



PROJECT NO: 3-014

**Australia's Disability Standards for
Accessible Public Transport and
Connected and Automated
Vehicles – Stakeholder
Engagement Report**

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Risk and Opportunity assessment for People with Disability

This report provides a full account of the stakeholder engagement with regards to the risks and opportunities Connected and Automated Vehicles (CAVs) represent for People With Disability (PWD). The summary can be found in the main report “**Australia’s Disability Standards for Accessible Public Transport and Connected and Automated Vehicles**”, but we believe that reading through the actual words that people use to describe risks and opportunities is valuable, hence this report allows us to bring some of the issues summarized in the main report further to life. We have also included the feedback of the manufacturers in this report.

Methodology: Risk and opportunity exploration

Four focus groups (two at the beginning of the project and two towards the end of the project) were conducted online (via Zoom) with participants representing disability groups including physically, visually and auditory impaired persons with 26 participants. Participants were selected after an Expression of Interest (EOI) was distributed among members of Australian Federation of Disability Organizations (AFDO) and online media by AFDO. The response to the EOI was one of the highest ever experienced, demonstrating the importance of the topic.

Prior to the focus groups, an information session was conducted to brief the participants on the concept of Autonomous Vehicles (AVs) and what we were hoping to investigate in this study with a particular focus on Autonomous Shuttles and Air taxis – vertical take-off and landing (VTOL) – see Industry Workshop section. A document with detailed information on AVs including benefits and technology readiness level was provided, so that all participants had an equal level of understanding on the topics discussed prior to the focus group.

The discussions were subdivided into three topics, firstly being the driverless factor, secondly the vehicle design, followed by the connected aspect of AVs and finally comments on Air taxis. Each focus group lasted approximately 2.5 hours and all participants were given the chance to express their opinions on the four topics. The sessions were recorded for validation purposes.

It was not the objective to solve transport related issues in these sessions. Some of these issues are fairly complex and require more effort and time than what was allocated in the focus groups.

Two workshops were conducted where a group of 11 peak body representatives were brought together via Zoom to review the needs and challenges that CAVs offer for PWD. The 2-hour sessions included participants from Physical Disability Council of NSW (PDCN) & National Inclusive Transport Advocacy Network (NITAN), People with Disability Australia (PWDA), Spinal Cord Injuries Australia (SCIA), Paraquad (PQ), Guide Dogs NSW/ACT (GDNSW), Vision Australia (VA), Council for Intellectual Disability (CID), Synapse, Stroke Recovery Association (SRA), Deaf Society (DS) and Hearing Matters Australia (HMA).

We also conducted desk research to identify existing studies on the challenges that PWD see with CAVs. The literature review was conducted using multiple sources ranging from Government reports and journal articles to private research and news articles. These challenges and needs have been identified from the start to end, also known as Whole Journey taking into account pre-journey planning, public transport stops/station, public transport service, interchange, return journey planning, potential disruptions and as well as supporting infrastructure requirements based on twenty-three international research reports. Disabilities have been categorized into physical, cognitive, visual and auditory with an attempt to recognize unique issues that each group may encounter when travelling using public transport services. An article published by AutoAlliance in Washington (2019) is frequently cited as the article provides a comprehensive list of needs identified by PWD to improve accessibility when designing AVs.

Methodology: Industry engagement

We engaged manufacturers and industry representatives in order to understand their roadmap. This roadmap was summarized and presented to PWD as input and to familiarize them with the topic.

Phase 1: Issue identification

Industry engagement	Interviews and correspondence with manufacturers and operators of CAVs: <ul style="list-style-type: none">• HMI• 2getthere• Navya• EasyMile• ADVI• eVTOL.org
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Phase 2: Co-design

Regulatory review	<p>5 major CAV manufacturers:</p> <ul style="list-style-type: none">• HMI• 2getthere• Navya• EasyMile <p>Representative organization</p> <ul style="list-style-type: none">• ADVI <p>Operators</p> <ul style="list-style-type: none">• SMRT (Singapore)• Keolis Downer• Yarratrams <p>Air taxi: Industry</p> <ul style="list-style-type: none">• EASA - European Union Aviation Safety Agency• VTOL.org (USA)• The Vertical Flight Society (USA)• EVTOL Insights (UK)• Advanced VTOL Technologies (Melbourne)
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Phase 1: Exploring issues and opportunities

Phase 1: Focus groups

A wide variety of responses were obtained for each of the four topics discussed (driverless aspect, vehicle design, connected aspect and Air taxis) during the two focus groups. Participants expressed their concerns for AVs, current challenges when traveling on public transport, positive and negative experiences with current technology solutions, what is currently working right and areas that require attention, opportunities AVs will bring to PWD, frustrations as a result of discrimination and excitement to experience new technologies to name a few.

Autonomous or driverless aspects

The fact that there will not be a driver or direct assistance in AVs raised significant concerns as PWD heavily rely on the driver of a vehicle to not only transport the person from A to B, but to also assist with navigation, communication for general purposes and during emergencies, physical assistance such as wheelchair assistance (particularly if wheelchair is manually operated) and to pick up and drop off at safe locations avoiding obstacles on the road which is challenging for the visually impaired to name a few. In addition, perceived safety of having authorized personnel (driver) physically being present was also important, particularly to those who are vulnerable.

"I would like to always understand that whatever system I use, I can get feedback from a human being to tell me that my communication has been noted and will be acted on. So, I want to be able to say to an electronic system, and I'm not - I don't care what it is, that I would like to go to such and such a destination and my needs are I'm a guide dog user and my needs are such and such. Can that be achieved and get some feedback that has been noted or that will be enacted. Because just pressing a button or communicating with a piece of inanimate technology, doesn't give me feedback or comfort that I'm actually going to have my needs met."

"I have a difficulty, so it takes a while to gather my things to get off the bus. How will the bus know when to wait for me if there is no driver? I have difficulty with auditory processing which means people speak too quickly for me, so the announcements are difficult for me to understand."

"I'll just mention very quickly the metro that's been introduced in Sydney covers a lot of the issues that have been discussed. The train pulls up at exact level with the platform, there is essentially no gap, there are doors to stop you falling off the platform before the thing arrives, and the announcements are very clear. There's quite a bit of redundancy so when you leave one station, it tells you what the next station is going to be and as it's pulling up it tells you the name of the station, it also tells you which side the doors are opening on, there are beeps to indicate the doors are opening and also when they're closing."

"One of the things I love about this autonomous vehicle stuff, being blind, is that I can't see the driver anyway in any circumstance. To have no driver there doesn't disadvantage me in any way. I don't know if you've heard of the concept KISS - keep it simple stupid - I find that with - if everything's built the same way and it's all to the same standards, doors open the same way, everything else like that, it's just so much easier to learn. So if you learn by repetitive learning, it's easier to learn and you don't get overwhelmed with all this new technology and stuff like that. I absolutely can't wait for all this to go ahead. And look, I think good on you guys when it does come, I hope to be one of the first people to trial it."

"When I enter the bus normally, I need to talk with the bus driver and say, like, OK, could you wait until I'm in the correct position to hold the bar and finish parking the scooter or whatever. So, without the bus driver, how can I manage that time to stay in the correct position and hold on the bars because, yeah, in the past once I fell down from the scooter because the bus started departing before I was in the correct position."

The bus driver has a complex role and fulfills many important aspects, beyond the ability to provide direct access:

"I guess there is a level of at least perceived safety with a driver actually there who can provide direct assist. So, my first question is, so you don't have someone who has direct assist available, and the second question is that, if there's a way of contacting, you know, this remote person who is monitoring the vehicle, is there a way someone in the vehicle, or other passengers could block access to request for safety?"

"Is there service connected to any app where you can organise your journey to say, I need to start here, and I need to get out here? Those are the questions because, yes, every single time I use the bus I need to talk to the bus driver to say, OK, I need to get out or, you know, in that stop or whatever."

"I also want to go back to last time we talked about the vehicle stopping at a place that isn't safe. That's an enormous concern, you know, hopping off the vehicle into a row of rubbish bins or some footpath works or whatever. And the other thing was around if I miss my stop, what do I do? I can't say to the driver what's the best option. I'm stuck, truly stuck. And even if there's somebody I can access with a button, are they going to, like, have the skill to know that? So, it's more about feeling vulnerable."

"If something happens and the pod breaks down, literally stops in the middle of the road or somewhere, and, you know, heaven forbid you lose communication as well with whoever the emergency voice is at the other end, so you have a total blackout on one of these things, sort of what's going to happen in that situation where you can't make contact with anyone at all whatsoever. That would be a big concern for a lot of people and a confidence thing as well."

"Rural travel is really important because, yeah, there's going to be different obstacles than there is in metro Victoria, metro Melbourne or metro places, and I just think it's important to have that in consideration. And also know that getting stranded really is going to be a massive problem."

Table below (Table 1) includes additional comments from participants not mentioned above on autonomous or driverless aspect of AVs.

Table 1. Additional comments from the focus groups regarding Autonomous or driverless aspect of AVs.

Common topic	Direct quotes
Lack of direct assistance	The biggest issue with automation will be a lack of transport assistance based on direct access. Direct access is something that a lot of transport providers use when their conveyance, and when I say conveyance, I mean the bus, the trains, the taxi, etc, the conveyance isn't quite accessible for a person with disability and so they throw staffing at it. The easiest example of direct access is a staff member bringing a ramp out to assist getting on a train at a platform that isn't level. If you're automating things, you lose that ability for direct access because there simply isn't a staff member there. Now that puts a lot more pressure on the conveyance being 100% compliant because without that compliance it's unusable for a person with disability.
Lack of direct assistance	I think for a start we need to differentiate between taxis and other forms of mass public transport for a start. And what I've focused on here is, of course, other people are covering it quite well, about mass transport, so where you're on a vehicle with numerous other people. But with a taxi it's a different situation and this sort of things that taxi driver does at the moment, for instance, is help you with your luggage. So, you arrive at the airport, or you're at the supermarket and you've got 50,000 plastic

Common topic	Direct quotes
	bags full of crap, and you need to get home, so you call a taxi. And the taxi driver will not only help you load that stuff into the taxi, but if you get a nice taxi driver, they will probably even accompany you to the front door and put it inside the front door for you.
Lack of direct assistance	So for me, the driver represents safety. So a person with a vision impairment might hop on a train spot and say to the driver "Let me off at such and such a spot." There's no scope for that at all. So how am I going to identify where I want to hop off?
Lack of direct assistance	If somebody was deaf and blind- they might learn where the button is to push but they're not going to be able to converse with the person on the other end at all.
Lack of direct assistance	Same for someone who is hearing-impaired in any way, shape or form. A camera being able to see into the space is good for the operator to be able to see what's going on, but the hearing-impaired/Deaf person on the other end would need some other way to be able to communicate back
Lack of direct assistance	I suppose being a blind person, my fear and reduction in confidence will be both from the point of view of not knowing what is - well, first of all where the vehicle will be stopping. So, for example, we're talking about entering or exiting the vehicle if there's, you know, footpath works or if there's building rubbish or anything like that, but also, if it's not going to stop. If there's soot vehicle or something in the way, building materials or something, it can't stop in the normal position, I don't know - I get a bit nervous because, you know, if I can't geographically sort of identify where I am, I get fairly anxious and to get out of the vehicle either before or after or somewhere different from where I would be trained the designated place was, I would lose confidence very quickly. And then, being able to find whatever the vehicle is that I'm having to enter, if I'm changing transport, say, for example, and if trains were changed from its normal departure point to a different departure point that I'm not used to using, it might be becoming something overwhelming for me.
Lack of direct assistance	With giving instructions or trying to find out where something is going to go from or go to or what time, of course, the only way I would be able to do it is by voice interaction. So no map and no printed information on a screen is going to be able to assist me and, again, I won't be able to feed back by printing or typing something in unless there's voice interaction as well. So whether you have a speaker or have to put some headphones or whatever, it's going to be a long process.
Lack of direct assistance	The other thing, having been involved in a bit of a train emergency, that might be very rare but something that really scares me, is that I was on a train where vandals had spray painted and also broken the camera in the train which caused other damage and if there's no direct assistance and even if you can find the button to speak to somebody, I'm worried that they're looking after 10 or 15 vehicles and are going to be preoccupied with another situation where somebody else needs some help, understandably, and if they come and answer my query, but somebody's damaged the camera, then they're going to have no visual input and if I don't know where I am and they can't see what's happening. It's going to make it very distressing to be honest.
Lack of direct assistance	I don't have to interact with the drivers when I'm travelling except for when there is disruption. And that's when you really need to know what the drivers have to say because they are the first responders, and they know what the situation is. Because in the various apps, they don't get real time information as quickly. So, yeah, I have often found myself relying on other people as to whether they have had - when I say other people, I mean passengers, whether they understood whatever the announcement was being made, whether they know anything more because that really affects how long I'm going to be just stuck where I am and planning for alternate journey. That's one of the main things, with disruptions you can really rely on the driver because they know first-hand as to what's happening and how to actually plan your journey ahead.
What is working well	Next point I've got is that, for example, in Victoria we've got Victorian taxi cards and Victorian travel passes. I think there needs to be a standard universal thing across all

Common topic	Direct quotes
	platforms and all States and Territories. So that way when you go from a shuttle in Sydney to a shuttle in Melbourne, it's smooth, it's consistent, it's easy to be used and easy to access.
Ramp design and surrounding infrastructure Lack of direct assistance	The other one is what about when, you know, when you are in the pathway and the bus comes and they put the ramp, sometimes the inclination of the ramp is too high. So how can you enter because sometimes - you know, I use an electric scooter, and I have problems pushing it up. But I have seen people that, you know, don't have a power assist chair so the bus driver needs to go down and help them to enter to the bus. The same when they're going out, that is in my case. For example, in the stop that is near to my home, it's too high so the ramp is very inclined. So when I need to go down from the bus, it's very difficult so I get help from the bus driver.

Vehicle design aspects

There are many factors to consider when designing a vehicle that is universal to all and in doing so meet the various and unique needs of PWD that may differ significantly, even within the same disabled category. As an example, physical disability should not only take into account how mobility aids will be incorporated in the design, but also factors such as lower dexterity, position of buttons and screens should also be carefully planned. Consistency is a key point mentioned when it comes to the vehicle design and surrounding infrastructure as it aids in repetitive learning resulting in increased confidence when traveling using public transport. The current size of autonomous shuttles is cause for concern, due to not having enough space for multiple mobility aids, guide dogs and ambulant passengers in a single ride. How the vehicle design will mitigate risk of antisocial behavior was another point raised during the discussion.

Easy and consistent controls are a concern if one can't talk to a driver or assistant:

"For me, one of the points I wanted to raise earlier about the vehicles, the buttons, everything inside the vehicles, platforms, etc, is consistency. So, once I have learnt a vehicle, a train, for example, I know where the various buttons, where the things are, where the handrails are, etc, same with on the platforms. So, having a blueprint for what each platform would look like, making them very consistent by area, or by route or whatever else, for me is vital, similar to the inside the vehicle. It's all about consistency. Dealing with variations as they come up is fine but keeping the variations as a minimum will be nice."

"Well, the challenges again, just currently, would be that the swipe on points - when you go into a designated spot - I've got a mobility scooter, so I park it in the bay, but the access points to swipe on and swipe off are facing away from me. So, I can't actually reach around and swipe on. I must ask somebody to actually say "Can you swipe this on for me?"

"On the touch screens, easy English and pictures. If you can't actually read English, like you're an overseas student and you want to come to Melbourne and you want to go to Southern Cross. You don't know what it is, but you know what it looks like, you press that picture. Or if you want to go to the hospital, you press that picture. So easy English would be really good. Call signs help, assistance, telephone, whatever it may be, to be able to get more assistance. Go, stop, things like that. That should also be on the touch screen."

"I'd put a suggestion forward that we could perhaps look at putting in some sort of braille, like display into the touch screen so you could communicate tactfully, not necessarily with your voice, so that for Deaf blind folks that would also be of some benefit as well. So, we should also look at braille being the big point here."

