two transport modes. There is mass transport and personalised transport. The question is: how do those two modes work together as seamlessly as possible to deliver an integrated transport service that can replace a private passenger car?

At the moment the Government does most of the investing in the mass transport—that is only in mass road transport. A plane is also a form of mass transport and that is almost completely privately owned, so to me the ownership does not matter as much as what we think about how personalised transport and mass transport interact. In the end I do not want to use public transport; I want to use personalised transport that works for me, and that might include personalised options with a mass transit backbone. It is likely that this technology will compete with mass transport which people call public transport in areas where it does not fit the situation very well.

At the moment we are trying to service suburban environments with a mass transport option and it is a very bad mix, which is why everybody owns a private passenger car. The only way out of that at the moment is the densification strategy which basically says, "I will just build my way out." But that is a 70-year job. So this is the one option that says, "Maybe I can service that in a completely different way using this new technology base and that still has to integrate with the mass transit backbone." So do not think of one versus the other; think of how they work together to give the personalised transport service.

Dr MEHREEN FARUQI: How do you think that works with active transport?

Dr ELLEM: You are asking me to predict how the technology will roll out, in a way, and how society will respond to that.

Dr MEHREEN FARUQI: I think I am asking two questions. If you have that expertise in a safety sense how does it interact with pedestrians and cyclists? We have heard that trials have not really proved that it

is a safe interaction, at the moment, between pedestrians, cyclists and automated cars. In the other sense, if we look at transport as an integrated system, active transport is part of that system.

Dr ELLEM: First of all, I hope that it would encourage active transport. Once you have a private car you tend to use it for everything. If you do not have a private car you tend to use other options. So, hopefully it will increase the level of active transport. That would be good for all of us, I am sure.

In terms of safety, it is important not to think about this as a binary thing—that autonomous vehicles are either safe or unsafe. Think about every different organisation building their own autonomous system, and each system having its own strengths and weaknesses. It might be that Google and Volvo build a very safe system but some unnamed company—which I will not talk about because that would be bad—builds an unsafe system. So you could not say that autonomy in itself is safe; a particular configuration of a system will be safe or unsafe. One of my recommendations was to think about things on a system level. If you think about licensing a driver, there are people who are good drivers and people who are not so good drivers. We license drivers individually. You might want to license systems individually—like the driver—in that approach, and hope that they all reach the appropriate standards. It is certainly possible to build an unsafe automated system.

Mr NICK LALICH: Your submission states that New South Wales needs to build a State-based capability for the proactive testing and certification of driverless vehicles. Would you agree that there is also need to balance State initiatives against interstate cooperation in this area? What sort of testing and certification facilities do you envisage? Where would it be located and who would be involved?

Dr ELLEM: You might need to remind me later of different parts of that question. Certainly, there are two things that we need to do. The first is that there is obviously a need for a national approach. There is no doubt about that. At the same time, in that national approach, if you are keen to get some of the upsides—like increasing industry or innovation systems and those sorts of things, that will attract developers to your State—then you need to be proactive while still working with the national body. So you would try to position New South Wales as the leader in the national forum. How you might think about doing that is relatively straightforward. The next point was how and where we might have test beds. Is that right?

Mr NICK LALICH: Yes; where would you do it and who would be involved.

Dr ELLEM: Things have moved on slightly since I made my submission. Since I put my submission in Transport for NSW has become a bit more active in this space, which is good to see. I said we were lagging and we needed to catch up, but I think we can see that we are catching up. We have a way to go but I think we are moving positively at this point. Part of that was the Transport Futures summit that was held recently. At a similar time to that the Transport for NSW Smart Innovation Centre was launched. That innovation centre immediately put out an expression of interest call for organisations to come and work for Transport for NSW in the Smart Innovation Centre. Having written this I was prepared, which was good.

I managed to run around with a group of friends and we came up with the hypothesis that if we thought about the transport challenge in New South Wales we would see that the bulk of the transport challenge is in Sydney. That being said, Sydney does not need to be the test bed. In fact, because Sydney has the biggest transport challenges it should not be the test bed. If it goes wrong in Sydney it goes really wrong. So we might want to have a strategy of using regional cities as the test beds.

Mr SCOT MacDONALD: Like the Hunter.

Dr ELLEM: Yes, like the Hunter. In response to that EOI a group of us put together something we called AUTON, which is the Agile Urban Transport Open Network. Within that we are looking at the digital disruption of transport and taking some of the management tools that digital disruptors use and try to bring those over into the infrastructure and transport system. There is no use building a 50-year transport plan if the technology that underpins that transport plan is disrupted and rolled over in the first three years of the plan. It would not work. So there is a different strategy and that is called the agile strategy.

We have said, "Let's position the lower Hunter as the zone for the national test bed." Why? It has pretty much every transport mode in New South Wales—everything from the airport to pedestrians. It has the full range of environments—residential, rural, city, inner city and industrial—and there are different kinds of land. So it is representative but is about one twentieth the size of Sydney and Melbourne and does not have the same transport challenges of those cities. So if it goes horribly wrong it is separated enough from Sydney to have good boundaries. You do not have what we call "edge effects" during trials. At the same time it is close enough to Sydney, where most of our intellectual capital is located to interact with it.

We think that places like the Hunter and Wollongong—those sorts of regional cities—are ideal places. If we set this up right we could try to position that as being not only a New South Wales test bed but an

Australian and global test bed for how this might work out. So regional cities are the places to test it, with an idea to roll it out. We need to look at the limitations to rolling the system out in a place where there is a transport problem—like in Sydney—and what we have to prove. I am talking about proving up the technology and how that technology impacts on all the other parts of the transport and social systems, and how we have to think about infrastructure in different ways.

Maybe we have to think about how we collect our taxation around road access and road use to pay for that infrastructure. All those things need to be test bedded at some sort of scale first so that we can inform that process as we roll it out more strongly. Have I ticked off most of the things you asked me about?