"There's just a need for universal acceptance of all on all of these vehicles at all times. When it comes to touch screens, there's also an ability to not have to touch, to use your voice, perhaps with your personal voiceprint allowed. So, your profile is automatically known if you wish it that way. The reason why I mentioned that if you support access for people with extra challenges, is because the flow-on effect is, if you do that, is that you also assist others, all others, and I mentioned the examples of a person in a wheelchair, designing for them is designing for others with temporary injuries, prams, etc."

Entering and securing the wheelchair or finding a seat are a concern – that are exacerbated if there is no driver:

“There should be mandatory accessible seating for all people with disabilities. So close to the doors, and stuff like that. There's nothing worse than trying to get to a door when people are standing up in front of you all the time or someone won't give up the seat. Fully capable, fully able, but they don't want to move because they don't have to.”

“So currently in Victoria, usually PTV will have to come and try days for people with disabilities. So, I think that should be a very important thing as well for these shuttles. But not only that, but also getting back down to a basic technology type situation. I think they should have try days or user days and training days in primary schools and things like that. Because if we're looking at 10 to 20 years in the future, then we're sort of got to look at our youth now, hopefully in the future, so that way it will be fully abled for those using it but then also they may be able to teach us how to use it as well.”

“My last one is with the transition from starting and stopping. The shuttle has to be very smooth in starting and very smooth in stopping. No sudden jerks, no sudden stops. Trams are absolutely terrible for it and same with trains. When they're running on a timetable, they're pulling up at a station. They're hard on the brakes and it almost throws you forward or backwards in a seat. Trying to walk up to a door when it happens and it almost throws you.”

“There needs to be coordination between wheelchair manufacturers and public transport systems in that there needs to be a universal design for lockdowns. So every wheelchair needs to have a universally designed docking pin that will fit into obviously a universally designed docking station so that it doesn't matter what brand of wheelchair you have, it will automatically be able to be locked down just by simply driving into right position in one of these vehicles, whether they're a mass transit or an individual one. And, of course, you need to be able to release that lockdown. Again, I know that sneaks into the third area we're talking about technology, but that lockdown probably needs to be able to be inactivated, in other words, released from the lockdown, using voice or something else, or maybe an app that a person can manipulate, not simply rely on you having the manual dexterity of reaching up and pushing a button.”

“Seating that is really, yeah, secure and comfortable as well for people with pain, sitting on really hard seats is really painful and, you know, if you're trying to brace yourself with the movement of a vehicle, that's difficult as well if the seat is almost just this tiny little hard thing. And it's hard if you have back pain and you're standing up and you have orthostatic intolerance issues as well.”

“On some of the trains you've got to be Hercules to lower the disabled seats. So, a person who wasn't very strong or who was frail, would not be able to lower the seat. The opposite is when you're a wheelchair user and lift the seat, sometimes you need to be Hercules to lift the seat.”

“I'm a little bit concerned about how much standing room there is as well. I have a guide dog and he's quite large. Guide dogs will always try to lie on the floor so if there's people around, they will be stood on. In most transport there's capacity to slide dog under the seat because the seats are a certain height, but that's not always part of the option. If the seats are too low, the harness from the dog can get lodged under the seat, it's difficult to get a dog from under the seat so the person will miss their stop and the dog will be stuck.”

PWD count on the driver to wait for them to close the door and alight them in safe places and resolve conflicts:

"The touch screen is completely flawed if we have to interact with it. I can't see any way if I'm blind and I walk up to a touch screen, how it's going to be able to interact. If I'm going to be able to interact with it and then if the next person is deaf, how are they going to change the mode from my settings to their settings. When we're in busy environments and, you know, if we're trying to listen to the audio feedback from a touch screen, it's completely flawed and it will not work in this scenario, I don't believe. My personal idea would be that we all seem to have our own devices that we can configure to our needs".

"We can fix the actual vehicle, that may not be a problem because it's privatised, but when you actually get off that's owned by somebody else, there will be problems. In the case of buses, it's the local council. So, there's that disconnection between the two. So, with the infrastructure side of things, you have actually got off and then what happens, and a lot of people have pointed there are bins or if there's no dedicated platform or a stop indicating, how does that all work together? I'm pretty sure that we will come up with a fabulous design for the shuttle itself, but we will still struggle with the infrastructure side of things because that's what we are facing even today and that's like an ongoing discussion."

"A big concern of mine is just doors shutting on me, doors shutting on people as they're getting into the vehicle. This already happens quite a bit, but I imagine if the process is automated this could happen a lot more. And so that's something that I worry about, doors shutting and kind of taking off."

Information will make it easier. Some people with intellectual disabilities might get bullied on the bus without a driver. Some people have intellectual disabilities can't read so they might find it difficult to select their stop on a touch screen. It might be good to have a phone app where you can have a picture associated with a destination so they can choose and use that instead."

Table below (Table 2) includes additional comments from participants not mentioned above on vehicle design aspects of Autonomous Vehicles.

Table 2. Additional comments from the focus groups regarding the design of AVs.

Common topic	Direct quotes
Discrimination	But what it's saying to me in the background is that despite, you know, 20 years of antidiscrimination legislation against people with disability, we're still getting a tone of something that is public, public transport being designed for people who are able-bodied. Right through that document you can see that, you know, they sometimes have a wheelchair space but it's really mainly for standing. The announcements are usually muted. In the hovercraft-type approach, you know, they've made the seats padded enough for people who are standing but they haven't quite worked out what to do with people who use wheelchairs.
Consistency to aid repetitive learning	The other one I looked at was when you mentioned different companies looking at different designs for vehicles, once the design is looked at, I think it needs to all be a universal design, so that way then, instead of going from one bus where the lift might be at the front, then the other one might be in the middle, the other one might be at the back, they all need to be identical. So that way we don't have to keep chopping and changing and learning all new things.
Cleanliness	<p>With the personal hovercraft and the shuttle, with using something small with a personal hovercraft, how do we keep it clean or how is it going to be clean? is it going to be safe? So COVID's going to be with us for a very long time. If it's going to be for a number of people, how does that environment stay safe? Will it have an automatic clean down unit inside the hovercraft or shuttle and same with in the shuttle? Will that be a thing that personalised staff will have to do each day or each fortnight or whatever?</p> <p><i>In response to a question about hygiene relating to a disability:</i> I'm a double transplant recipient, so, yes, it is to my disability. It goes back then to the touch screen with being blind. Not everybody has got good personal hygiene, so, you know, pick their nose, scratch and whatever else and then start touching screens, and, you know, from there we might jump on it and touch that same screen and get crook.</p>
Communication design	If I could say that the communication needs to be interactive and verbal, if possible, and also possibly electronic. Buzzing when you get to the stop is useless otherwise you've got to go back to the arrangement that Martin Stewart suggested and that's counting your stops. If it doesn't tell you that you're at Smith Street or your next stop's Smith Street, a buzz to say the bus is stopping is a waste of time, I think.
Communication design	Well, the challenges again, just currently, would be that the swipe on points - when you go into a disabled - I've got a mobility scooter, so I park it in the bay, but the access points to swipe on and swipe off are facing away from me. So I can't actually reach around and swipe on. I have to ask somebody to actually say "Can you swipe this on?" And, yeah, I can just see - on the notes, I can just see that, yes, you can make the screen really big but for someone with dexterity issues who is affected by stress, punching in all the information on a screen when it's a crowded shuttle or whatever could be a real challenge.
Communication design	A question I had was where the location of the touch screen is actually within the shuttle because if it's at the entrance and you need to change your mind that's another point that I don't think anyone - I didn't hear anyone raised. Sometimes I would change my mind because I see something else or feel unsafe on the vehicle or whatever it might be, and I want to get off earlier or later. If I have to get up to press the button to change where I'm going, that's really difficult and sometimes impossible. So, I would need a solution for that.
Communication design	You need multiple buttons at different heights. And consistent, so a blind person would know, for example, at railway stations we have to rely on the mobility and orientation officers from Vision Australia or wherever to train us on individual stations. Well, they won't have enough people to train everybody on where buttons are in different locations

Common topic	Direct quotes
	as well as in different vehicles. And if there are people that are standing around, are we going to be able to get to the buttons and find them on the wall or wherever they are?
Comfortable ride	The mode in which these pods are travelling, so the speed, the comfort of the ride, you know, if it's braking, if it's got to brake suddenly, you know, is somebody going to fall over, fall out of their wheelchair, things like that. How smooth the ride and that is going to be. That's an issue with the buses currently as well. I've heard of a few people where, you know, the chairs topple or somebody's fallen out of their chair because the driver has taken the corner too quick and things like that, hasn't thought there's a person in a wheelchair on his bus.
Lack of noise in Autonomous Vehicles	The only thing that I want to touch on that hasn't been touched on yet, I agree with all comments previously listed, is I want to come back to the white noise situation that was written in the document surrounding when you're going to know whether a vehicle has even approached you because I was even talking to my orientation, my mobility specialist yesterday about white noise and it's actually not something that even orientation mobility specialists even recommend to their own clients to even listen to white noise. So I think there really needs to be a way or an approach to work out even when your vehicle has stopped or approached or has even stopped. So I think, you know, because there's no point being able to even get on the vehicle if you don't even know the vehicle has even turned up. So you could be standing there and the vehicle may be there and you may have missed five vehicles. But if you don't know that they're there, then there's really no point in even making the effort to even get to the vehicle.
Lack of noise in Autonomous Vehicles	Also, I think [participant x] talked about the noise on approach, that's vital as well. Whatever that noise is, when the doors open, noises and things like that. That happens currently on trains, I believe, so it should be pretty repeatable.
What is working well	I just want to quickly just add, in New Zealand, my home city, it's not automated but they've got audio announcement at the bus stop. So there's several stops, because my city is not that big, but there's like a screen that announces bus waiting at such and such stop which is easily identified by, you know, tactile sort of. And when the bus leaves it will say bus leaving and another one coming in and will say the bus is now at bus stop 3. Once they get on the bus, every stop is announced so they know where to get on and get off at each stop. So it's fully audio.
Locating the right vehicle	Because that's what I'm trying to navigate how to be able to find which bus is where and the other thing I was thinking of, which I don't know if you guys have actually looked at. You said that the shuttle can crab walk and because it opens in the middle, could it be possible to bank three shuttles side by side and walk through one, two and get to three and get three off which would potentially make parking spaces, instead of being longer going length ways, it would make it wider?
Seat belts	Seat belts, they need to be able to be applied and whatever the restraining system is without passenger - without the passenger needing to push something. So it needs to be done somehow either programmed in that when you get to your stop it automatically releases, or that there's some way you can do it by voice or whatever.
Time allowance	A big concern of mine is just doors shutting on me, doors shutting on people as they're getting into the vehicle. This already happens quite a bit but I imagine if the process is automated this could happen a lot more. And so that's something that I worry about, doors shutting and kind of taking off.
Time allowance	I guess, some of the stuff we talked about, think we should have - there should be a button for extra time to get off for one as well. So we can press it and that time should be really measured with disabled people who actually get off and on vehicles because it takes us just longer and I often have doors nearly closing on me.
Space allowance	The size of these pods as well in relation to if, you know, one or two wheelchairs are getting on at the same spot at the one time and you've also got, you know, 20 or 30 people like you would in a train or a bus already in there standing up and then the safety restrictions around that. So, you know, we've got to look at things like layout and have obviously designated areas like we do in the trains for where this is where the wheelchair is

Common topic	Direct quotes
	going to be located and then that separation of, you know, wheelchair passengers and obviously ambulant passengers as well and safety restrictions around that.
Ramp design and surrounding infrastructure	Other thing, too, is obviously the built environment in respect to where we're getting on and off. These things as well and making sure that each point along the route is, you know, exactly the same height and things like that so when the ramps come down, we're not dealing with different gradients and things like that with people entering.
Ramp design and surrounding infrastructure	Another one I looked at as well was when the bus comes to a kerb, as it was previously mentioned, I believe that a ramp should automatically come out onto the kerb when the bus lifts up or lifts down so that even though it might be close by a couple of millimetres, a smooth and effortless transition from platform to shuttle can be done. I think that would be the ideal thing to put into place. Also, when the doors open announce doors now opening, doors now closing, but around the doors, have high visibility through lighting. So that way then you know if you have low vision, you will be able to see the - hopefully be able to see the lights around the doors to show you that that's the doors and now you can go in.
Prams	And also what about prams? I know there's a lot of - I often go with a pram. That sounds like there needs to be kind of a solution for that as well and we talked a lot about different wheelchairs but I often would need to use a pram for my child and that would need to be secure because it doesn't sound like there would be any seat belt for the child and I'd have to secure the child and having to hold that pram. So we'd need some kind of way to secure that as well.
Synchrony between transport provider and councils	We can fix the actual vehicle, that may not be a problem because it's privatized, but when you actually get off that's owned by somebody else and that's in buses. In the case of buses it's the local council. So there's that disconnect between the two. So with the infrastructure side of things, you have actually got off and then what happens and a lot of people have pointed there are bins or if there's no dedicated platform or a stop indicating, how does that all work together? I'm pretty sure that we will come up with a fabulous design for the shuttle itself but we will still struggle with the infrastructure side of things because that's what we are facing even today and that's like an ongoing discussion.

The connected aspect

A key point highlighted by many participants was the ability for individuals to have a communication platform that is personalized to cater to different needs of PWD. Some participants were willing to share personal information about their disability, in order to customize the service. Although the use of mobile apps was favored, if mobile apps were used as a main source of communication, in the case of an emergency or if the device is not operating, how a person with disability will be able to communicate to seek assistance was a problem. This was an issue frequently raised within the groups as there is still a significant lack of trust in technology and human presence and ability to speak to a human was deemed the most reliable option.

Digital applications present opportunities:

"I think when it comes to driverless vehicles, the Deafblind community rely on communication, the ability to communicate with the vehicle is really important. In terms of the iPads and the announcements that come through with the vehicle, perhaps it could be some sort of syncing with the mobile phone that they can have access to, whatever format they wish to have. Having the formats, the language they understand with pictures and it's pretty common for the Deafblind community, to, to have simple English that they require, braille, whatever it may be, pictures."

"And also, is it possible for the seats to be somehow recorded, whether they're taken or not, so that before you actually board the vehicle you know if you have a seat. I wouldn't board a vehicle if I knew there wasn't a seat available. You can wait for the next one or whatever because that's really important."

"Maybe an app like a 'Book It' app. If you're at your local bus stop, you can put in, you know, I'm here, I want to leave at 12:00, and I want to go to a shopping centre, and then, because there might be three buses that are all going to that shopping centre, then the first bus will send you a notification, bus arriving in five minutes. So, when you walk onto the bus, it automatically clicks you onto the bus and then possibly gives you notifications when you're almost at your destination."

"I have a situation where I will wait for a bus and buses just drive straight past me. So, having some sort of way of signals that I am wanting to get on that piece of transport, be it a button - I think we talked about this, a button at the particular stop, albeit a way of using my phone that I can say I want to get on this thing, and it knows not to take off until I'm actually on it would be great."

"Personally, I don't mind sharing my information because at the end of the day if it's going to make my travel experience a lot easier then I don't see an issue with it."

"I'd written down about the Uber app or ride sharing generally and although there's a human driver at the moment, it is getting, for me, very close to independence. I book the service, it knows where I am, it tells me how far away the car is, what the car is, I can communicate with the driver if I need to before he or she arrives. And I jump out at the destination and go on my way. It really has been a transformation because a couple of other people have mentioned, but the taxi, you know, as my son said years ago, taxis are the most expensive form of public transport and the least reliable and this whole ride share thing is completely turned that around for me."

...but:

"We still have unlabelled buttons in the apps, which is quite astounding considering that we have transport providers that are still not complying with app standards. So really getting into fixing those apps up would be nice."

"So, unless these access technologies become very accurate, they are not going to be very useful at all and we certainly aren't there yet and there's a lot of work to be done. If they get there, they will be fine because the concepts and ideas behind them are wonderful, but as I said, I've stopped using them because they're no use because they actually lead you astray."

At the end of the day there needs to be some sort of human being at the end of the technology or involved with the technology or overseeing the technology, even if there's the person - if they're the person who is looking at screens that are monitoring 20 autonomous vehicles. That person needs training to understand the needs of people with disabilities or the needs of everyone, really, so that they need to be well trained and perceptive people."

"A lot of local governments won't actually have - so take bus stops, for example - a lot of local governments won't actually know, as ridiculous as this sounds, whether a bus stop on a particular street is accessible. They literally do not have records of this. So, trying to design systems that are integrated and connected, that allow you to be able to say I want to go from X to Y, involves a lot more data than what local and State Governments currently have access to, despite whatever apps a person with a disability might be able to implement, to be able to interact with the conveyance. The conveyance won't actually end up being the issue, but the hard infrastructure on the two ends will be the issue."

"And I just, as someone that works with technology every day, I just don't trust it enough, that I wouldn't want an escape hatch where I can always talk to a human. Even if that's via the app or the touch screen or whatever it is, I still feels more reliable to me than trusting the software entirely, so say, you know, I know we talked about it before but the touch screen on the conveyance or the touch screen, or on your phone, sometimes there are cases where the things aren't working the way they're meant to and I always want to be able to speak to a human if necessary."

"What do we do if we don't have a mobile phone in that instance or our mobile phone died because I ran out of battery or data or whatever, how do I call a shuttle then? That's a really big problem if I'm stuck on the road and I don't have a battery, so that's another big one."

Table below (Table 3) includes additional comments from participants not mentioned above on the connected aspect of Autonomous Vehicles.

Table 3. Additional comments from the focus groups regarding the connected aspect of Autonomous Vehicles.

Common topic	Direct quotes
Emergency communication	Another one that I looked at is if there's a breakdown. So, for example, not last year, the year before, a train broke down in between two stations, and we all had to jump off the train onto the tracks, go to a safe area for the buses to come pick us up. There needs to be implements put into place so if that does happen, you know, the information has to be put there, OK, there will be people to be there to assist you in ten minutes because nothing is worse than to be stuck in the middle of nowhere or when you're blind and stuck in the middle of somewhere where you can't see and don't know when assistance will be coming. So the information backwards to and from really needs to be clear and transparent.
Emergency communication	If there was a blackout of some sort where communication was lost with the supervising person to have a secondary back-up because I've heard of situations where, you know, either the power has been lost or where, you know, Eftpos facilities have been lost because of wi-fi or some wire somewhere being broken or something and that would be a very

Common topic	Direct quotes
	frightening situation if there was an emergency and they couldn't call for medical help or something because the operator couldn't hear or couldn't see anything.
Emergency communication	And the other thing when you have nobody in the vehicle, I'm just concerned of antisocial behaviour that may occur. And also the cameras you mentioned, if the cameras were there to provide any additional support, people with Deaf blindness would not be able to locate the camera.
Communication design	In Sweden there's a company called Drive Sweden and they're working on a tactile vibrational prototype and that will assist three cohorts - the Deaf community, the blind and Deafblind community. And they're actually working on that. So that might be something that's really useful to put into the vehicle to make it universal.
Communication design	I understand the beacon system that exists at the moment means you've got to carry your mobile phone in the flat of your hand and point it around to where you're going to get feedback. I think that that's a problem because if you've got, in your other hand your guide dog, you're carrying a parcel, and you've got a cup of coffee, the beacon arrangement is not a piece of technology that's particularly easy to use. So I think there's always got to be communication with end users, consumers, people with disabilities to get their feedback on how user-friendly the technology is.
Communication design	Information will make it easier. Some people with intellectual disabilities might get bullied on the bus without a driver. Some people have intellectual disabilities can't read so they might find it difficult to select their stop on a touch screen. It might be good to have a phone app where you can have a picture associated with a destination so they can choose and use that instead. The idea of that would be you'd have an app like you can do on your bank, you can associate a picture with a particular bank account and that way, you know, if it was going to be work, you know, the person could choose an image that, you know, they associated with work and then they could just click on that.
Communication design	But the big thing, I think, that we skirted around is the touch screen. The touch screen is completely flawed if we have to interact with it. There is no - I can't see any way that if I'm blind and I walk up to a touch screen, how it's going to be able to interact. I'm going to be able to interact with it and then if the next person's deaf, how are they going to change the mode from my settings to their settings. When we're in busy environments and, you know, if we're trying to listen to the audio feedback from a touch screen, it's completely flawed and it will not work in this scenario, I don't believe. There's been some other sort of ideas. I don't know if this is an ideas forum. My personal idea would be that we all seem to have our own devices that we can configure to our needs and, you know, similar to when you get on a bus and at least in Sydney, you swipe something to say that you're on the bus. Swiping some sort of Opal reader or something like that where you can say I'm on the bus and you can select your destination or select what you want to do, your personal device has all your own settings, your language, your contrast, all those sorts of things, if you're a braille user, etc, all that stuff seems a whole lot easier than trying to muck around with a touch screen.
Communication design	There has to be a way of if you don't have a device or if you didn't bring your device or whatever, there has to be a back-up mechanism. It can be, you know, pressing a button and you interact with a remote person and say please, take over from me and program in that I want to go to stop C or whatever it happens to be.
Communication design	The biggest issue with any kind of connectivity is that it puts pressure on Whole Journey planning. It means you need line of sight the whole journey whether it's going to be accessible from end to end. Otherwise you can end up with a system that leads a disabled person to a dead end. That's not necessarily an issue that any kind of app that a disabled person might have access to solve. That's largely a transport provider and state and local government data issue.
Communication design	Then I guess the potential of, you know, if you know that you're getting to stop and you know, let's say I'm going somewhere in the city I don't really know, the ability to have connected an Uber or something of some description where I might be doing the last section of that travel could connect me to get off, get on, have an Uber sort of waiting there for me. I think I mentioned taxis, my issue with taxis is that, even if I book taxis, I live

Common topic	Direct quotes
	in a busy area and they just pick other people up. So having something more connected would be great.
Communication design	I've been thinking about the whole app situation. If there was a possible way of being able to communicate to the vehicle, to have your home saved so you could actually say I want to go to so-and-so, actually from your home, which would completely avoid the issue of turning up at a very noisy transport substation or a very noisy place and communicating in the vehicle. Why don't we communicate to the vehicles from our homes before we even leave our homes and that would avoid a lot of - a huge lot of issues surrounding noise and that sort of thing. The other thing I would like to say is around improvements in technology, one of the things up here in Queensland is a lot of the taxi apps are highly inaccessible.
Communication design	So there's a lot of discussions around the apps and perhaps when people don't use apps or they're not able to work with this sort of technology. But I feel, you know, there's quite a lot of diversity in how we get onto technology. Particularly in the Deafblind community it's very diverse. We have different formats, different ways of communication, so I feel if we're going to work with technology, we probably need to have very specific design around technology and look at what things are available, and what things we can use, that it can be universal. For example, there is some research around Deafblind people, actually the research in Europe, including England and Britain, they're designing a jacket called tactile jackets where they have cameras attached to the jacket and that's where they provide senses for people with Deaf blindness. That could be something that we can integrate into the technology that would be suitable for each one of you.
Communication design	How do you - is there a platform that lets you know how long your trip is going to take so you can at least know what you're up for and how do you - yeah, so is that like a platform on your phone or can you directly ask someone that question? I guess in terms of thinking about cognitive and sound overload. If lots of people are asking that remote person and they're speaking into the vehicle, there's quite overloading for people because, you know, I would find that - if I don't have that direct question, sometimes the information is helpful for me but it's also, you know, every five minutes there's someone going blah, blah, blah, with another extra bit of information I didn't need. So, again, I'm thinking about the complexity of flexibility but predictability and overload.
Communication design	If they could develop some way of disabled people conversing with the shuttle or the bus, to let them know that there is somebody who will need assistance and maybe they have some sort of electronic pass that a disabled person can actually tell the bus, look, I'm getting off at this train station or this stop and then it's all pre-programmed. Because in my scenario, I've got MS, I won't have the dexterity, if it's a hot day or if it's too crowded or whatever, I won't have the dexterity to actually punch all this information into the scan. I find, currently, even swiping on a Miki can be a bit challenging. So, yeah, if there was a way of pre-programming the shuttle to actually tell the vehicle exactly where I'm going to and the shuttle then can actually say, well, OK, well, we need to allow another 30 seconds so the ramp can be deployed and this person can get on safely, that would be great.
Communication design	Again, if you had an app, like the current train tracker or whatever, it would be a no fuss sort of - you program in. So, you converse with the shuttle and the operator, and it would also mean because the other concern for me with the autonomous thing is that if there's only two spots for wheelchairs and you turn up and they're both taken, you know, can you say to the shuttle send another one because there are three people with wheelchairs here?
Communication design	So at the moment, for anyone that uses, in a number of our smart ticketing arrangements across the country, for anyone who can't use a swipe card like a Myki or Go card up in Queensland, they will have something called a flash pass or something similar, where it's a pass they would wear around their neck and the staff member will see and they will let them through the gate rather than them having to touch on and touch off. I know in Queensland we're moving away from that and moving towards the disabled equivalent of a Myki or a Go card being an RFID situation. So that allows a hands-free operation. But that does also, because it's an RFID with some information that will be stored, it opens the

Common topic	Direct quotes
	possibility for it to be able to hold information. For example, going on his way to work, he goes to stop X and needs the door opened for 30 seconds more.
Communication design	I would like to be able to say to an app, or whatever, this is where I want to go and say I need to have a seat on every vehicle, this is how long it takes me to board and exit a vehicle, so ask for that extra time and see how long it takes to do the whole journey. So that's an opportunity to know exactly how long it takes from whatever, A to E, to be able to know if I need to skip a vehicle or not.
Training	[Participant X] really uses, as you said, the city mapper, so anything that would make sure that any of those apps actually connected up with what was, you know, with the transport, with the shuttles and the ferries and things like that, I think. However, saying that, there are lots of people with intellectual disabilities who haven't been taught to use these sorts of technology, so they would have to be a whole lot of money put into doing that, I think.
Universal design and Personalization	I think people with disability tend to be fairly aware with what their functional impact is and what will help them if they're presented with a pick and choose. So I think it's more beneficial to let the person define either what the functional impact of their disability is or just let them pick, such as here is how I'd want my trip to be altered to accommodate for the disability because just telling someone your disability, whether it be a person or a computer system it works out, whatever, telling them your disability and letting them work it out relinquishes a bit of control and you're putting trust in a system which frankly I, especially I am legally blind and I'm not a cane or a guide dog user and my sight is just on the cusp of being legally blind. A lot of things if I was to say to a system that I'm legally blind and it selected from a predefined list of alterations, probably wouldn't help and I'd want the opportunity to be able to define that myself based on my understanding of my disability and how it impacts me.
Universal design and Personalization	Expressing your specific needs is important and but it has to be controlled by the person. You go too far down this road you can just fly in the face of universal design. Accessible public transport should reduce needs for specific adjustments. It should be designed in a way that caters for the widest, possible range of people's needs and preferences. So, you need to be careful about setting up systems for special support.
Universal design and Personalization	Personally, I don't mind sharing my information because at the end of the day if it's going to make my travel experience a lot easier then I don't see an issue with it. But in saying that, too, the amount of distance that I have to travel to go into Melbourne, for example, is 300 kilometres each way. So, people are going to see that I'm blind because I've got a cane and if I've got a guide dog they're going to see a guide dog. If I'm in a wheelchair they will see the wheelchair. If I've got an invisible disability, then that's going to be harder to pick up on.
Universal design and personalization	If I could also say if there was this customization, it would also be good if we could notify that there was a seeing eye dog in which case if there were seats with adjustable heights, it might be able to do that and also to alert the people that you need either voice, you know, prompts or whatever if it's not continually on in the vehicle or be able to speak to the operator that's on duty. Of course, if there's going to be a connection problem with a train, if the trains are not going to have drivers then, it should notify that you've missed the train or it is going to wait for you so you would be prepared for whatever you're doing at a changeover point.
Reliability	I know [participant X] mentioned having a backup but it would have to be a goddamned good back-up because when signal goes down, then everybody is screwed pretty much. And often it happens, you know, internet jumps in and out, wireless, going on with GPS, it's all relying on those signals. I think it's fantastic, I love technology, it's amazing and I think this sounds so promising, I'm very excited about it. But that could be a little bit of a fly in the ointment there. Just it needs to be addressed. Having something in place. What, I don't know.
Reliability	Actually, having sop of the announcements, being able to access, if I wish to, being able to access a feed of where actually am I and making that based on, you know, physical, real physical locations in some way rather than just a GPS because as Martin said, GPS is very inaccurate.

Common topic	Direct quotes
	One of the apps I think that does this really well is called Move It. I don't know if it's available all over the place, but it gives you good information on what you're up to and gives you get off alerts and warnings which can be audio, tactile and vibrations. I think their model is the best I've come across.
Flexibility	So, if you are managing a really tight energy budget and you need to know, OK, it's going to take me this long to get from A to B, but if someone else gets on the bus - on the pod and says I want to go to - how long do you know that trip is going to take? There's a benefit in flexibility but you lose a level of predictability and I think if you - so I would find that quite - I would find that challenging because I would be like, well, is it suddenly going to take me 45 minutes instead of half an hour or 20 minutes because there's other people on, you know, with their requests. I'm assuming there's a few people on this vehicle, yeah, so that's, yeah, that's the other one, that's the second one.
Consistency to aid repetitive learning Synchrony between transport provider and council	I think something that can be done on a standards level is to come up with designs for interchanges, transport interchanges so that where you've got trains, buses, trams, ferries, all coming together and people needing to move from one vehicle to another, or one form of transport to another. It would be useful if there were some standard designs and recommended designs that would give people with vision impairment and maybe even other - everybody else some sort of expectation that there is logical movement between - logical paths of movement between transport or types of transport and that it's as safe as possible and that you're not walking - you're not having to move a kilometre and a half to catch a taxi if you're getting off the train in that area.
Synchrony between transport provider and council	So when we start to talk about connectiveness, we need to make sure that those local councils and the data they're developing their local areas is up to scratch because that will be what determines where safe and unsafe zones are. I fear now that - even if we could come up with the system of determining - of saying let's only stop at this zone and that zone, our local governments and local councils wouldn't have that data to input into the system. So that data generation is a huge issue.
Synchrony between transport provider and council	The vehicles need to be designed in such a way that there is flexibility so that it won't be one solution that fits all. So, whether it be, you know, the interface between the vehicle and the environment or whether it's the interface between the passenger and the control system, whatever, it needs to be consistent but it also needs to be flexible. So, someone who is blind needs to be able to access this system. Someone who is deaf needs to be able to access the system. Somebody who is Deafblind needs to be able to access the system. Somebody with no hand function needs to be able to access the system, etc, etc. So that no matter what your disability is or what your limitations might be, there still needs to be consistency in what you can expect to encounter.

Air taxis

The concept was appealing to the focus group members. Concerns were expressed on areas including noise pollution, invasion of privacy when flying over residential properties, economic factors and what happens in the event of failure. The need to test designs during the early stage directly with PWD was emphasized. It was also mentioned that there are many PWD who do not use public transport and that Air taxis may provide new opportunities for such people hence the need to include this demographic as a primary stakeholder.

It is an appealing concept with similar access issues and concerns, but “not having ground under one’s feet” make the safety aspects and controls even more important:

“I've got one quick comment that I thought about in terms of the air taxis, in terms of an opportunity, I think it can be a big opportunity for rural areas to cover a lot of gaps in the transport. So that could be a real opportunity for people with disabilities and I think if they do get designed accessibly then I think we will use them, especially in places where stations are not

“This will be a benefit for people with disability, and absolutely I agree, people with disability will be a very, very small subset of the customer make-up, therefore, the economics suiting it to people with disability will absolutely not make sense. It would make much more economical and business sense to suit it to the able-bodied population. So, figuring out that economic rationalisation will also be your biggest issue.”