Mr NICK LALICH: Yes. To keep our State sovereignty but to have it as a national development, should it be under the control of the Federal Government, where they have an overarching body and have input into the safety and technological aspects of the new development of those cars? If we are talking at the national level you have to include the Federal Government. You could do it at the State level but who would be in control—New South Wales or Victoria?

Dr ELLEM: In the end it has to be a collaboration between State and Federal levels of government. You cannot have one being in control of the other. In some ways what you are asking for, to get the operation up and running, is an exclusion from some rules. You would be saying, "Does this rule really need to be there? Can we implement a new rule? Can we have a regional exclusion so we manage the risk by managing the scale?" While, yes, there are Australian design rules for vehicle construction that do not cover all vehicles. They cover the major vehicles that are imported into the State but there might be entirely new vehicle categories that are created that are not actually under the ADR legislation at all. What you are doing is trying to see the kinds of standards of those vehicles that might inform a new ADR process in the longer term.

There are also a number of bits of legislation like the hire car legislation, for example, or bus or taxi legislation, which is often State-based legislation. There are a number of factors that are State-based legislation so the State Government has to be involved and play an active role. Most of the things that the State regulates are the important parts in the business case. So without the State being an active player, the business case for a lot of these things will not get off the ground. Yes, it does have to inform national level standards, but that is the idea of a test bed. You are not saying, "Here is this whole rule from New South Wales. " You are saying, "Here is this rule for this test zone. If that works that should inform State- and Federal-based legislation.

Mr SCOT MacDONALD: Can you put your mind to the economic model you are talking about in this blurring of public and private systems. In the past you went out and bought your car. Are car manufacturers putting their minds to keeping some sort of presence when the individual might not necessarily own the car or whatever that vehicle might be?

Dr ELLEM: I think you would say that most of the world's major automotive manufacturers are scrambling to try to work out how this goes. There are two models. One is the driverless car that the manufacturer is going to sell, just like it sold a private passenger car. Then there is the driverless car that will undermine the entire business model—

Mr SCOT MacDONALD: You are talking about 90 per cent less vehicles.

Dr ELLEM: —and reduce the number of vehicles in the global population. In the end the reality will probably be the it is a bit of both of those. Tradesmen, for example, who use their vehicle most of the time as a work vehicle—odds are they will still own their vehicle, because there is no real advantage to them sharing the vehicle as there is no change in business case. Those kinds of vehicles will still be owned privately or leased from companies—all these different business models are available. In terms of the passenger vehicle replacement, in some ways a whole suite of business models are viable. If you look at the taxi or the hire car industry, often the network is constructed of reasonably small-scale ownership of vehicles. Lots of people own taxi plates and integrate them into the taxi industry; lots of hire car companies own their own cars—like Uber drivers own their cars.

In the Uber and the taxi scenario, there are organisations that aggregate a bunch of cars and lease them out to drivers. There is nothing to say that a company like Uber might move in and make a deal with Chrysler, for example. Google operates the network, and Chrysler builds the vehicles, and Google gets in some vehicle operator to maintain the vehicles and keep them running. Lots of different business models are available. Public and some private business models could still work. I do not think the business model is necessarily the linchpin to making it work, as long as it is agile enough to keep up with new technology, and position itself and understand how to be customer focused.

In terms of mass transport, we see the same thing. We have mass transport where the vehicles are owned by government but operated by a private operator. In other models the private operator owns the vehicles

and operates under a government contract. The ownership model does not have to be either government or private; there are lots of ways it could work together and there are several models that can work in the same way.

Mr SCOT MacDONALD: Do you think it will be fairly flexible?

Dr ELLEM: It is really hard to say. Prior to Uber you would have said that a big player would come in and run most of the show, but Uber has shown that you can have aggregation of private vehicles, and there is nothing to stop investors buying vehicles and operating them in that network. The answer is that I am not sure which business model will win. Maybe they will all still operate at the same time.

Mr SCOT MacDONALD: We were talking before about taking 90 per cent of the vehicles off the road and that means 90 per cent less rego, 90 per cent less CTP, 90 per cent less fuel excise et cetera. I take your point that we might not need as much infrastructure or different infrastructure, but is much thinking going into how to keep sufficient revenue stream from road taxes to build the necessary infrastructure?

Dr ELLEM: I have to say that globally I am not aware of discussions around that. I think people are relatively confident that governments will find a way to tax them. You are probably right that there would need to be some sort of taxation reform. Even if you accelerate the uptake of something like the electrification, that would mean that you would lose fuel tax, and there is really no electricity tax at the moment so you would have to think how that operated. There is vehicle registration tax, and you would probably have to have those taxes in place. How you would fund road infrastructure or specialised infrastructure needed for driverless vehicles remains to be seen.

Mr SCOT MacDONALD: At the moment we pay a fixed charge for registering a vehicle and the fuel excise. Is there a greater opportunity for user pays, so transport operators doing a million kilometres a year would pay an appropriate fee compared with someone who does 5,000 kilometres a year?

Dr ELLEM: You would need to collect better data. There is an opportunity in terms of data to charge on a user-pays basis. The question that needs to be asked is: Is that what you want for society? Is that a good thing or would that undermine equality or accessibility? The distribution would be a community and political decision. It is not necessarily obvious that it should be user pays; the data system to make it user pays would be much more available, if that is the path you want to go down. That being said, I am not necessarily an advocate of blanket user pays. There is the ability to pay, and you do not necessarily want to undermine the capacity of people who by no choice of their own are stuck doing longer journeys. You could charge different rates for travelling in a pool or mass transit vehicle than in a personalised route. You could try to use that to direct behaviour.

Mr SCOT MacDONALD: I think Transurban is starting to go down that pathway.

Dr ELLEM: There is the capability to do that. I am not going to tell you what to do. There is an equity and fairness argument and I am not going to make a call on that.