“The access issues, as far as I can quickly think, are exactly the same as what we've already been discussing. So, everything we've been discussing would also apply to aerial taxis. All the challenges of getting in, getting out, getting secure, being able to communicate, all of that stuff. I think it's the same. I don't think there's a difference.”

“What I fear is, rather than look at all the problems with aerial taxis, and obviously there are many, I would be really disappointed if our needs were not taken into account on the basis of economics, that there were a small proportion of the likely patronage. So that all of a sudden in, you know, 50 years from now when aerial taxis are everywhere, and they're still not catering for people with disabilities because they weren't right from the beginning.”

“In terms of an opportunity, I very rarely use public transport because of my disability. If this makes it accessible, from a business point of view, I think you've got a bunch of people who have similar conditions to me who aren't accessing it at the moment who would want to access it. So, I think there's probably a hidden number of people with disability who aren't using public transport that would. So, from an economic point of view, I think, I guess that's good to remember that there's a hidden bunch who would want to access it but can't at the moment. So, I guess - I don't know if it's a strong enough selling point.”

“I just want to also say that with an Air taxi, the lack of confidence that I would feel just, you know, an unfounded fear of the battery giving out or a connection becoming loose when it's halfway through a flight or, you know, not being able to - I mean, talking to somebody may not quite satisfy my stress levels if they're safely on the ground and I'm hurtling towards some sort of obstacle or not even knowing that I'm doing that. So just not knowing where I am in terms of not having a ground under my feet and also the fact that if something went wrong, as sometimes it does, you know, what do I, you know, what can happen as a back-up.”

Table below (Table 4) includes additional comments from participants not mentioned above on Air Taxis.

Table 4. Additional comments from the focus groups on the topic of Air Taxis.

Common topic	Direct quotes
Safety	How stable are these vehicles in high winds? Tasmania has horrible, horrible winds, so, you know, I mean, I guess, it's just like how stable is it if you're going to be in a vehicle in the wind, that's not going to be cool.
Safety	Providing a level of confidence in being able to use it without getting stressed during the trip. That's the only thing I'm thinking of and I would be quite happy to volunteer one of my support workers for us to go and test one of the air taxis out prior to me going in it for the first time.
Discrimination	We need to be careful we don't see any one solution as a need not to make other solutions accessible. If we end up with the individual pods nice and accessible, they don't need to be able to use the mass transit pods. The big ones that hold 20, 30 people, they don't need to be accessible because if they've got accessibility, there's individual ones to use. That's unacceptable. We need to be able to use everything that other people use, or can use, if they choose to.
Design	The other design thing I want to do mention as well, and in that document you sent around to us, at the bottom, talking about the flying vehicles, there were two different designer vehicles. One had the propellers in the bottom and was lifting the vehicle up. I think, you know, I think they're not going to work at all from an aspect of loading and unloading. Obviously you're going to have issues there of how people are getting on when the propellers are below you and are rotating when these things are parked. So I think whatever design they come up with it's going to have to lift from the top from a safety point of view as well.
Trials	I don't know how you're proceeding with this, but if you build a mock up, it would be good to have it tested by real people, not students sitting in wheelchairs, but real people like the group you've got here - it's not going to go anywhere, it's just sitting there, but working out what works as far as access, what works, whether the buttons are in the right place, all that sort of stuff. Dry runs actually, before you get too far down design path, can be very beneficial. Saves you going down a few blind allies and then having to fix it.

Phase 1: Peak Body workshop topics and responses

Overall, discussion throughout the session was robust, with both the issues and advantages of the automated vehicles being highlighted, these being quite different depending on the disability type the particular Peak Body represented. Agencies represented at the meeting included Blind Citizens Australia, Deaf Society NSW, Guide Dogs NSW ACT, Hearing Matters Australia, NSW Council for Intellectual Disability, Paraquod NSW, People with Disability Australia, Physical Disability Council of NSW, Spinal Cord Injuries Australia, Synapse Australia and Stroke Recovery Association.

Individual concerns or advantages are picked up in the notes and quotes below, separated into 3 areas of discussion: autonomy & vehicle design, connectivity and other considerations (including drones) below.

Autonomous or driverless aspects

The first topic of conversation was on the autonomous aspect and the design of AVs. Some of the issues discussed included lack of direct assistance and reaching out for assistance, challenges faced by wheelchair users, lack of sound in electrical vehicles, orientation and way finding to and inside the vehicle, guide dogs and other pets on board, surrounding infrastructure including stations and stops, technology failure, safety in terms of antisocial behavior, rural transport and associated challenges, adaptability to technology, training and building trust and communication system design.

Examples of participant expectations included the option to personalize the service, booking system using GPS, assurance of safety, reliability of technology and consistent design of AVs.

Similar issues are raised in this group as in the group with PWD about the role of the driver:

“For people with intellectual disability, the human factor is actually really important like a lot of people have mentioned here. I understand that the way of the future is automation. One of the guys I work with, he always uses this quote is that ‘technology is innovative’. But it’s not always innovative for people with intellectual disabilities - they take the people away and that is where they gain information from, where they can gain a sense of trust and understanding in the service. So, it will take a long time to help people understand that the service would be safe and how to use it.”

“I think there’s a general passenger rider security question that will come up without the presence of a driver. And it depends on the size of the vehicles and how many other passengers are there. I’m also presuming they’ll be security cameras but who monitors if a passenger is aggressive towards another and how can they intervene in a timely manner?”

“I keep thinking here, taxis, single vehicles, but also, public transport more generally, the social connection that you have. It may just be saying hello to the driver, it might be the driver telling you to “hold on, they’re lowering the step on the bus so that person can get out” and so on. So that social participation or interaction can be so important for people who are otherwise living on their own or isolated or don’t really have that mode, or other forms of social connection.”

Table below (Table 5) includes additional comments from participants not mentioned above on autonomy and vehicle design of Autonomous vehicles.

Table 5: Additional comments captured during the Peak Body workshops regarding Autonomy and Vehicle Design.

Common topic	Direct Quotes
Personal Safety – Vehicle design	I think the fact that there is no or limited to no sound (electric vehicles) is a real issue for people with hearing loss. Both inside a vehicle as well as outside. Because you don't know where they are, there is a real safety issue there.
Personal Safety – Lack of direct assistance	Say for example, trying to drive into a driverless vehicle and your wheelchair gets stuck. It's jamming the door or whatever else, you need some help. Who's going to help you? Obviously, light rail is great. It's driverless, but it's within its own system. And even then, you can have a number of problems. But there's always someone who's close by that. If you lose that connection, there'll be a lot of problems.
Personal Safety – Lack of direct assistance	The other thing was, it was mentioned a little bit earlier, but what happens on a bus, you know, at times unfortunately, people with brain injury can be quick to aggression and things like that, if the wrong thing happens, and there needs to be fail safes in there in relation to it.
Lack of direct assistance	Assistance – who will help if you do need assistance?
Lack of direct assistance	I guess, really, the overarching concerns that I have is artificial intelligence. My concern is what happens when things go wrong or not even wrong, even general public don't even have the intelligence to understand or be able to put themselves in the shoes of people with disability in standard situations, let alone when things go wrong. I'm an old sceptic when it comes to being able to program artificial intelligence in such a way as it will be able to anticipate or be able to respond. It will be responsive to the whole range of different situations that can arise. I would find it difficult to understand or to have faith in a system that's going to work for our benefit, where you don't have another person such as a conductor or somebody else that's trained in the operation of that vehicle.
Lack of direct assistance	I certainly had isolation began as a real problem in that social interaction for people with a cognitive disability and brain injury specifically.
Lack of direct assistance	I can say for people with brain injury that, there'll be a lot of confusion around how things how it works. Unless we get to a system that's completely point to point, which I don't think the early sort of system is looking at them, there's going to be different routes and if someone gets on a particular mode of transport and then realises they're on the wrong one - there'll be some high anxiety and inability to work out how to get off in a timely manner.
Lack of direct assistance	How it would affect a rural/regional sort of situation? How it interacts there, when you've got distances that could be massive, and people realizing 100 kilometres down the track that they're in the wrong spot?
Assistance animals/guide dogs	From a guide dog perspective, potentially not sure what the parameters will be on this, there might be other passengers who expressed concerns with a passenger trying to avoid the vehicle with a guide dog. So who would mediate or provide some inside support there? So the person with a guide dog isn't in a difficult situation, but also potentially if other passengers have their pets who may be aggressive towards a guide dog - who's monitoring that and can intervene at that time?
Signage and alerts	There have to be visual cues for people with hearing loss, there has to be some way of alerts and easy ways to manage that
Signage and alerts	Cues aside from visual that would be inside the vehicle to let someone with a hearing impairment know what is happening, and what would happen if electronic software goes offline?
Signage and alerts	I agree with what [Participant X] has said, I think yes, visual cues as far as where you are, and upcoming stops as important as are audible announcements, which I think is required on all vehicles these days. I don't think it needs to be one or the other.
Locating vehicle & Vehicle access	With locating the vehicles, I'm presuming there'll be consistency of pickup and drop off locations with the routes being pre-programmed, and that the vehicle itself will be accessible to enter and exit for all passengers. I.e. no steps in or out, easy to locate seats but also locating the entry point to the vehicles.
Locating vehicle & Vehicle access	If it is a consistent location for stopping and departing, will there be appropriate TGS eyes or directional for locating the entry point?

Common topic	Direct Quotes
Vehicle access	Does the vehicle have the capacity just to pick up and drop off wherever? And if that's the case, what is the infrastructure around that? You don't have the controls over curbs and driveways. Obviously, for people with visual impairment, where in fact is the stop? I suspect that you interact with the vehicle, if it's not done on a set route like our regular buses are?
Communication design	Do you have technology to interact with the vehicle so that you can get picked up specifically at your pickup, or dropped off at your drop off? This means that you are reliant on technology. This is throwing people into the world of technology where they may not be able to afford or they may not be able to use it. So certainly, advantages but also potential disadvantages come with that.
Communication design	Need an app that has a link to relay service or Auslan interpreters, or if in English then needs to be in simple English, as not all deaf people have a high level of English. Or visuals and pictures to assist comprehension.
Vehicle Design	Touchscreens inside and outside of the vehicle (and at stops)
Vehicle Design	Ensuring universal layouts across vehicles where possible - so people know where wheelchair space is, for people with vision impairment to be able to know where they can safely sit, etc
Vehicle Design	I read that the screens would be at shoulder height. This may not be accessible to some people with disability.
Vehicle Design	How much space is there? If someone who's already on perhaps is using a wheelchair, is there enough space for yourself and your guide? Is that in the app? Or is it in some sort of live information?
Vehicle design	And again, this is going what Jackie was saying - silent vehicles. Really, really tricky for people with visual impairment because of the inability to hear them. So will there be regulation to put a sound into them? I don't think there is in Australia as yet. I guess that's the thing we've definitely would be pushing with all electric vehicles.
Vehicle Design – Boarding and Ramps	I was thinking about people with physical disability who again, might have mobility issues or wheelchair users. So how to identify anyone that might need assistance to actually board a vehicle? How does the vehicle know to actually extend a ramp or open at the time for someone who's a wheelchair user?
Vehicle Design – Boarding and Ramps	How would an automated vehicle line up at the curb and drop the ramp? How would an automated bus system deal with the complexities around the boarding and exiting the vehicle.
Vehicle Design – wheelchair tie down inside vehicle	How will wheelchair tie down occur if wheelchair user can't physically tie down the wheelchair to some sort of interface? What's the process? Will there be an electronic process?
Vehicle Design	Space requirements to cater for all disabilities in one vehicle (wheelchairs, people with assistance animals, deaf/blind and guide)
Vehicle Design – Automation /AI	My perspective is, if everything goes well, it goes well within that environment. But unfortunately, in the real world, where things go, often, not correctly, even minor things can cause big problems. We need some sort of remote intelligence that can oversee these issues, and deal with them. And quite frankly, based on my experience with AI, I think we're a long way from having an understanding system that can focus on anything that goes wrong,

The connected aspect

The second topic of discussion was on the connected aspect of AVs and participants shared their thoughts on areas including vehicle to vehicle interaction, smart technology solutions of PWD and on apps and other booking platforms.

“And the other thing is, if you come down from the country and it's totally new technology to you, and on one off, I think it actually precludes people's ability to adapt really quickly, which is often an issue with those who are working in brain injury or stroke.”

"When you're using GPS for booking and the satellite navigation may not be exact. E.g. -when I book a taxi from my place, sometimes the taxi pulls up on the other side of the road or if I'm in town, in a cul de sac and the GPS driver is getting a destination of roadway when you're actually in another back street 50 meters away from where you are.

So, there's some issues around the GPS location may not be perfect as well."

"If you need the connectivity, and you've gone between the rural areas that are hundreds of kilometres away, and perhaps that's not there, what does that mean then if someone needs to be connected? Or if the actual connectivity is what runs that whole system? How does that work? If it's physically not in place? (internet connectivity)"

"If it's like a tram, where there's set route, then that will be easier to understand and participate. If it is on demand type service, or if you could say I want you to go to x, then that makes it much harder for people with intellectual disability, especially if there's an input involved. If you need to tell the vehicle where you want to go, then that will be very difficult, especially with usually low levels of literacy, perhaps a speech impediment as well, if its voice activated, so that will make it much harder. That's where the problems I think are going to arise more for people with intellectual disability."

"For example, the on-demand ferries we have in Sydney at the moment are not accessible for the guys that I work with because it requires an app. It requires you to have a specific app and you have to go in and know how to say where you want to go and where you want to be picked up, etc, etc. It doesn't work for people that we work with because it requires lots of manual input. Some can some can't, it depends on the person. People with intellectual display will have low levels of literacy and ability to use technology, not because of lack of wanting but because of lack of opportunity, affordability, and then being trained to use them a lot of the time."

Other considerations (including Air Taxis)

Participants were given the opportunity to discuss other areas of interest or concerns on AVs and Air taxis. Participants had questions about how the technology will cater to those who are deaf and blind, facilities such as toilets, regulation changes and training people with cognitive difficulties. Particularly on the topic of Air taxis, questions were raised on the continuous path of travel, weight limits and implications for wheelchair users, the number of taxis in the air and ramifications and the design of wheelchairs as drones themselves.

"There's one concept I think that does have an opportunity which is where it is not mass transit, but individualized transport, like calling a taxi or ride sharing vehicle that was autonomous that you could call it, it would arrive, and the back would open, or ramp would come down.

And for people who do self-driving vehicles, there's a docking system that fits on the wheeled bottom of the wheelchair. When you drive into the vehicle there's V shape, and the male pad on the chair locks into female pad on the in the vehicle. And so, you're locked in. It's all hands free."

"At least at the beginning, importance of being assured that there's going to be somebody at the other end of the line, that is not just a machine - that can understand the situation and call up resources that are relatively close by to resolve any issue."

"So, what might be the issues around transport, depending on distances in terms of access to toilets or other facilities that might be needed on board? The sorts of vehicles we're talking about have become much smaller, and don't seem to have any of that sort of capacity for anybody?"

"I think it comes down to being able to test - we do a lot of work prior to vehicles going on to the roads to see what they look like, how they interact, what the buttons do, are they the right size, shape, colours, do they act as we expect are they in the right locations etc. So being part of the process to design and interact with the vehicles and or the actual systems the IT systems in place to make sure that as much as possible has already been fed into the system."

"Then of course, as you say, it is around testing and understanding scenarios and being aware of what's then in place for when things go wrong."

"Relatively speaking, we do have standards, but those just because we have standards, and even when transport providers are meeting those standards, which they're not, but even if they were, that doesn't ensure accessibility and usability for people in the community. We need to really go beyond transport standards, or beyond the legal requirements, to really look at how the things work for people with disability on the ground and a very practical way. And that's where the connectivity is, is key."

Long list of Connected and Automated Vehicle related issues and opportunities for People With Disability

In the below table (Table 6), we have aggregated all the insights from both the focus groups as well as the peak body workshop into a list that was already generated by the literature review.

Table 6. List of needs identified for PWD (physical, cognitive, visual and auditory disabilities) taking into account the Whole Journey concept. Please see reference section to access the numbered references used in this table.