Mr ADAM CROUCH: As technology advances, we will have a mixed fleet on our roads. We will have automated cars, semi-automated cars and non-automated cars, as outlined in the Government's submission. What do you believe will be the implications of those vehicles using our roads simultaneously that we will face over the coming years, given that there will also be drivers with different skill sets?

Dr ELLEM: That is something that most of the autonomous vehicle developers are facing. They know that there will be a transition and so they are deliberately trying to make the vehicle operate on-road in existing traffic in the way that normal traffic on normal roads operates. They are not asking for special dispensation for their vehicle; they are happy that there will be a mixed fleet and for the their vehicle to operate successfully and safely in a mixed fleet. The Google car has been in quite a number of accidents, but most of those accidents have been caused by human drivers driving into the back of the Google car because the Google car stopped when there was a red light, for example. There are certainly some challenges and that is why Australian Design Rules are still important for passenger safety and those sorts of things.

It is important not to necessarily think that the risk increases with the level of autonomy. There is an inbuilt perception that it is harder to build a good autonomous vehicle that is completely driverless than one that is halfway between and that somehow the risks would be less if we allowed a little autonomy and not total autonomy. That fundamentally misunderstands human behaviour. My largest worries are to do with the lower levels of autonomy, mainly because the vehicle itself is not ready to accept the full task but the human is fairly happy to hand over control. You only have to go on YouTube to find people who think it is fun to sit in the back of the Tesla while it is on autopilot.

The Tesla autopilot was not actually designed to be hands-free; it was designed to be a supervised system. Suddenly the driver puts themselves in a nonsupervisory role in a system that was not designed for that. The human trusts the system more than the engineers who built the system trust it. There has to be an extra layer of stuff in those vehicles to make sure that the level of supervision that is required for the level of autonomy is actually in place. When things fail, we like them to fail gracefully, not ungracefully. That is why Google has gone for its fully autonomous car straight off the bat. They tried the partial route but when they looked at the data they saw that people trusted the car far too much, too soon. The driver said go and the car went down the road for the first kilometre and it did not crash, so they said it must be perfect and they turned off.

Google said, "We had better build a car that is good enough for them to do that. Otherwise they are going to do that anyway." I am saying that we should be aware of that. We should not think that the low-level autonomy vehicles are the safe ones and that the high level ones are high risk. I think it is completely the reverse. The lower level ones are scarier than the high level ones, in my opinion.

Mr SCOT MacDONALD: Thank you very much.

Ms ELENI PETINOS: Thank you for coming in this afternoon, Dr Ellem. A study conducted by the Massachusetts Institute of Technology in Singapore, which is cited in your submission, used actual transportation data to ascertain whether all modes of personal transport in the city could be replaced by a fleet of shared autonomous vehicles. The study found that such a transition was feasible. Furthermore, the study found that the fleet that would be needed to transport Singapore's commuters would be approximately one-third the total number of passenger vehicles currently in operation. However, the report warned that further research would be needed to quantify the extent to which traffic congestion could be alleviated, given the increased distance to be travelled by the shared automated vehicles to complete their round trips. Do you see value in New South Wales undertaking its own analysis of actual transportation and traffic statistics to determine a specific future implementation strategy, such as has been done in Singapore?

Dr ELLEM: The short answer to that is yes, but I also see value in having a deeper look at the assumptions that underpin the transport study. You need to think of the integration level with a mass transit backbone and the influences of that. You need to think about the opportunity to add ridesharing or pooling services. Often other things can come into play. For example, at the moment, the number of vehicles you need is really the number of vehicles you need to handle the peak. If there are other mechanisms in place that are designed to try to spread the peak, that influences the number of vehicles you need in the system to handle that and the wait time that people associate with that.

A number of assumptions underpin Singapore's number of 30 per cent. We could do significantly better or worse than that, depending on how the system is set up. So a study is required, but one that looks at those other mitigating factors to help inform a deeper policy approach. Rather than saying, "Here is a car and here is a shared autonomous vehicle," you need to think about the suite of policy arrangements that need to be in place to provide that output. So, yes, but they need to look deeper into the assumptions and test a wider range of assumptions.

Ms ELENI PETINOS: Earlier you said that I should ask my burning question and we would see whether or not you would have an answer to it. We have already touched on data and connectivity. What do you see as being the impediments to data sharing?

Dr ELLEM: The data question is interesting on a number of different levels. That is an insightful and difficult question; congratulations. One consideration about data is what access people have to the vehicle and the data stream from the vehicle, and being able to interact with that data stream. There are cybersecurity issues to do with the operation of the system that are important at one level. Another issue is taking data out of the system. There are a few different considerations. These are cars will be the most sensor-laden vehicles we have had in the history of mankind. There will be thousands of them driving on our streets on a day-to-day basis. There will be a huge amount of information from them. They have data acquisition cameras. They have lidars. They have sensors everywhere. Their ability to take in information from our environment will be greater than ever before. It will be like having multiple security cameras driving around the city on a day-to-day basis collecting an enormous amount of information.

That could be fantastically helpful for local councils that want to look at the quality of their roads or at what is happening to the trees on the side of the road or at where a telephone pole is going. It could be a fantastic method of data collection to use to run our cities. It sounds as though open data is wonderful. On the other hand, there are privacy considerations for people. Is it all right that government knows where I go? What level of privacy am I allowed to have? On top of that there is anti-terrorism and other legislation under which authorities would like access to that information. What data we want to collect, what data we want to keep and how we want to analyse that is still unknown. The value of that is unknown. There will be an enormous amount

of data. Will we throw 99 per cent of it away because we do not know what to do with it or will we try to collect it all and do something interesting with it?