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
HMI communication: Given that the face-to-face interaction with a human driver will disappear or diminish, the need for accessible communications increases.	1	Non-visual interfaces for people with visual disabilities: compatibility with emerging assistive technology such as Tongue interfaces, Bionic eyes to understand the surrounding.	X	X	X	X
	2	Non-audio interfaces for people with auditory disabilities (e.g.: providing Assistive listening devices (ALDs), Augmentative and alternative communication devices (AAC) and using alternative devices such as sound, light, vibrations or combination of all those). In Japan, there are white boards placed at stations, so the passengers with hearing disorders can easily communicate with the staff.				X
	3	Multi-modal interfaces to minimise the lag time between original or immediate messages, such as dynamic braille systems. A team at University of Michigan is working on creating a readable tactile surface that can allow visually impaired people to read a message or notice in form of a paragraph content, rather than in a single line content, allowing the readers grasp the content faster compared to the conventional method.			X	
	4	Provide an appropriate interface for Auslan users (deaf). Where possible Auslan signed information (appropriate where information will not change regularly) or information via an app that is in easy English as many deaf people do not have high level English skills. Use of captioning or relay service where communication must be 'on the spot' for emergencies, changes to services etc.				X
	5	Provide options for those who do not or cannot use a digital app (affordability, skill, intellectual capacity, memory issues).	X	X	X	X
	6	Tunable and multi-modal interfaces (using repeated image guidance systems) can improve comprehension for people with cognitive disabilities ranging from short term memory loss to Autism, e.g., through reduced verbosity and adjusting stimulus intensity. In order to make contents usable for people with cognitive and learning disabilities, studies have shown to prioritise few objectives, such as helping users understand what things are and how to use them, provide support for different ways to understand content with clear text and images, helping users to maintain PWD Focus, avoid mistakes and make it easy to get human help and give feedback.		X		
	7	Provide a variety of communication methods apart from touch screens, such as voice activation commands, app preferences, direct contact with the shuttle supervisor at that moment etc.	X	X	X	X
	8	People with disabilities from migrant communities	X	X	X	X
	9	Beeping sounds and lighted pathways to provide easy movement inside the vehicle.			X	

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
	10	PWD specific data filtering options to get the necessary information quickly: e.g., platform accessibility, guide dog toilets, steep hills for wheelchairs etc.	X	X	X	X
	11	Make the remote operator visible in the vehicle and ensure they have the ability to understand and use Auslan.				X
	12	Apps with simple English or with pictures to communicate/ give commands to the shuttle. Using images of Black and White combination for easy understanding.	X	X		X
Whole Journey customer service.	13	Easily accessible customer service will be key - especially in the early years of deployment of CAV. Customer service will likely need to fill in tasks currently performed by the driver	X	X	X	X
Whole Journey accessibility: With the projected increase in flexibility to hail, pick up or share a vehicle, the need for accessibility of all routes increases, not only those to stops or platforms.	14	Drop off in a location where there are accessible doors, direct accessible pathways, space and safety as a drop off location.	X	X	X	
	15	Provide wide entrances and exits in and from the stations and stops.	X	X	X	
	16	Safe exit or entry method without any supporting infrastructure such as platforms, curbs etc at the station/stop.	X		X	
	17	Handrails and other supportive infrastructure positioned in easily accessible locations such as the door and towards and near accessible seats.	X	X	X	
Hailing, booking, and paying/entering a vehicle without a driver is a concern.	18	Provide accessible apps or other means to hail the vehicle. This would help notify the vehicle that a person with disability is at a particular station thus prepare to stop.	X	X	X	X
	19	Smartphones cannot be operated or cannot be operated proficiently by all people who have a disability. Multiple, diverse means of hailing / booking to be developed through co-design.	X	X	X	X
	20	Extended communication with the vehicle prior to boarding, beyond hailing e.g.: Indicating that wheelchair user is attempting to board will allow time for the vehicle to prepare to board the passenger such as starting to extend the ramp.	X	X	X	X
	21	Driver can identify the passenger [Card used by deaf-blind people] and the place that they need to alight. Acknowledgement that the passenger is on the right vehicle is required, toolless payment or contact with the remote operator.			X	X
	22	Booking platform must be accessible and capable of accepting TTSS, pension or other discount programs; secondary option must be available to those who do not use electronic payments.	X	X	X	X
The mobility options available are set to become more fluid. To easily and reliably identify correct vehicle and boarding location is already a concern today.	23	Design of stations and stops with regard to parking locations of AVs to minimize travelling distance from station/stop to the vehicle. Long distance between parking areas and the station or stop is a significant issue for PWD.	X	X	X	X
	24	Multi-modal queue information that helps people with sensory disabilities find car, e.g., audible tones for people with vision disabilities.	X	X	X	X

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
	25	Clear, easy to read and understand signage, no glare, interactive touchscreen at stop/boarding location.	X	X	X	X
	26	Passenger unable to see or discern that their booked or hailed AV has arrived. Use sounds and/or real time accurate information to communicate.	X	X	X	X
CAV presents an opportunity to provide Easy entry and exit practices - Accessibility of Air taxis is a concern.	27	Design vehicles with PWD in mind: wide doors, ample floor space. Make entry wide enough and height high enough. (60" in at least, see latest data from University of Buffalo on wheelchair dimensions)	X	X	X	X
	28	Lifts and ramps able to cater to variety of assistive vehicles (size-wise and capacity-wise) that should be available at the boarding locations etc.	X	X	X	
	29	Provide enough seating arrangements inside the shuttle, allowing passengers to seat comfortably during the journey.	X	X	X	X
	30	Air taxi's do not seem to be accessible at this point for any particular person with disability without extensive direct assistance. It is not clear if people with a wheelchair can use them at all.	X	X	X	X
	31	Easily find the entrance door, for instance by orientation and wayfinding to and from the vehicle, or by parking at fixed positions vis-a-vis infrastructure. Studies have shown two important elements to meet the requirements in wayfinding applications, which are the data must be compliant to agree upon available standards and it should be free and presented in an open platform, to be used by developers to develop personalised wayfinding applications.			X	
	32	Remotely opening and closing the vehicle door for instance with smart phone.	X	X	X	X
	33	Leverage nodes such as beacons to assist with accurate wayfinding vehicles to fitted with accurate location technologies.	X	X	X	X
	34	Vehicle will need to be positioned at an accessible curb area when parking. Crabbing ability and height adjustment will be beneficial.	X	X	X	
	35	If the curb isn't at the same height, a universal lift or ramp is required. Either is required to cater a broad variety of uses. For ramps, e.g., edge protection, redundancy, and slope (1" rise per 12" length, ADA regulations). There are different types of ramps for wheelchair with wide range of sizes and styles to offer different functionalities (e.g., Lego-style threshold ramp, aluminium threshold ramp, rubber threshold ramp etc.)	X	X	X	
	36	Provide user with information about accessible entrances to the vehicle and boarding instructions.	X	X	X	
	37	Automatic door opening and closing. People who have limited hand and arm function may not be able to operate door controls. People who have vision impairments may not easily locate the door controls.	X	X	X	X
	38	Address entry / exit queues for wheelchair users and blind people. Are people still coming out, or are there other people that still need to go in?	X		X	

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
Safe entry and exit practices.	39	Provide information about potential hazards outside the vehicle, e.g., cars approaching entry / exit points. Or confirmation that it is safe to exit the vehicle. Special devices or cameras can aid in knowing whether all the passengers are safely out of the vehicle when exiting.	X		X	
	40	Operation of the vehicles should be smooth without any sudden jerks, especially in curves and corners, and when leaving or arriving.	X	X	X	X
	41	Have vehicle make a sound identifiable to blind people, who have otherwise trouble hearing the vehicle.			X	
	42	Handrails and other supportive infrastructure positioned in easily accessible locations such as the door and towards and near accessible seats.	X	X	X	
	43	Warning alerts when the surrounding is not safe (with moving trains or other vehicles near the entrance or exit of the gate).	X	X	X	
Safe departing: Vehicle does not depart until passenger is ready.	44	Customize the experience (as an attentive driver would). This will require passenger profiles to include for instance service-animal- related needs.	X	X	X	X
	45	Vehicle communicates to passengers before moving.	X	X	X	X
	46	The vehicle needs to detect that the passenger is ready to move (e.g., enabled by seat belt or wheelchair securement sensor), note that more than one passenger may need to be secured, and a secured wheelchair is not the same as being prepared to depart. The vehicle needs to know when the passenger is ready to leave, and when the passenger has fully left including, for instance, a service dog.	X	X	X	X
	47	Provide passenger with a means of signalling he/she is ready, multimodal (e.g., voice, tactile) or a gesture to the remote operator.	X	X	X	X
	48	HMI to accommodate users (audio and/ or non- visual methods for communication) and using motion sensors to provide with some additional time to enter or exit the vehicle. BEA sensors are a great example for the sensing solutions as they can be used to enhance the safety on the busy terminals, preventing automatic closure of the doors as well as to detect pedestrians/ passengers standing outside the vehicle to signal the door to open.	X	X	X	X
Accommodate service animals (This is not unique to CAV)	49	Space and floor surface (flat and non-slippery preferred) to accommodate a range of service animals, e.g., from chihuahuas to Great Danes.			X	
	50	Seat height: Guide dog harnesses can get stuck under seats if they are too low. If there is standing room, guide dogs want to lay down. There is increased risk they will be stood on if they cannot tuck under seats.			X	
	51	Interaction of numerous service animals/guide dogs in small space, ability to know if already animals are onboard particularly service animals.			X	
	52	There is an opportunity to provide a digital heads up for guide dog space that is available.			X	
	53	Ingress / Egress for animal - automatic detection or the remote operator need to notice the animal.			X	

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
Seating: Independence for the passengers to allocate the seat, connected vehicles have the opportunity to improve an important concern of PWD.	54	Maintain a uniform design inside the shuttle, so that the passengers know where the seats are located, and to find it quickly.	X		X	
	55	Provide real time data, regarding the available seats in the shuttle, areas for prams, and request on seats before the journey.	X	X	X	X
	56	Help people with vision disability identify which seats are available.			X	
	57	Design seats with PWD in mind: e.g., curved chairs are easier to maintain balance, a pull up chair shouldn't require much strength.	X	X	X	X
	58	Seatbelt designs that are accessible to a variety of disability groups. The traditional buckle seat belt may not be accessible to all.	X	X	X	X
	59	Seatbelt designs that are accessible to children with disability.	X	X	X	X
	60	Incorporate grab handles in the design.	X	X	X	X
	61	Provide sense of orientation and wayfinding inside the vehicle. This helps to find the location of the door, seated direction, traveling direction, etc.	X	X	X	X
Wheelchairs: Safe transport for people with wheelchairs. How to provide a safe and easy experience, without direct assistance.	62	Provide independence for the wheelchair users, i.e., not require an attendant to secure and be simple. Manual tie downs reduce independence; automatic securement is ideal. Independent and safe use of occupant protection and mobility aid device restraint system- wheelchair tiedown and occupant restraint systems including for people with low dexterity.	X			
	63	Automate ramps for feeling of freedom and inclusion (poor experiences with driver reluctance to pull ramps, etc.).	X			
	64	For restraints, consider "roll in" systems like Q'STRAIT for users that may be unable to self-secure restraint, Wheelchair user restraint systems should accommodate low levels of functional mobility /dexterity and provide a high level of safety.	X			
	65	Accommodate passengers with a growing variety of wheelchairs.	X			
	66	Crashworthiness standard WC19: frame is reinforced, securement brackets for tie down, handles occupant restraint forces.	X			
	67	Consider creating passenger profiles include disability-related HMI needs to customise experience. The ticketing machines in Japan are lowered, in order to make it accessible for the wheelchair users, and for those with visual impairments, tenji-blocks (raised blocks that indicate direction and safety information) are led to the machines. There are separate wide platform entries and gates for wheelchair users, some feature escalators that allow wheelchair user and some stair-climber type lifts that are attached to the wall for easy access.	X	X	X	X
	68	Clearance for wheelchair or mobility scooter and person to fit and manoeuvre within vehicle, which may be a challenge for electric vehicles with batteries. *Disability Standards have specified space for manoeuvring, but are	X			

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
		these still recent? Wheelchairs are getting larger, and scooters are even larger; turning radius is also larger now.				
	69	Provide passenger with guidance on how to secure, e.g., identify which type of securement mechanism.	X			
	70	Protect the occupant in both low and high G circumstances.	X			
	71	Secure wheelchair AND the person: Movement restrained systems for the wheelchairs with the arrangement of seat belts for wheelchair passengers, and the ability to do it effortlessly.	X			
	72	Provide minimal impact to the chair. (e.g., increasing weight, decreasing foldability)	X			
	73	Vehicle detects that wheelchair securement is done correctly.	X			
	74	Seats in the vehicle should be automatically rolled up to make room for wheelchair users.	X			
	75	Easily lift-able or supportive device attached into the vehicle, when the wheelchair users can easily transfer chairs to seats while travelling.	X			
	76	Allocating space to store mobility aid storage. This includes mobility aids such as crutches and other walking aids.	X			
	77	Securement of child and child carrying devices within vehicle (e.g., Adjustable seat belts, and locking/securing systems for prams built into the vehicle that can be used when necessary etc.).	X			
Controls: Must be consistent and operable by persons of all ranges of motion and strength/ provide via multiple input modes (Audio, tactile). When CAV's are not taking fixed predictable routes, interactions and controls become even more essential.	78	All controls are consistent across all modalities - including CAV.	X	X	X	X
	79	Currently manufacturers and operators of CAV have designed their own interface on touch screen. Standardizing HMI and user interface will reduce adjustment users must make between vehicles.	X	X	X	X
	80	Accessibility to the touch screen or buttons inside the vehicle, to make sudden changes to their travelling path (without having to stand-up).	X	X	X	X
	81	Confirmation of control, acknowledgement that the control request will be implemented in various formats.	X	X	X	X
	82	HMI needs to cater to passenger cannot physically, verbally or cognitively direct the vehicle. Passengers in an AV taxi who have poor hand function and are non-verbal or whose speech is slurred may not be able to direct the vehicle. Alternative means of directing the AV will need to be considered. Passenger unable to effect a change of destination in transit or of pick-up location while waiting. Passengers in the above category may not be able to independently alter destination en route or pick up point while waiting.	X	X	X	X
	83	Controls that vibrate or have sound so PWD can easily locate them.	X	X	X	X
	84	All controls to have braille.	X	X	X	X

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
	85	Placement of screens with trip progress visible to all passengers. Line of sight issue for those in wheelchairs when seated in a vehicle which inhibits the passenger's ability to understand where they are going, particularly when other passengers are standing	X	X	X	X
	86	Screens that are 'glare' resistant.	X	X	X	X
	87	Touch screens' that are also hygienic - gesture recognition instead?	X	X	X	X
	88	Controls which are situated at the platform where the CAV stops and can be used to indicate destination and potentially the need for an (automated) ramp, or other assistance.	X	X	X	X
No reliance on smart phone	89	Provide options for those who do not or cannot use a digital app (affordability, skill, intellectual capacity, memory issues)	X	X	X	X
	90	Passenger pickup locations for circumstances where the person has an inaccessible phone or no phone at all, e.g., Kiosk and fixed locations	X	X	X	X
	91	Concierge service, such as go-go grandparent.	X	X	X	X
Payment	92	Ability to involve in each activity in the process of Whole Journey with minimum physical efforts, such as auto identification of the passenger without swiping a Myki card, easy recharging of the card.	X	X	X	X
	93	Payment methods may be limited, consider options for unbanked (e.g., CVS offers a service).	X	X	X	X
	94	Subsidized smart phones (or other payment and communication facilities available during the trip to communicate with caregivers or emergency need etc).	X	X	X	X
Direct assistance - human interaction. A driver's role is diverse and complex and not all of the functions of a human driver can be automated (many have been mentioned above)	95	A human need to be easily contactable in order to solve problems that can't be automated, particularly near the designated space for PWD	X	X	X	X
	96	Driver can identify the passenger [Card used by deaf-blind people] and the place that they need to get alight - can the remote operator perform that function?			X	X
	97	Resolving conflicts/requesting access when an able-bodied person is occupying that space (or a mother with a pram). Also resolving social tensions, e.g., when another passenger is afraid of a guide dog.	X	X	X	X
	98	Provide customized services, for instance: Passenger can ask the driver questions, e.g., to communicate well in advance of a stop, or what the best stop is to get to a final destination, etc. CAV can leverage remote operator and digital tools to help.	X	X	X	X
	99	A HMI that can help with the luggage (either assistance devices or other luggage to load into the shuttle and place keep it near the passenger, and help unloading it as well.	X	X	X	X
	100	The remote operator needs to have tools to communicate in various modes that suit PWD (e.g., trained in Auslan).	X	X	X	X