The project we are working on is working with open application program interfaces [API], trying to make as much data open as possible for transport planning and city planning. But, on the personal side, do you want to be tracked? Do you want people to know where you go? Is that important? These things will be able to read licence plate numbers. There will be a real-time map of where every car is on the road at all times, whether they are autonomous or not. They can collect all that information and make that available. If they are doing that, is that required? In the United States, for example, they require the car to collect and log its data in case of an accident. If an accident happens, they mandatorily have to make the car data available for the period leading up to the accident, and whatever data was collected through the accident, so that they can carry out accident investigation. Here, there could be mandatory data collection and provision rules and some that are left up to industry to decide, depending on whether they can make value from it by selling or sharing it. There are some things that you would definitely want to keep private. I could not tell you what the balance should be between all those things. It is a complex area.

Ms ELENI PETINOS: Thank you.

The CHAIR: Regrettably, we are running out of time. I have one final question. Mr Crouch asked about the mixed fleet. I want to tease that out. With vehicles operating at different levels of automation in that situation, and with different weather conditions and types of roads, what are the implications for drivers learning to respond to the many different contingencies? What are the implications for the Government in regulating the fleet according to the level of vehicle? How do we ensure that drivers are able to interact? How does the Government ensure that it has regulations allowing for those different levels?

Dr ELLEM: Are you talking about how a driver of another vehicle would react or how the driver of a partially automated vehicle might interact with another vehicle?

The CHAIR: With different levels of automation, in a mixed fleet, there could be different rules applying to the different styles of vehicles on the road. This would be over a period of 20 or 30 years.

Dr ELLEM: At the moment, no-one is really talking about including training for driverless vehicles in the licensing systems.

The CHAIR: My question goes to that.

Dr ELLEM: No-one is talking about that, but that does not mean that it is not important. It could be important. More of the dangers will be associated with cars with lower levels automation, where control is handed to the driver and then back to the car on a frequent basis. At the moment that is unregulated. Companies like Tesla update their car and make that technology available without a licensing or training program in place. That could be a mistake.

The CHAIR: The Committee wanted to identify that as a potential issue. Thank you very much, Dr Ellem, for appearing before Staysafe today. We appreciate your submission and your ability to answer the Committee's questions. If there are any further questions, we will submit them to you. Time is of the essence for all of us.

Dr ELLEM: May I make one final statement?

The CHAIR: Certainly.

Dr ELLEM: I did not perhaps emphasise the opportunity that I see for vehicles that are not designed to carry people. Entire classes of vehicle will be designed for small-scale delivery, such as delivering your pizza, your shopping or your washing machine. Vehicles that might never be designed to carry people can be autonomous from the beginning. At the moment we do not have much experience with the design rules for those kinds of vehicles and how we would do that. But there is a compelling business case to have that type of transport, to provide a service.

The transport system is not only to transport you; it is to transport the things you want to take with you. We might see a bifurcation of types of vehicles: those that specialise in carrying people and those that specialise in carrying goods. With regard to the innovation industry in New South Wales, our capacity to innovate with passenger carrying vehicles is not as strong as our capacity to innovate with and build delivery vehicles. I advise the Committee to consider that as part of the regulatory approach. That could be an active area of opportunity for innovation and industry for New South Wales, if we get the legislation right.

The CHAIR: Indeed. There could be drones in the air and automated vehicles on the ground. Thank you.

(The witness withdrew)

ROBERT BRUCE McDONALD, Director, IAG Research Centre, Insurance Australia Group Ltd, affirmed and examined

TRACY GREEN, Executive General Manager, Customer and Underwriting, Insurance Australia Group Ltd, affirmed and examined

CECILIA WARREN, Emerging Product Lead, Insurance Australia Group Ltd, sworn and examined

GEORGE KARAGIANNAKIS, Head of Government Relations, Insurance Australia Group Ltd, sworn and examined

The CHAIR: Do you have any questions in relation to the procedural information sent to you in relation to witnesses and the hearing process?

Ms GREEN: No.

The CHAIR: Before we proceed with questions are you happy to provide a written reply within 10 business days to any questions taken on notice or any supplementary questions the Committee may have?

Ms GREEN: Yes.

The CHAIR: Do you want to make a brief opening statement?

Ms GREEN: IAG thanks the Committee for the opportunity to share its views regarding driverless vehicles and road safety. IAG has been involved in the automotive industry in New South Wales and Australia. Through the IAG Research Centre our business is involved in the design, performance and testing of vehicles, and our supply chain network is made up of industry specialists who repair hundreds of thousands of vehicles for our customers each year. We also work closely with the vehicle manufacturers and original equipment manufacturers [OEMs] and underwrite commercial vehicle fleets and agriculture machine through our commercial insurance lines. While there is potential for improved road safety, we do believe that the true extent of the benefits are difficult to predict at the moment. Even though much of the research and commentary projects a 90 per cent reduction in collisions, it is speculative and still needs to be tested in real world conditions.

We recommend that analysis is read cautiously as a great deal of more on-road testing is required to understand the grey areas where varying levels of automation and intersect with human intervention. In the first instance a nationally consistent approach to defining control of vehicle will be critical to provide business with regulatory confidence, and providing a common infrastructure across State and Territory borders will also help facilitate the development and take-up of automated vehicle technologies. Participation in a national approach to road signs, signals, lane markings and roundabouts, which have historically been developed at a State level, is an additional and crucial consideration for the New South Wales Government, particularly if Australia is to gain economic advantage.

We have a wonderful opportunity, I think, to learn from history here and seek to avoid the disunified approach that occurred in the 1850s as the national rail network was being introduced. And despite the initial attempts to work together to get a uniformed approach, the colonies were under pressure to develop their own systems. When train lines were expanded to travel between States, the lines, equipment and operating practises were incompatible. Passengers and freight would often have to be transferred from one train to another at State borders. In 1917 a person wanting to travel from Perth to Brisbane on an east to west coast crossing of the Continent had to change trains six times.

The benefit of hindsight can actually help us ensure efficiencies are achieved at the outset by ensuring a collaborative and national approach to developing the AV networks in Australia. IAG recognises the National Transport Commission's role in leading the public discussion on this issue and recommends that the New South Wales Government continues to support the work.

The CHAIR: How that resonates with me coming, as I do, from the electorate of Albury which has, I understand, the longest railway platform in the Southern Hemisphere because of that exact problem with passengers having to change trains from the standard to the broad gauge. At night it was not appreciated and Mark Twain made a very pithy comment about that which was not flattering to Australia. In your submission and again in your introductory remarks you referred to the fact that the potential for improving road safety should be treated cautiously as more on-road testing is required to understand those grey areas of how varying

levels of automation intersect with human intervention. You comment that this is particularly true for level three and level four automation. Will you expand on what those grey areas are?

Ms GREEN: I will start and then hand over to some of my colleagues in that respect. If we think from an insurance perspective at this point in terms of where the person is intersecting with the technology, at what point does control of the vehicle transfer from a consideration of a liability perspective? So that is a grey area. Where will liability be transferred? Is that transferred to the vehicle manufacturer? Does that stay with the individual intersecting in terms of the car? How does the model actually need to be thought about and contribute in making some of those decisions, particularly in that sort of technology which requires the intersection of the human intervention?

There is this border level data perspective as well that sort of sits in behind there. How do you get access to the data to forensically examine where the liability or the fault may apply? Who was the driver or who was in control of the vehicle at the intersection of an accident, for example? I think there are broader levels, sort of grey areas associated around there.

Ms WARREN: It is fair to pick up on some of the comments as well made by previous witnesses, certainly members from the Australian Driverless Vehicle Initiative and the previous witness just eluded to some of the things that occur when a human interfaces with a machine. You know, the question of how quickly someone takes control or understands their role in doing that and the nature of what that means? Simply being told to take control, how quickly does your brain switch into saying "Yes, I am taking control now"? Do you understand that if you have just touched the pedal or the brake that that might interfere and do something else, as we have heard earlier today as well.

There are things really around how people start to interface with this machine and understand it. The fact that people are generally quite good drivers and these machines need to beat good driving, not just bad driving. So that is where you may, sort of see, while technology in theory in a controlled environment will be able to reduce accidents, and we certainly see significant potential to reduce accidents, we are not willing to say it is X per cent right now. It will take time and we need to see what will happen in the real world, and this is why we need to test it and understand it and work with manufacturers and industry to really understand the nature of the risk and what happens and what would cause something to fail.

Mr NICK LALICH: You would have a dilemma because you would be insuring the car manufacturer and the person who is driving. Regardless of the argument about whose fault it was—whether it was the result of interference by the person in the car or whether it would have happened if that person did not interfere—you would have to pay anyway. The entire insurance industry will have a problem because you probably cover both sides. One way or the other you will be paying out.

Ms GREEN: Yes, and that is the business we are in. We provide protection around risk and that is why the regulatory environment is so important in terms of who is defined as the driver, at what point does control transfer, and is that important in respect of how we design products to respond in a new environment. That is the business we are in. We are very supportive of this technology in terms of the reduction in injuries and death on the roads that we believe will occur with its adoption. In terms of setting up a regulatory framework that provides flexibility as the environment changes it is important to enable the industry to innovate and to respond with regard to protection.

The CHAIR: Obviously the Committee is concerned about and is focusing on the road safety aspects. You have noted that the full potential of autonomous vehicles in reducing road trauma may be reached only when levels four or five are connected to the cooperative intelligent transport systems thereby allowing communication with other vehicles and infrastructure. Can you elaborate on that? It follows on from what we have been discussing.

Ms GREEN: It is probably relevant to this point in terms of the intersection of the human connection and technology as well as the time it will take for the fleet to change over time. When we liken it to horses and carts and motor vehicles coming on the road together, there will be long periods during which dual technologies are being used. Confidence in the technologies is also an issue. If you are a designing these systems to be better than the best driver and they are fully automated, you will not have the randomness of individuals in the environment because the controls are set up in respect of the system.

Ms ELENI PETINOS: The Motorcycle Council of NSW quoted the RAND Corporation, a global policy think tank, suggesting that "to verify self-driving cars are as safe as human drivers, 275 million miles"—or 442.57 million kilometres—"must be driven fatality free". Are you aware of an internationally recognised benchmark that could be useful in clearly verifying that self-driving cars are at least as safe as human drivers? Do you believe that we need such a benchmark?

Mr McDONALD: It is probably too early to say that, because we have different technologies coming from different manufacturers and different countries. The average driver makes rational and irrational decisions every day. It will take a while for the software to be developed to a point at which it can equal a person in a restricted traffic environment like Sydney's where there is a lot of congestion and interaction between cars as opposed to a long-distance vehicle travelling on the freeway between Sydney and Melbourne, which is a much simpler task. From my experience, differences between manufacturers and the their cultural origins can affect how they decide to design their cars. Some cars have features that seem to be logical and others have features that seem to be illogical. Often that is a regional thing. When we have cars coming into this country potentially from China, India and the other places that do not have a long history of manufacturing motor vehicles or extensive involvement in vehicle ownership, how that progresses will be interesting.

Ms GREEN: When we talk about a nationally consistent model, the vehicles are by and large imported. Vehicle manufacturing will be looking to respond to regulatory environments developed overseas. There is a broader level view in terms of international consistency and how we design what would probably be considered to be the base level of safety and the controls that we want included in coordination with international jurisdictions.

Mr McDONALD: We are actively testing autonomous braking vehicles. We have been offering insurance incentives for more than a year in NRMA Insurance and our other direct brands in Australia to try to encourage standard fittings. The insurance industry around the world is trying to encourage that technology as it did with electronic stability control, head restraints and other design features of cars to make them less damageable and easier to prepare. We are taking a positive approach and are actively testing all vehicles with autonomous emergency braking [AEB] to learn how they work. They work in different ways because different manufacturers use different technologies.