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
Trip progress: When CAV's are not taking a fixed predictable route, understanding trip progress becomes even more essential as it is today.	101	Clear audio and visual announcements of vehicle departure, trip destination and progress	X	X	X	X
	102	Tunable and multi-modal interfaces for persons with sensory disabilities to receive trip progress communications - hearing loop, and other real time wireless communications.	X	X	X	X
	103	Ability to make corrections: e.g., notified the shuttle of the wrong destination, or forgotten to get out at the correct destination. Tunable and multi-modal interfaces for persons to send and receive communications with rider support or caregivers.	X	X	X	X
Easy Transfer. The promise of last mile CAV is to provide easy transfer between multimodal services (e.g., rideshare to bus to train). The connected aspect of CAV offers opportunities to help identifying best pathway for next destination during trip.	104	Especially for PWD, this requires real time, correct locations by using GPS systems, mapping systems or through an accessible means of communication.	X	X	X	X
	105	Effortless and smooth transition facilities in between infrastructure and transportation systems, e.g., when moving from home to station, station to shuttle.	X	X	X	X
	106	Opportunity: Improve the predictability of the transport system with respect to its travel time, traffic, delays, and for PWD the transfer time required for instance using a wheelchair or walking slowly with a cane.	X	X	X	X
	107	Provide directions to access next leg of trip with details such as waiting time, boarding location, maximum boarding time, considering the specific disability, etc.	X	X	X	
	108	Suggest how to connect to next leg of trip with disability needs in mind e.g., where are accessible doors.	X	X	X	
	109	Leverage nodes such as beacons to assist with accurate wayfinding vehicles fitted with accurate location technologies.	X	X	X	X
	110	Real time optimization between modalities: e.g., let the next bus, train, tram know that PWD will require an extra 1 minute to transfer.	X	X	X	X
	111	Communicate connection information to Assistive hearing devices; Hearing loop and personal communication interfaces.	X	X	X	X
Passenger safety monitoring during trip: the driver of a vehicle is often attributed with the responsibility to look after the passengers' safety by PWD.	112	Provide a means for passengers to signal an emergency situation using multimodal input (e.g., voice, button). Multiple emergency buttons fixed at different heights throughout the vehicle. This feature is particularly important if the passenger is travelling alone.		X	X	
	113	Monitoring of cameras 24/7 remotely to provide safe surrounding especially when travelling after hours. Females with disabilities are particularly vulnerable.	X		X	
	114	Fall detection via camera.	X	X	X	X
	115	Monitor passenger cognitive comfort and in response, provide communication (from vehicle) to passenger that is multimodal.		X		X

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
	116	Allergy and contamination concerns for those with allergies or fragile breathing (e.g.: Regular data recording device to screen the surrounding environment within the vehicle with data such as the humidity, temp, air contents etc. or providing air purifiers into the vehicle).	X	X	X	X
	117	Provide a means for passenger to communicate with caregiver or rider support (preferably human).		X	X	X
	118	Prepare user for potential other passengers and their service animals.	X	X	X	X
	119	Due to the connected nature of the vehicle, there is an opportunity to provide linkages to other health monitoring devices, including pacemaker, hearing aid, phones, smartwatches. Consider FDA in this discussion.		X		
Reliable emergency plans and emergency communication methods.	120	Consider a support solution specialist in case of vehicle-failure-related emergency, e.g., if person needs to exit vehicle.	X	X	X	X
	121	The remote operator and public safety officials and personnel are trained for emergency situations.	X	X	X	X
	122	The availability of the crucial information available by multi modal means especially during alerts, so that the PWD can respond in sync with the other passengers.	X	X	X	X
	123	Consider a support solution specialist in case of vehicle-failure-related emergency, e.g., if person needs to exit vehicle.	X	X	X	X
	124	Provide a means to provide emergency assistance or to get people to hospitals.	X	X	X	X
	125	Consider a safe phrase or word, and calming music, lights, or voice for persons with cognitive disabilities.	X	X	X	X
	126	Communicate/educate about contingency plans: e.g., In case of a sudden power failure/ sudden stop of the vehicle, the backup powering system or the special vehicle replacement to make passengers proceed with the rest of the journey with minimum delay time/ effective support systems etc.	X	X	X	X
	127	Direct communication with the hospital in case of a medical emergency by means of emergency buttons in the shuttle that can be connected to the mobile app.	X	X	X	X
	128	Having connections links to hospitals and other medical centres around the area.	X	X	X	X
	129	Method to return to origin or to continue on to the destination, in case of an emergency such as vehicle collision.	X	X	X	
	130	Provide a way for emergency escape (e.g., open windows) without physical operation.	X	X	X	X
Illumination: Absence of a driver places more emphasis on the need to see well and be safe.	131	Sufficient illumination to find seats and provide the feeling safety.	X	X	X	X
	132	Sufficient illumination so that the remote controller will be able to notice issues should they occur.	X	X	X	X

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
	133	Contrasting and illuminating colours in the vehicle design to aid visually disabled people to navigate.	X	X	X	X
Privacy	134	Solve: disclosure of service animal often leads to discrimination.	X	X	X	X
	135	Keep a passenger profile, but use preferences rather than health information, and limit access and use of data.	X	X	X	X
	136	Limit access to personal information (only the transport authorities have direct access to details).	X	X	X	X
	137	Incorporate option out feature on personal details.	X	X	X	X
	138	Consider auto-delete feature when trip ends, but do not delete from user's settings.	X	X	X	X
Reducing stress and anxiety in general related to travel in autonomous public transport services. (Air taxis in particular)	139	The speed, route and the capacity are important factors that influence a positive experience and should minimize disruptions and increase smooth ride and comfortability. This can be set by AV's: some vehicles have 'G-force' settings and limiters.	X	X	X	X
	140	For people with cognitive disabilities, user may consider calming effects (dim lights) and updates about detours or options to avoid loud areas, loud noises preceded by warning (e.g., construction zone), confirmation that the vehicle is on the right path, sensory stimulus can cause problems.		X		
	141	Travel training can provide guidance to users and their service animals.	X	X	X	X
	142	Successful service to the first and last mile depends on the reliability, frequency, route and capacity.	X	X	X	X
	143	Supportiveness to good and bad weather conditions.	X	X	X	X
	144	The rider identification method with their respective disability characteristics and with special needs such as extra space, calming music, space for the guide dog etc.	X	X	X	X
	145	Having multiple accessible options to choose from such as by air, train, tram, bus etc.	X	X	X	X
	146	Streamlined pre-planned service for better discretion. This helps avoid having to explain disability to people for assistance thus giving the passenger a feeling of control and independence.	X	X	X	X
	147	Consistency: Familiarity with sounds, visual displays, audio instructions to feel more confident and anxiety free.	X	X	X	X
	148	Training often done in person, but may potentially be done virtually for some aspects, e.g., websites for basic education, Able Link, "Be my eyes".	X	X	X	
	149	Automation of ramps, for feeling of freedom and inclusion (poor experiences with driver reluctance to pull ramps, etc.).	X	X	X	X
	150	Aspects of transportation systems that typically require training include payment systems, voice prompts, a-typical situations, fixed pick-up locations.	X	X	X	X

Needs associated with CAV	Ref #	Considerations	Physical	Cognitive	Visual	Auditory
	151	Taking steps to increase familiarity with public transport services such that it encourages PWD to take more trips annually (focusing on factors such as the age, working status, educational level, income and sex).	X	X	X	X
	152	Including PWD in the design and testing of systems, infrastructure and vehicles.	X	X	X	X
	153	Maximizing the trial numbers will lead to advocacy and greater adoptions.	X	X	X	X

Phase 2: Review of the list of Issues and Opportunities

The general response was that majority of the participants were pleased with the organization of the issues discussed and were keen to provide more feedback on the various aspects. Key points such as having universal emergency procedures, safety concerns, having back-up systems in case of failure of operation, convenience from start till the end of the journey were emphasized by the participants during the second session. The complexities of PWD where there isn't a single solution to fix a problem (e.g.: not all visually impaired clients find braille accessible) thus developing solutions to meet challenges faced by people with different levels of disability (including catering to those with invisible disabilities) was discussed.

General comments below:

"I'm looking at the area of the language that was used as for people with disabilities. Why can't we just say to these developers for all people, just straight out say and all of the diversity that all people come with? It's one of the reasons why sometimes the ball is dropped because a lot of developers think it's all too hard if we have to cater for people with disabilities. You've got to convince them no, it's inclusive design that we want here for all people. Then of course you can include the reasons why after that. But to say "for people with disabilities" is already using segregated language which can cause the developers to be overwhelmed. You've got to explain the concept of inclusion."

"I'd like to close as well by saying that what a lot of us are putting to you and whoever else wants to listen is that this is 2021. This is the chance to get it right at last for a properly totally inclusively designed vehicle from beginning to end, from top to bottom at the procurement stage, at the design stage and the outcome. That's where we're at with this."

"Predominant users, potentially, are either aged people or people with disabilities who are not driving, so the model should be set up for them, not as a secondary to them."

Phase 2: Focus Groups

Monitoring and direct assistance

Direct assistance was a topic comprehensively discussed in the first focus group session. A smart system to hail the vehicle was favoured. The role of stewards at stations and bus stops was discussed and how the current set up would change if public transport is to be made autonomous.

"One of your opportunities here on the communication of trip progress is that the driver can identify the passenger and then in brackets "card used by a deafblind person." I'd counsel you not to have those kinds of recommendations in a document like this. That might be what's done now by a person who's deafblind, but that's not necessarily what they would like to be doing if the technology was better. They're simply doing that now because that's the only option for them."

"A lot of buses just drive straight past you even though they can visually see you. So, it doesn't always work. So having a system that and I think you referred to having the touchscreen, or whatever it was going to be, outside is a great idea, but being able to confidently get on, have the mode of transport come and actually get you, I guess, and being able to obviously get off confidently is priority number 1 for me."

"Some sort of education, maybe an automated voice that comes and says, 'Please give up your priority seat, priority passenger coming on board.' That way people can be alert and be aware to give up that seat for me and my dog. Sometimes I can't see if they have a disability, or they might be pregnant or something. It's really difficult to I guess organise the priority seating there."

"I can't see how the stewards or the roving stewards, maybe they'll contribute but in my own peace of mind, they won't be much of a resolution because I can imagine they won't have a group of stewards standing around and it is just a matter of fluke if you have someone there to assist you if you have a situation of conflict or if there is a medical emergency or if there's something where a person is confused and is really distressed. Like if I'm completely disorientated, I get quite overwhelmed and so I don't know that the steward is likely to be anywhere near and if they have to notify the steward to go to such and such a platform or wait for the vehicle that's coming wherever, I don't know that that would work all that well."

"One of my most memorable metro train trips was when there was a disruption, and the train driver was constantly communicating the information. You weren't guessing then what your journey would look like to wherever you were going. It was not automated but it was by the train driver. That was one of the best examples. It was constant, like at every station, so you know what is happening. It makes you better prepared."

"I want it to be safe. If I'm going to get on this thing with no driver, I want to be absolutely guaranteed that if the thing breaks down, that I can get off easily, quickly, just like everybody else. I want it to be reliable as well."

Vehicle design aspects

Stemming from the previous conversation on vehicle design, certain specific areas were discussed again but with more detail. Colour contrast was a recurring concern and how the correct design not only cater for PWD but the elderly population, particularly living with conditions such as dementia in the community was discussed. This does not just include colours for seats and floor, but also more detailed aspects such as seat margins so people with poor vision can distinguish the outline of the seat based on colour contrast. Redundancies in the design and engineering aspect was deemed critical to increase reliability and safety for all commuters. The use of vibration in addition to audio and visual systems was a new area not discussed in the previous session and is an important feature for deafblind commuters. Suggestions were also made on wheelchair securement such as the use of magnets. Paying attention to detail is critical and to continuously test the design with varying levels of disabilities is important to ensure that the design is truly inclusive.

"Braille is not accessible for many people who are blind or have low vision, so especially people with age related blindness or low vision who haven't learnt Braille throughout life. So really you need to actually pair that with raised lettering and numbers."

Regarding Wheelchairs “we need to be very careful to ensure that we're not inventing a scenario where a person with a disability needs to come to a connected and automated vehicle with something already attached to their chair. The securement that you were describing that works on the pin, that only works because a person with disability has what I'd call the female part of that pin already attached to their chair. That system limits who can use that mode of transport quite substantially because they'd have to purchase the pin, they'd have to have the pin installed. There's certain limitations to using that kind of securement.”

“Low vision and contrast are big ones for me. Black and white is a higher contrast than yellow and green. Look, some people with low vision might like that, but generally the contrast is still very minimal, as opposed to black and white as a suggestion. “

“For someone who's unable to hear in the event of an emergency, could there be an inclusive system where the seat or something vibrates, because obviously they can't hear, but they feel the vibration as a signal that you need to get off the vehicle because.”

“You can use all the cameras all you like, but there's a lot of invisible disabilities there. That's why there should be inclusive design right throughout because you won't know and, quite frankly, you probably shouldn't know, but you've got to plan for what you don't know.”

“If I were to make something accessible to deafblind, I'll start with someone who's totally deaf and blind. They can't see, they can't hear. So how can I make that accessible? So that's something that's worthwhile looking at the benchmark, will these all cover the needs of deafblindness.”

“As a blind person, I need to take some sort of specialist equipment with me, whether it be a white cane, a guide dog, assistance from an able-bodied person who can give me instructions, understanding the layout of a vehicle, watching out for tripping hazards, that sort of thing. If I could be much more comfortable in terms of the equipment I need to carry and the homework I need to do to take public transport, I would feel much more comfortable.”

“I love magnets, they're a brilliant invention. If you had a high-powered magnet, only a little one, on the back of your wheelchair or near the base of your wheelchair, then you could reverse back into that spot and that magnet is on a slide in the taxi, that could slide straight up to where your magnet is, turn on a little bit of power and lock you straight into that. That way you're not using much power out of the taxi because you don't need a lot of power to make that magnet become high powered.”

"In terms of the seating, there's a new cantilever type seat that's coming in in the new trams which allows a person who uses a dog guide to actually put the dog under the seat and so I think somewhere that sort of idea, which will really make a huge difference to floor space, safety, convenience, et cetera."

"Certainly, there's a lot of standards I understood from places like Vision Australia and Blind Citizens Australia in regard to colour templates for vision impaired people. I really appreciate your point about them not using their branded things. It's got to be the aesthetics of what they are trying to achieve as marketers or promoters or branders. It has to be completely thrown out the window in favour of simple black and white, high contrast, the odd other coloured button in terms of people with vision impairments. I imagine that's not a disadvantage to other disabilities. I could be wrong. But certainly, get rid of the branding and the pastels and that sort of stuff. It's got to be about contrast, not brands."

"Very young babies can't sit in a seat and have a seatbelt. You have to hold the pram, which is very difficult for someone with disability, and there is not really space for it, so you have to keep trying to move it. It doesn't work very well. Whatever solution you find for securing a wheelchair, I think it should also consider some kind of modification to be able to secure a pram because for someone with disability, if I can't secure the pram, then I won't be using the vehicle."

"Why not make the button itself triangle or square and then from there inside of that where it might be a blue square inside of that have a clear bit that's for a tick or a clear bit that's for an X."