While some of the technologies used are the same, some might come from Bosch or Continental in Germany, or they might come from an American organisation such as Delphi, or Nippon Denso in Japan. They are all developing their own systems. We are trying to learn as much as we can and to encourage the industry as we go. I have gone from a vehicle that had autonomous braking to another vehicle with a slightly more advanced autonomous braking system and automated steering. I take every opportunity when I drive my car and other cars to see how they work. While they work 90 per cent of the time, there are little scary things that would not make you very excited about sitting in the back seat. Those vehicles are sometimes confused by some of our irregular lane markings and strangely shaped traffic islands, and we make little corrections. However, the technology is generally impressive. In another 10 or 20 years it may be even more impressive. We should carefully monitor it carefully.

I currently chair the Research Council for Automobile Repair [RCAR], which is an international organisation representing all of the world's insurance research centres, including the big ones like the Insurance Institute for Highway Safety. We collaborate to work out what is the best approach to take to maximise the benefit of some of these technologies and to minimise collisions. Car manufacturers are not always experts in car collisions, and certainly not in fixing the cars. They are also not expert in what causes them. Often the insurance industry knows a lot more about that than the car companies, and that is why we try to work with the car companies.

Ms ELENI PETINOS: Another submission states that the estimated reduction of up to 90 per cent in cent road accidents and associated costs is optimistic. What do you believe are the minimum preconditions that would facilitate that reduction in accidents? I appreciate that you have already mentioned a couple. Is there anything else you would like to add?

Ms GREEN: It would be the encouragement of continued adoption and trialling. The fact is that we do not know what we do not know in a rapidly changing environment. However, we do know that we want to encourage the use of, experimentation with and adoption of these new technologies. We also want to provide enough protection but also enough to room to innovate and to start picking up on the areas that are working and to discard those that are not. It comes back to the design. IAG starts from a principle base, and our purpose is to help to make the world a safer place. This type of technology sits in there in terms encouraging adoption in a safe way. It is about experimentation and control and early discussion, along with thinking about how we can design a principle-based regulatory framework while we enable that experimentation to continue. Some people say that driverless vehicles will not crash. The reality is that they will fail, and we accept that that will happen.

However, having a system that will have a better performance on the road that actually protects people's lives and protects them from injury is a good thing. The sustainability and growth around industry and innovation is a very good thing that will come from this type of technology. It is probably not answering your question specifically, but I think it is a world of "we do not know what we do not know" in terms of how

quickly these things are developing. We have got views coming through. There is nothing to say that something will not disrupt in another four or five years that could change the playing field.

Mr ADAM CROUCH: Thank you very much for coming in today. Obviously we are talking about the speed of development of this technology. At the same time you noted in your submission that the changes obviously need to be addressed with both training of drivers and licensing needs for those vehicles. We have had feedback from multiple witnesses on this issue today and I am obviously keen to get your feedback. As an insurer, what are the areas of training that you see as vital in needing to be looked at for driving autonomous and semi-autonomous vehicles? How would you suggest that training should be implemented across the drivers of New South Wales?

Ms WARREN: I think education is a big key here. People need to understand that the nature of driving is changing. So what is their role? Is their role to drive the machine or is their role to monitor the machine or to be a passenger. They need to understand what their roles are. Some earlier comments were made about skill degradation and the need to maintain your ability to understand this machine. I think there is a role for continued either driver training or education—that will need to play out. It is certainly something that needs to be considered. I am sure there will be business models that spring up around that. I am sure that is something that will occur.

And then of course there is that question of who we are licensing. Are we licensing someone to drive a machine? Are we licensing the owner of the machine, the manufacturer of the machine or the software developer? This is where we are very happy to be working with the National Transport Commission on thinking about these issues, because as Ms Green alluded to earlier, we do not fully know what we do not know, but we do know that the key to this is to be involved early—to be speaking with regulators, industry and manufacturers. This is why we are so supportive of the approach the NTC is taking.

We are working with some of the people who are preparing reports for Austroads around some of these issues. What we are finding is that we might come with an early view and then, as our understanding develops and as we hear from other stakeholders, we are getting a richer view. So I think as 2016 progresses we will end up at the end of the year with a much more robust understanding of the sorts of things that regulators need to be thinking about. All States have agreed—and New South Wales is one of them—to considering a national regulatory framework. All governments need to be commended for that and for addressing this early. We will continue to work to help understand these issues.

Mr ADAM CROUCH: You have answered my next question which was about the national framework. As seen with the example of rail, States have traditionally gone off and done their own particular thing that they believe best suits them, but by having a national framework on this there will be some continuity, which obviously you will be supportive of and contribute to as it grows. It is such a rapidly changing area, as we have seen in the last five years—it is quite incredible.

Ms WARREN: It is also quite incredible to see regulators being proactive in this space. The fact that you are holding an inquiry and the fact that NTC and the transport safety committee and Ministers have all agreed to look at this helps to set up the conditions that we need to progress this. The more there can be cooperation across the States—there is obviously this cooperation that is occurring already—and cooperation in terms of trials and sharing of knowledge and information, the economic boost will be not just to an individual State but to all of Australia.

The CHAIR: Thank you very much for the endorsement. That is why we are undertaking this particular inquiry.

Mr SCOT MacDONALD: You made a point about liability moving from personal over to the manufacturer. What are the hurdles there? What are some of the things we need to think about in a regulatory sense? And how does that link in with the other point you have made that we will not have a car industry here in about a year or two, so everything will come from overseas? We are just technology receptors or takers, really. How do you think that is going to work for Australia?

Ms GREEN: There are different models that have been discussed. One, more broadly, would be if you define the technology or the automation as a driver under the licensing regulation. The way the industry is currently constructed is to cover the driver, then the cover is essentially in place. There are other things that sit in insurance policies about mechanical failure and that needs to be thought through associated with it. So it comes back to the licensing and how the structure will sit in terms of how we design products to respond to that environment. We have quite a strong view to aim for simplicity for the customer. There needs to be confidence in knowing that protection exists. If we have to have the liability discussions associated with it, it should be a

seamless interaction for a customer to come in, say, with an insurer or with us at a point in time to let us respond and work out the liability issues at the back end as to whether it goes to the manufacturer or sits with the person.

To do that, though, we see that there would likely need to be thought given in and around the data and data ownership—who owns the data, access to data—to enable those types of forensic examinations. And then it comes back to the question of how people who are uninsured operate within that environment and gain access. We would expect that there would be different types of business models that would emerge associated with that but it comes back to the data intersection with the privacy laws that have already been raised during this inquiry. It is an interesting point in terms of who owns the data and how you would construct that from an environment perspective.

There are other things to consider in and around some of the structure—for example, compulsory third party insurance. The fault-based or common law basis and design associated with CTP schemes mean that you could remove the friction by moving into no-fault basis, where there is no argument about who was at fault but rather about health outcomes and getting people back to work, or limiting the interaction, if you like, associated with the fault-based arguments. There are other ways that you could think about responding to the liability issue associated with the design, depending on the class and type of insurance. We obviously have a view around that design and are very happy to be open and discuss it. Ultimately though our business model is to be thinking about the risk and the liability associated with it and designing products to help protect people. That is where our models are designed to respond. Getting an environment in place so that we have the confidence to do that is pretty important.

Mr SCOT MacDONALD: Regarding the second part of my question, if we are 1½ per cent of the global vehicle market and they are not too worried about kangaroos in Zurich, are we going to fall behind with that technology?

Ms WARREN: Mr McDonald, did you want to talk about kangaroo testing at all? It is a very good point. There are environmental conditions in Australia—storms, dust, the particular animals that we have—that all mean that there are reasons to test this technology in Australia. Car manufacturers have started to do that and we encourage that. Mr McDonald can probably talk a bit more about the technology side of things.

Mr McDONALD: In testing autonomous braking we are finding some differences in vehicles. That is why we are currently producing a target vehicle that is a pick-up truck, purely because it is such a popular vehicle in Australia, to make sure that advanced emergency braking system [AEBS] cars can not only pick up small European hatchbacks but will also react to a pick-up truck which has quite a different shape. Then we have the different challenges with our wildlife. We spend millions of dollars a year repairing vehicles due to collisions and many people are injured in collisions with kangaroos around the country. Some people such as Volvo are experimenting with kangaroos to see if they can make sure their systems can detect them. My own car stopped for a pedestrian in King Street the other day. I was very impressed because it is very hard to get volunteers to walk in front of the car.

Mr SCOT MacDONALD: In Newtown?

Mr McDONALD: Without my doing anything, it was one of our suicidal pedestrians holding a mobile phone. My car braked until he got out of the way. That is very gratifying because as an insurance industry we developed the model of the dummy that we use to try and represent a pedestrian. Obviously, the systems are reacting in real life.

I spent the morning at Manly Dam with no phone coverage. That is a particular blackspot in the connectivity. A high level of connectivity will be required for cars as we go to a fully autonomous vehicle, yet we have such massive distances. The whole of the United Kingdom probably fits into Victoria and we have a fairly small population. If you travel in rural Australia you will find a lot of differences in the road system and in the brightness of our sunlight, especially compared to Europe, where the sunlight levels are often much lower. All these things can interact with camera systems and the sensors. I would like to make sure that if we are testing vehicles it is as robust a process as possible and that we do not just have a couple of simple rules—it has to recognise that vehicle, that post and that sign—and let them go at that, when every day even people who are bad drivers are making lots of complex decisions and making calls on things that are very complex to write into software codes.

I consider myself a technophile and I am quite fascinated by this but there are quite a lot of challenges. Cecilia mentioned good drivers earlier. That should be the target. The average person has a collision about once every seven or eight years, overall, but many people go much longer than that. That is the target for an autonomous vehicle. I do not think I have ever had a vehicle that has not had a fault of some sort within the three-year period. I do not mean that if they have a fault they will crash but it could mean that there are slip-ups

and things that will happen in the meantime. It is going to be a very interesting period. The period where we have some level of autonomy and human-driven cars interacting is the time when there will be most risk and we need to look at how we manage that.

Mr NICK LALICH: Professor Toby Walsh from the University of New South Wales suggested that automated vehicles should be visually distinct and easily identifiable. He suggested that this would be done by using plates similar to those used by learner drivers and P-platers. Do you consider that this would enhance road safety and, in particular, benefit vulnerable road users such as bike riders and pedestrians?

Mr McDONALD: I do not think that that is a bad idea because autonomous cars will have a level of logic that is quite different from human thinking. It would be good if people could know that a vehicle may behave differently to how a person may behave. I know, from reading about it, that while the Google test cars in California have had quite a few collisions, most of them have been due to people underestimating them or doing something that the computer is not expecting them to do. I think that identifying them—as we do with LPG cars and with L-plates for learner drivers—would give people a general warning that the car is being driven by a machine. Then people may behave a little bit differently around it.

There have been cases of road rage in California, I understand, because many of the cars are very conservative in the way they drive. They probably obey the speed limits, which most people in California do not, in my experience. That can lead to people doing erratic things around them. So I think that that is a good suggestion.

Dr MEHREEN FARUQI: Most of the questions I had, have already been asked. So that is good. I do have a couple of small questions about the liability issue. Will the amount of work required to determine who is at fault—whether it is the driver, the person sitting in the car, the car manufacturer or the other person involved in the collision—result in premiums going up? Or will it be quicker to establish that so that premiums might go down? Have you given some thought to how driverless cars will affect insurance?

Ms GREEN: We have claims models that do that today. There is a skill set differential in terms of the types of skills that we would be bringing into our claims models that would be changing with the changing environment. In relation to the data analytic piece associated with it there are some other skill sets that we might have sitting in there. Our high-level view, without knowing what the environment would be, would be that it would shift but not necessarily increase additional friction in terms of the process. It may even drop the speed associated with it, because when you think about the data and analytical skill sets that are developing you realise that you can build automation around that.