"Just with emergencies and the bus driver, obviously if the vehicle loses power or whatever, will the vehicle have a backup battery because I can just see that if the mechanism to restrain the wheelchair or the scooter or whatever is a bolt system and the vehicle loses power, will there be a back-up battery to disengage that bolt, and in the same breath, keep the lights illuminated for other people with vision impairment, hearing impairment, whatever, so that they can negotiate themselves out?"

Humane Machine Interface

One of the key points raised by the participants was the ability to communicate using multiple modes to convey messages and that too to be able to link to personal devices via technologies such as Bluetooth. Another point was on building confidence and trust if the human aspect is replaced with a machine in such a way that people can comfortably, easily and confidently adapt and interact with the 'machine.' Having a simple yet reliable and efficient system is a key feature to improve confidence, increase independence and increase acceptance of AVs by the public. It is also important to note that not every passenger is able to interact with digital platforms thus developing a system that is inclusive to all including the aged community who rely heavily of public transport is very important.

"About inclusive communication, and I think that if we look at any type of communication that's going to be delivered, whether it be emergency evacuation procedures or even information in the carriage in relation to stops and all that sort of thing, I think if every piece of information is given, is equally given in audio as well as visual information. I think that would sort of meet a lot of people's requirements particularly looking at people with a vision impairment and also people with a hearing impairment as well. So I think that whatever information is being delivered should be delivered in as many different ways as possible."

"If I were to make something accessible to deafblind, I'll start with someone who's totally deaf and blind. They can't see, they can't hear. So how can I make that accessible? So that's something that's worthwhile looking at the benchmark, will these all cover the needs of deafblindness."

"I think most people with disabilities have a piece of equipment or some sort of aid or some sort of assistance that they use to assist them to interact with the community or with the public transport system, so the bridging between that piece of equipment and comfort levels in using that piece of equipment is the broad I suppose principle that is important from my point of view."

"Just thinking about I guess in my point of view automated vehicles because I have a hearing loss and a vision impairment called Usher syndrome and I have to tell you I struggle with machines, I struggle with audio voices, like announcements, I struggle understanding what's being said because the computerised voice doesn't work well with my hearing aids. So I'm wondering whether technology would work in with the automated vehicles with my hearing aid with Bluetooth that could connect right into the hearing aid, it could be an option, and also with announcements with TV screens I don't see very well and knowing I'd like to know where I am and when I need to get off because it could be 20 stops, or something like that. If I could have an app that's connected to that automated vehicle, like a public transport system, that would just tell me what stop I'm approaching, like 'The next stop is Flinders Street' so that's something that would be valuable for me."

"That's the thing really complex about deafblindness. You would need to be as autonomous as possible. Sometimes in situations we do need human interventions and with the camera thing they're not going to be able to see the camera and the person is not going to be able to respond to any of the cues that may occur around them. So it needs to be more human interaction. Because we have to consider the technology does break down and we need to have back-ups so a deafblind person feels safe. We would need intervention. I don't think there's any technology other than vibrations, research on vibration jackets that give tactile cues to working in conjunction with emergencies that's occurring at the time or whether someone tries to interact with them and has some sort of tactile response or communication, but that's not at this stage."

"Signage. I know some trams have signage on the side, so you're not standing in front of it to read it, but if you're near it and you have some vision, you might be able to see it on the side of the vehicle from the outside. You know how some trams have lit up bits on the side saying where they're going. And there are different devices that we can use that will read two us, so it just makes it more accessible than trying to stand in front of a vehicle. That just doesn't work."

"One of the potential solutions to some of this could be audible information feedback. So, one of the things that we have done very poorly has been bus audio announcements or any sort of bus audio announcements. So, we could be looking at more of an audible feedback to provide information about what's written on signs instead of people having to go to all this crazy looking and different colours, where we could have a much more audible related system that gives us information without us having to crane our necks around and look at certain things."

"I am sorry to advocate but, again, as I can't use an app, if I'm on a platform where there is a lot of noise and if the audio is not loud enough, the only thing that help me is if there can be a speaker up the machine or closer to the person's ears or whatever that can be louder because all these apps are absolutely tremendous unless you're getting older and never really got the ability to use the apps and then are finding it very, very challenging, particularly if I have memory loss and stuff. Unless it is on the machine, it is simply not there for me."

"The app is not for everyone but for a lot of people, it does resolve a lot of problems, and it wouldn't be the only means of information, but it does resolve a lot of issues for a lot of people."

"The vehicle will have to prepare to give me more time to board. The vehicle is going to have to know in some form that it will need to have to wait for longer, it needs to make a sound for me to find it at the station."

"So, my big thing is that I want to be able to get on to this vehicle without assistance. So, I want to be totally autonomous in an autonomous vehicle. So, I don't need to rely on other people to get down a ramp or put my bag up or tie down my wheelchair or anything like that. I want to be able to get on and off in the flow just like able bodied people, I guess. I need it to be simple so the simplicity of it means that I just get on and the payment is taken care of somehow without me having to arduously get a card out or tap my watch or whatever."

"One of the things I would say here is there needs to be a way that I can control that touchscreen on my own device, so on my iPhone, I need to be able to use my iPhone, which has all of my custom settings and my predefined voice settings and all my customized settings for all my speech rates and my sounds and all the stuff in order to be able to use that touchscreen or be able to use that touchscreen device. Because one of the challenges you are still going to have is that even though you're going to have voice on, the voices have been terribly low and have been unable to be heard over the bustling and rustling of traditional movement around the station. That's the challenge that you face, unless you do some sort of a tactile Braille input feature on it or provide some sort of feedback, but there's feedback that can be provided via tactile feedback, so the iPhone does different pulses. If anyone has used the Apple Watch for doing time recently, you can set it up to give you pulses on your wrist of when different times are met. So, there's a lot of potential ways that you could go."

Vehicle operations

Reliability is again emphasized in operations and features such as constant feedback and real time information can help people plan the next course of action in case of disruption and delays to service occur. There was some debate on declaration of disability status as the method in which this would be done and which authority is in charge of making decisions was unclear. Particularly to people with invisible disabilities and the elderly.

"I'm looking sort of like with the dots with beacon location, so where you can if you choose to, you can track your journey, but also when a bus does stop at a bus stop, because the bus won't always stop at a bus stop, that when it does stop at a bus stop, then there needs to be something there that sends that the bus is there and how long it's going to be there for because if you are running a couple of seconds late and you know the bus isn't going to be there for another three or four minutes, then if you've got to get your wheelchair out, or whatever it may be, it allows you that little bit of a heads up time. I know that to catch public transport, usually you're supposed to be there 5 to 10 minutes beforehand so you know you're going to get a spot, but just this will be departing in 10, 15, 20 seconds, whatever it may be."

"I'm wondering with myki, it could be used rather than state based and whether the myki could have some sort of code where you tap it on to get on a vehicle, automatically detect the needs of the person getting on the bus, like please give up your seat, because myki would register the needs of the person. All the colours will be designed for that person getting on the vehicle to tailor that person, because there's a very small number of people with disabilities getting on public transport who can cater for that person."

"At major stations, train stations, et cetera, the customer service people are all increasingly being trained to provide support for people when needed and they're roving. So it is a very good initiative and could be used with autonomous vehicles at stops and stations, et cetera."

"The really important thing around this declaration of needs, et cetera, which as I agree it does absolutely help in some instances, but it's got to be focused on the functional need, not about a medical diagnosis. So that's where it gets insulting and gets into the privacy issues, is when they insist on having a medical diagnosis and proof of that. It's about your functional need to travel. I need assistance getting on the train because I can't see, or whatever it is."

"I think with the changes of times and the changes of trains, you know, sometimes they swap with different routes and I don't hear the announcements in that regard where they say, 'now change to platform 1' and I often get on the wrong train. So I think there's something there that needs to ensure you reach out to the passengers before they get on to the right service or right bus or whatever it may be. I think they're pretty important points, trying to engage with technology the best way possible."

"If there's some way to know in advance that there is seating and it's being used by someone else, I am not going to know if it's going to be used by a person with disability or if it's just another passenger that has taken that spot."

"It's about how do you know that someone sitting in a seat has a disability? Not all disabilities are visible. I would just hope that the design isn't so punitive that you have to have NDIS or something as a way of flagging your disability because not everybody with a disability has NDIS."

"I don't look ill, and I have been challenged before and it was quite uncomfortable. So, I can see the benefit of having a standardized way of identifying, say, through a booking system, but it would have to be an integrated thing where general practitioners are aware and can provide some sort of authority outside of the NDIS so there is equity of access for everybody into that system and it's not one entry point into being able to identify as a disability. I think that is what I am saying. It needs to be more than one entry point into that identification system if it is not just reliant on self-identification at the time."

"One of the issues that we face sometimes is you get on a train and for whatever reason, the audio system is not working so you've then got to go back to counting your stations and making sure that you are trying to really remember you're the number 25th station along your journey and making sure that you're actually getting off at the right station, versus maybe getting off one before or one after, which could potentially be not very good outcomes for anyone. So, it needs to also have some sort of back up way of being able to produce those systems."

"My big thing is reliability. So, I can't be waiting 20 minutes for a connection because fatigue is my main issue. So, it becomes a useless exercise of catching public transport if I have to have lots of clunky connections and don't have a reliable system."

"I don't need to make lots of decisions when I get into the vehicle, so it's all clear and mapped out about how I use it. The less decision making I need to make and how clear it is I can make those decisions, the easier it is for me to access it."

"The big one for me is this issue of booking, whether a person with a disability needs to book for a service because typically these connected and automated vehicles are being portrayed as a turn up and go, and if they're a turn and go for the broader community, they need to be a turn up and go for the disabled community. Under our Disability Discrimination Act, there's really no way around that, so this whole issue of booking is the big one for me."

"I want it to be cost effective and cheap actually. I want it to be cheap."

Make or Break factors

Participants were asked to each try and name the key make or break factors: What would stand in the way of them using a CAV? The below table (Table 7) summarizes the findings.

Table 7: Make or break factors that will influence adoption of Autonomous Vehicles by PWD identified by focus group participants.

Priority Item	Quotes
Accommodation of wheelchairs and scooters including easy boarding and alighting, space allowance and securement	<p>Now, I think most people with disabilities have a piece of equipment or some sort of aid or some sort of assistance that they use to assist them to interact with the community or with the public transport system, so the bridging between that piece of equipment and comfort levels in using that piece of equipment is the broad I suppose principle that is important from my point of view.</p> <p>I love magnets, they're a brilliant invention. If you had a high-powered magnet, only a little one, on the back of your wheelchair or near the base of your wheelchair, then you could reverse back into that spot and that magnet is on a slide in the taxi, that could slide straight up to where your magnet is, turn on a little bit of power and lock you straight into that.</p>
Colour contrast to identify buttons on doors and handle, seat outlines, signage	<p>I think from my perception, I wouldn't be able to access public transport if colour contrasting wasn't reliable on buttons where doors are handles, if you have to use handles or buttons or doors and seat outlines.</p>
Different shapes (and shapes within shapes) used for buttons	<p>I like the idea with the different shapes, but I also think with the different shapes, for example, if you're colour blind, for example, sometimes the different shades won't show up, so the different shapes, but then with a tick or a cross or something else that's inside of that shape that gives you another visual cue.</p> <p>Why not make the button itself triangle or square and then from there inside of that where it might be a blue square inside of that have a clear bit that's for a tick or a clear bit that's for an X. I guess our look at it is I haven't seen this for a long time, but the little green man and little red man. He's on a black background and when it goes, he'll turn green for go and red for no. But why can't we do that inside of a shape, so that way it says it gives a person a bit of an idea on what the shape is, what it's meant to be?</p>
Space allowance for Dog Guide including safety aspects	<p>As a blind person, I need to take some sort of specialist equipment with me, whether it be a white cane, a guide dog, assistance from an able-bodied person who can give me instructions, understanding the layout of a vehicle, watching out for tripping hazards, that sort of thing. If I could be much more comfortable in terms of the equipment I need to carry and the homework I need to do to take public transport, I would feel much more comfortable.</p> <p>Some sort of education, maybe an automated voice that comes and says, "Please give up your priority seat, priority passenger coming on board." That way people can be alert and be aware to give up that seat for me and my dog. Sometimes I can't see if they have a disability, or they might be pregnant or something. It's really difficult to I guess organize the priority seating there.</p>

Tactile markings and lights for navigation inside the vehicle	<p>Tactile markings in the vehicle to indicate if you get disorientated which way you turn to go to the seats which are accessible for people with disabilities and so forth.</p> <p>I want to locate the appropriate seating. So, whether that is some sort of tactile indicator or little lights along the floor, something like that.</p>
Other options for people unable to use apps and touch screens, and options when phone batteries die	<p>Just thinking about, I guess, in my point of view automated vehicles because I have a hearing loss and a vision impairment called Usher syndrome and I have to tell you I struggle with machines, I struggle with audio voices, like announcements, I struggle understanding what's being said because the computerized voice doesn't work well with my hearing aids. So I'm wondering whether technology would work in with the automated vehicles with my hearing aid with Bluetooth that could connect right into the hearing aid, it could be an option, and also with announcements with TV screens I don't see very well and knowing I'd like to know where I am and when I need to get off because it could be 20 stops, or something like that. If I could have an app that's connected to that automated vehicle, like a public transport system, that would just tell me what stop I'm approaching, like "The next stop is Flinders Street". So that's something that would be valuable for me.</p> <p>I think with the changes of times and the changes of trains, you know, sometimes they swap with different routes and I don't hear the announcements in that regards where they say, "now change to platform 1" and I often get on the wrong train. So, I think there's something there that needs to ensure you reach out to the passengers before they get on to the right service or right bus or whatever it may be. I think they're pretty important points, trying to engage with technology the best way possible.</p> <p>Also, being unable to remember clearly or use apps, to have audible announcements that can be heard, whether there's power or not to the vehicle.</p>
Multi modal systems for communication – Visual, auditory, tactile	<p>The announcements need to be really visual, so one of them. The second one is to have someone to contact in case of an emergency. The third one is knowing when to get off when people are going to a new place.</p> <p>Priority number 2 is having enough information when you're on board to understand where you are. I guess people have said having visual information, but I personally want audible information, so as much audible information as possible and clear, concise.</p> <p>I think with the changes of times and the changes of trains, you know, sometimes they swap with different routes and I don't hear the announcements in that regards where they say, "now change to platform 1" and I often get on the wrong train. So I think there's something there that needs to ensure you reach out to the passengers before they get on to the right service or right bus or whatever it may be. I think they're pretty important points, trying to engage with technology the best way possible.</p>
Ability to hail the vehicle	<p>I can stand in front of a bus stop and unless I wave my hands in the air, which the local bus company tells me I have to do, the bus driver won't stop. So, hailing would be helpful to know.</p>

Punctuality	<p>My big thing is reliability. So I can't be waiting 20 minutes for a connection because fatigue is my main issue. So it becomes a useless exercise of catching public transport if I have to have lots of clunky connections and don't have a reliable system.</p> <p>I want to be able to get on it when it says it is coming and get me to where I'm going when it says it will. And with taxis in a rural area at the moment, you can wait up to 45 minutes. So that's where I am coming from with that.</p> <p>I am hearing impaired, but the punctuality so you don't have any anxiety, and the difference between what is being said and what is being displayed, if that is consistent, because I can partially hear and if it doesn't match, you are not sure which information to follow.</p>
Independence – use of service without or with minimal assistance from people	<p>So having a system that and I think you referred to having the touchscreen, or whatever it was going to be, outside is a great idea, but being able to confidently get on, have the mode of transport come and actually get you, I guess, and being able to obviously get off confidently is priority number 1 for me.</p> <p>My big thing is that I want to be able to get on to this vehicle without assistance. So I want to be totally autonomous in an autonomous vehicle. I don't need to rely on other people to get down a ramp or put my bag up or tie down my wheelchair or anything like that. I want to be able to get on and off in the flow just like able bodied people, I guess. I need it to be simple so the simplicity of it means that I just get on and the payment is taken care of somehow without me having to arduously get a card out or tap my watch or whatever.</p>
Reliable emergency procedure with constant feedback using accessible systems	I want it to be safe. So if I'm going to get on this thing with no driver, I want to be absolutely guaranteed that if the thing breaks down, that I can get off easily, quickly, just like everybody else.
Cost effective	I want it to be cost effective and cheap actually. I want it to be cheap.
Safety	<p>For me, I want to be safe and that includes things like getting on and off and knowing the doors are going to stay open long enough for me and my dog to get on.</p> <p>I want it to be safe. So if I'm going to get on this thing with no driver, I want to be absolutely guaranteed that if the thing breaks down, that I can get off easily, quickly, just like everybody else.</p>
Ability to contact the operator in case of an emergency	If I do get in trouble, if I do get disorientated or lost, I want to know there is someone who I can contact who is going to have some empathy for the situation.
The location where the vehicle stops – ensuring that there are no obstacles on the path such as garbage, construction work, water, other tripping hazards, etc.	Having recharge points in the shuttle or the taxi or in the bus or whatever it's going to be. I'm looking sort of like with the dots with beacon location, so where you can if you choose to, you can track your journey, but also when a bus does stop at a bus stop, because the bus won't always stop at a bus stop, that when it does stop at a bus stop, then there needs to be something there that sends that the bus is there and how long it's going to be there for because if you are running a couple of seconds late and you know the bus isn't going to be there for another three or four minutes, then if you've got to get your wheelchair out, or whatever it may be, it allows you that little bit of a heads up time.