You may, in fact, have automation making determinations around automation. The amount of friction that is put in the process—in terms of access and the information that you need to have—may drive the cost. That is probably a question for consideration. Who owns the data, data access, the ability to get it quickly and the form of the data needs to be considered. Should there be standards associated and built that enable that ease of access to speed up that type of process? We have that question but we do not necessarily have the answers associated with it. That is definitely something that we are thinking about.

Mr McDONALD: There is also the issue that while collision frequency may reduce or change, the average cost may increase because the technology in the car is higher. So when a car has a collision—or even has a tree branch fall on it or it goes through a hail storm—there could be a higher expense. We encourage cars to have electronic stability control. That reduces overall collisions but cars once had headlights that were worth $100; they are now worth $2,000 or $3,000. So we might be replacing them less frequently but it is costing us more when we do it. There is always a bit of a balance. It is a role we play with the car makers. We say, "We like this technology but how can we make sure that it is in a place that is not vulnerable—that it is not in a place that is commonly collided with—and that it is easy to repair and that you do not have to do lots of technology replacements after the car collides?"

Dr MEHREEN FARUQI: My last question is about vulnerable road users. A number of submissions have raised concerns that driverless cars are not able to detect cyclists, for instance, or motorcycles as easily as humans driving cars might be able to. Do you have any views on that? Have you given that much consideration?

Ms GREEN: I would probably say at a high level it comes back to the fact that the technology needs to be developed to a level that is better than a good driver, because that exists today in terms of how we are accessing roads and driving and intersecting on roads.

Ms WARREN: The point is that technology should be an enabler for keeping people safe. We have certainly seen improvements over time, but it may be that you still need to have dedicated zones. Having bike lanes, where only bikes are in that lane, is a bit of a no-brainer, really, for keeping those people safe. I think you will see more and more technology emerging but someone who is inside a vehicle is always likely to have more

protection than someone who is more exposed. We need to try improve the conditions for vulnerable road users and think about how to educate pedestrians not to walk around looking, down distracted by their smart phones. These are things that are real and we need to try to find ways to handle that. I saw—I think it was in Germany—that instead of having "walk" signs high up they have them down in the ground. Pedestrians who are facing down might be warned by those lights.

I think we just need to respond to emerging challenges. I do not think the challenges should stop technology or causes us to pull back or be afraid of it. We simply need to ask, "How can we use technology to make people safer?"

Mr McDONALD: I was thinking today, when I was navigating the roundabout in Olympic Park that allows cars to turn right from the left-hand lane, that I could imagine a computer-driven car sitting there and doing the equivalent of the blue screen of death that my desktop computer does. The most obvious early application is going to be highway driving, and it is probably relatively easy to keep vulnerable users off those. I object greatly to cyclists being allowed on freeways where people are doing 110 kilometres an hour. It has been shown time and time again that that is a really bad idea, but we keep allowing it. Maybe, once we get to that point, that is the point where we say that only cars, motorcycles and driven vehicles are allowed on these roads—at least until the technology develops that can identify a small person on a small bicycle or even a small dog on the road and that is a bit of a challenge these days.

Dr MEHREEN FARUQI: Thank you for that. I do hope the New South Wales Government hears loud and clear that having separated bike lanes is a no-brainer.

The CHAIR: If members have no further questions, I have a brief question to conclude. Your submission encourages the New South Wales Government to consider ongoing investment in intelligent infrastructure development, research into innovative technologies and facilitation of contemporary training to help boost New South Wales productivity and prosperity for the long term. This Committee has been talking about road safety, but this is a slightly different angle to the same subject. Is there a particular area that you believe the Government should prioritise? Are you aware of any other governments that have undertaken this, and to what effect?

Ms WARREN: I think the New South Wales Government has made a start along this path by having the expression of interest for a Smart Innovation Centre. We endorse that and we have quite a keen interest in it. One of the things I think will happen as a result of this collaboration that is occurring across government, industry and start-up sectors we are seeing with various governments—the South Australian Government is to be commended and the New South Wales Government is doing it—is the Australian Driverless Vehicle Initiative, which I know presented earlier today and we are part of it. It is a group that is bringing together very diverse people and businesses and it is going to start to create something new. That is where you will get the economic benefit.

You will also get economic benefit if these technologies and the businesses that emerge around the technologies start to solve customers' problems—start to make it easier for people and goods to move around, start to make it more efficient, start to make it more productive. Obviously, these things will emerge over time. Certainly governments in the UK, in Singapore, in the US and in various other places are starting to see that they can drive economic value for their own economies because of what will be created out of these things.

Mr KARAGIANNAKIS: I would like to add the potential savings in infrastructure. In the long term, when we have a fully autonomous vehicle country, potentially we will not need multilane highways to the extent we need them now, because cars and even the concept of ownership is going to change. We may not need as many cars and there will be greater potential for ridesharing and, because of the ability to program vehicles, there is the potential to save on infrastructure spending. The actual economic benefits could be quite substantial in the long term, not to mention the productivity gains by having a better flow of traffic through our cities such as Sydney that suffer, as we know, quite dramatically from road congestion.

The other point I would make in terms of what Ms Warren was saying about consultation—and we raised this earlier—is that I think there is a real opportunity for the New South Wales and ACT governments to work more closely together. The ACT Government, similar to the New South Wales Government and the South Australian Government, is on the front foot and wants to develop this technology. Given the overlap between Canberra, Queanbeyan, Yass, Goulburn, there would be great opportunities to cooperate between those two jurisdictions.

The CHAIR: That is a good point. Thank you very much for appearing before the Stay Safe Committee today. We appreciate your submission and your time. That concludes today's hearing.

(The witnesses withdrew)

(The Committee adjourned at 17:03)