	<p>I want to know when it stops, that they're not going to stop in front of road works. That's really important for me to know that I can get off safely.</p> <p>If there's a great big puddle or something outside the door, that is pretty disconcerting or if someone has left rubbish nearby, that kind of thing can be a horror for people in wheelchairs or who walk into a mound of bits of wood or something that somebody has left there.</p>
Space allowance for prams including child safety aspects, securement, etc.	I have already mentioned about the pram, which is pretty important for me, and I agree with what other people said about I want to be able to get on myself, which is pretty obvious. I can't do that with current trams that are not flush to the pavement. So I need to be able to do that. You have to hold the pram, which is very difficult for someone with disability, and there is not really space for it, so you have to keep trying to move it. It doesn't work very well. Whatever solution you find for securing a wheelchair, I think it should also consider some kind of modification to be able to secure a pram because for someone with disability, if I can't secure the pram, then I won't be using the vehicle.
Reliable, convenient booking system	<p>I'm wondering with myki, it could be used rather than state based and whether the myki could have some sort of code where you tap it on to get on a vehicle, automatically detect the needs of the person getting on the bus, like please give up your seat, because myki would register the needs of the person. All the colours will be designed for that person getting on the vehicle to tailor that person, because there's a very small number of people with disabilities getting on public transport who can cater for that person.</p> <p>The big one for me is this issue of booking, whether a person with a disability needs to book for a service because typically these connected and automated vehicles are being portrayed as a turn up and go, and if they're a turn and go for the broader community, they need to be a turn up and go for the disabled community. Under our Disability Discrimination Act, there's really no way around that, so this whole issue of booking is the big one for me.</p>
Training to build confidence	As a blind person, I need to take some sort of specialist equipment with me, whether it be a white cane, a guide dog, assistance from an able-bodied person who can give me instructions, understanding the layout of a vehicle, watching out for tripping hazards, that sort of thing. If I could be much more comfortable in terms of the equipment I need to carry and the homework I need to do to take public transport, I would feel much more comfortable.
Assistance during the journey such as knowing when to alight when traveling to a new destination	Priority number 2 is having enough information when you're on board to understand where you are.
Real time feedback to commuter on bus journey, delays, how long bus will be at the stop for, disruptions	Having recharge points in the shuttle or the taxi or in the bus or whatever it's going to be. I'm looking sort of like with the dots with beacon location, so where you can if you choose to, you can track your journey, but also when a bus does stop at a bus stop, because the bus won't always stop at a bus stop, that when it does stop at a bus stop, then there needs to be something there that sends that the bus is there and how long it's going to be there for because if you are running a couple of seconds late and you know the bus isn't going to be there for another three or four minutes, then if you've got to get your wheelchair out, or whatever it may be, it allows you that little bit of a heads up time.

Ability to receive communication to own device which is customized to personal needs	Just thinking about I guess in my point of view automated vehicles because I have a hearing loss and a vision impairment called Usher syndrome and I have to tell you I struggle with machines, I struggle with audio voices, like announcements, I struggle understanding what's being said because the computerised voice doesn't work well with my hearing aids. So I'm wondering whether technology would work in with the automated vehicles with my hearing aid with Bluetooth that could connect right into the hearing aid, it could be an option, and also with announcements with TV screens I don't see very well and knowing I'd like to know where I am and when I need to get off because it could be 20 stops, or something like that. If I could have an app that's connected to that automated vehicle, like a public transport system, that would just tell me what stop I'm approaching, like "The next stop is Flinders Street". So that's something that would be valuable for me.
Charging stations to charge equipment and devices	No comment
Ability to use pass/ticket in metro, regional and interstate travel	No comment

Phase 2: Peak Body Workshop

A second 2-hour workshop was held with Peak Body Representatives via Zoom. Agencies represented at the meeting included Blind Citizens Australia, Deaf Society NSW, Guide Dogs NSW ACT, Hearing Matters Australia, NSW Council for Intellectual Disability, Paraquad NSW, People with Disability Australia, Physical Disability Council of NSW, Spinal Cord Injuries Australia, Synapse Australia and Stroke Recovery Association.

The preliminary report built based on the first focus group (Phase 1) findings and on the comprehensive literature review was circulated amongst participants to obtain feedback. A second focus group with the same group of participants was then held to discuss the preliminary report and to further revise the information presented.

Peak Body Workshop 2 - Topics and Responses

Overall, discussion throughout this workshop was robust, with varying opinions on the major priorities, these being quite different depending on the disability type and the peak body represented. The meeting agreed that it was important to continue working towards universal design as this would allow for the major issues to be addressed for all PWD. The group could then follow this up by investigating in more detail more the individual priorities arising from differing disabilities.

Individual concerns, clarification and priorities were discussed at the meeting linked to the following four areas:

- Vehicle Design,
- Monitoring and Direct Assistance,
- Human Machine Interface and
- Vehicle Operations

Introductory Comments

The opportunities listed in the provided documents for the second workshop were compiled following our first round of consultations with Peak Body representatives, in addition to some further recent consultation with PWD via focus groups. Consequently, we have developed approximately 170 issues and opportunities for our deliberation today related to access by PWD with automated vehicles. In the provided document for today's meeting there is a focus on shuttles as a transport option due to their testing status across Australia and their current production by five manufacturers. In addition, the meeting will address other forms of AVs.

For the second workshop, priority issues will be addressed that impact the lived experience of PWD. This same list of issues has been tabled with industry and most of their key stakeholders have responded positively in agreeing that these are issues that need further deliberation and may represent opportunities for development in the future.

Vehicle Design

Overview

- Design standards, particularly for shuttles, have seen an improvement when compared to what is currently on the market for trains, buses and trams. Of note is the introduction of wide doors, enhanced floor space, the elimination of stairs, and wider aisles. However, there are no current agreed standards for seating availability.
- Of note is the tendency of some Australians to neglect standing up and releasing their seat for a person with disability, typically resulting in the intervention of the driver. However, when there is a driverless vehicle, how will this situation be resolved? One option is for the installation of a camera in a shuttle, with a remote operator being able to intervene when appropriate.
- In relation to the use of wheelchairs, the disability sector and manufacturers acknowledge similar operational issues. The minimum option is for people with mobility challenges to sit with the back of their wheelchair facing the driving direction, therefore preventing risk of injury in transit. Ideally, wheelchairs should be able to be automatically clamped down, thus not requiring a helper to provide additional assistance. At this stage, however, we are not able to provide a ready solution for securing wheelchairs on public transport.

- There are additional issues related to the standardization of wheelchair clipping scenario. The recent ATSA conference provided us with a few options in this area. While the Q'STRAIT is a pin that allows for some travelling flexibility, there exists an alternative option that resembles a piece of metal that has the shape of an iron triangle that fits exactly into a holder, securing the wheelchair and preventing it from moving. This device, though, may present some significant issues for a person with vision impairment with a piece of metal protruding in an open space within the vehicle.
- The Q'STRAIT manufacturers have addressed this issue by developing a signal to detect obstacles and obstructions. The Q'STRAIT is flush with the floor when it is not in use and can then adjust itself to the appropriate height in response to barriers.
- We need to allocate adequate space for a guide dog in addition to other mobility aids.

Discussion

Issue: The issue of wheelchairs being placed in a rear facing position was raised. There was consensus that this was not the best perspective for a person travelling on public transport and that alternate options needed to be considered so that the person faced in a forward direction. A further suggestion was made that we create a consistent space for wheelchairs no matter what vehicle a person was travelling in, and that people should always enter a vehicle in the same way.

"I have a comment regarding standardization of any sort of wheelchair clipping scenario. How will it occur? How will we get all the different designers and marketers that produce wheelchairs to produce one standardized mechanism that will allow a wheelchair to be able to independently drive into and then secure into a base plate?"

Issue: Q'STRAIT devices

"There is a product by Q'STRAIT that is controlled by the vehicle operator, and it folds up. It comes from the floor - a sort of big pedal comes up and faces the ceiling - for a person in the chair, facing backwards. This then folds down and sits on the floor on the outside of the wheels, which stops the vehicle swinging with a centrifugal force when it turns. This could be adapted."

Response by Chair: This issue depended on what type of vehicle the person was travelling in, but normally if a vehicle is going around curbs and corners where the centre of gravity is shifting having a seatbelt provided added security. There was also a product developed by Q'STRAIT that could be controlled by the vehicle operator and folded up. It comes from the floor and a pedal comes up and faces the ceiling so that a person is reversed into the wheelchair space in the chair, facing backwards. It then folds down and sits on the floor on the outside of the wheels that stops the vehicle swinging with a centrifugal force when it turns.

Response from meeting: There was a further request for clarification regarding a person needing to be placed in the wheelchair backwards. It was explained that a person still needed to have their wheelchair placed backwards to the direction of the traffic. Once in this position, they would probably need to press a button when they needed to exit the vehicle and another button to allow the arm of the chair to come down.

Issue: Mobility scooters

"Many stroke survivors are using mobility scooters. Is there capacity for securing access to bigger vehicles? How big can these vehicles be, because there are large mobility scooters being used at the moment. This is something that needs to be reviewed."

Response from Chair: Because a mobility scooter is, in principle, no different to a wheelchair we should be able to accommodate them on public transport. Mobility scooters are usually more stable and require less clamping, however they are also less manoeuvrable once they are inside a vehicle.

Issue: The issue of controls was raised. It was proposed that the principle should be that a person be able to learn the control features and then apply them everywhere, using the same controls no matter what vehicle they were in. These controls, though, needed to be operated by persons with different degrees of motion capacity and strength, and levels of recognition. It was agreed that this issue needs further deliberation.

Issue: The issue of colours was raised, especially in relation to people with vision impairment. For people with visual impairment different shapes for the button was preferable to having similar shapes with different colours.

“I'd like to make the comment about colours. So, if there's no controls about the colours, then manufacturers want them to be in their own brand colours and then they don't meet accessibility needs”

Issue: This issue of hearing loops was raised. Due to many hearing loops and hearing aids not being fitted with a T-coil for integration with some devices, there needed to be an alternative sound system that was linked to visual captioning and/or auto captioning. A further issue that needed to be considered was that hearing loops were now less user-friendly and that there were better ways to do things e.g., digitally based technologies.

“People are suggesting that hearing loops are less user friendly, that there's better ways to do things. That there's more digital or more effective ways and that loops not as user friendly. But I just don't think enough people are aware of what they're capable of – what their devices are actually capable of picking up.”

Issue: The issue was raised about people not being able to see signage on public transport, particularly on journeys that were not linear. When shuttles travelled from A to E, and not just from A to B to C to D and then to E, it was important for PWD to understand where they are and when they needed to get out. Communication about their journey therefore depended on signage that was clearly presented and accessible. Data should be available in real time and communicated either through a hearing loop or through an app.

Response from meeting: It was agreed that there needed to be a range of communication modes available to PWD on public transport.

Monitoring and direct assistance

Overview

The second topic of discussion for the workshop was related to the connected aspect of AVs, with participants sharing their thoughts in areas including vehicle-to-vehicle interaction, smart technology solutions, the use of apps and other booking platforms for PWD.

Discussion

Issue: There was a concern that if vehicles were electric, people with sensory impairment would not be able to hear them approach.

“My concern is that if the vehicles are electric, then you won't hear them approach. So how do we do we address that? Especially if you've got vision impairment and are not using a smartphone to know that the vehicle has arrived”

Response from Chair: We may be able to develop a GPS variant on the vehicle in the future to address this issue.

Response from meeting: There should be a mandate for vehicles to slow down to a particular speed, with additional noise activation.

Issue: The issue of people not being able to use and manipulate controls was raised, particularly where a driver currently assists a person boarding and exiting. A person will typically advise a driver where they need to go, and the driver will then stop at the right location and help the person disembark.

Response from the Chair: There should be a way to contact someone and get help on a journey through the customer service department or perhaps remote controllers. Most of the operators contend that they will have somebody in their central office monitoring 10 or 12 vehicles and that they will have cameras available and will therefore know not only who is inside the vehicle but the situation outside the vehicle. Another option was that on some of the bigger stations there would be a steward who stayed on the platform and helped when assistance was needed. In the focus groups, however, there were stories of people sitting on the train and being the last one left, not realizing that everybody had exited. When there is a flat tyre or an engine breakdown, it is normally the task of the driver to explain this to passengers. Therefore, transport companies will need to have contingency plans for these situations with the needs of PWD in mind.

Issue: A concern was expressed that because of the small size of a shuttle vehicle, it can drive around more easily than the bigger buses; therefore, what is the infrastructure that is linked with this? How will the AV know when it is not able to access a designated parking place? Will it be safe for the person to embark and disembark?

Response from the Chair: That issue will be addressed later in this meeting in *Vehicle Operations*. The main assumption is that there will be a baton available and there will be an ability for the vehicles to park where they are supposed to park. When this place was already occupied, they would park at the nearest available parking space. This can be programmed for selected vehicles.

Response from meeting: Resolution of this issue is important, as PWD will be depending on a vehicle being at a certain place.

Response from the Chair: We will address these issues later.

Human Machine Interface

Overview

Participants were given the opportunity to discuss other areas of interest or concerns about AVs and Air taxis. There were questions about how technology will cater to those who are deaf and blind; facilities such as toilets, regulation changes and training people with cognitive difficulties. Related to the topic of Air taxis, questions were raised about the continuous path of travel, weight limits and implications for wheelchair users, the number of taxis in the air and ramifications and the design of wheelchairs as drones themselves.

“As a general comment, I would say the key thing to keep in mind is to look at the barriers that people are facing with this new way of transport with automated vehicles. Let’s move away from a focus on disability type and look at the barriers that people face every day.”

Discussion

Issue: The use of touchscreens in vehicles was raised as an issue. It was suggested that touchscreens should be located not just in the vehicle, but also outside the vehicle.

Issue: The issue of payment for a journey was raised. In terms of planning and booking a journey a person currently relies on a driver to take a booking and then process payment. People will now need to rely on technology that is accessible for everybody and adapted to address their specific disability.

Vehicle operations

Overview

Issues related to vehicle operations were mentioned in previous discussions at this workshop, particularly with regarding vehicle design.

Discussion

Issue: The issue of beacon technology was raised. It was noted that there were now apps that used beacons to find toilets so that it should not be difficult to extend other applications to assist people finding the entrance to a vehicle. If the vehicle is parked in a different location, technology should be available so that people with a disability could find the right entrance and find the right vehicle, perhaps communicated via a hearing loop or an app.

Issue: The issue of payment was again raised. In the focus groups it was made very clearly that even a swipe card was not usable by everyone, therefore there needed to be consideration of alternatives in this area.

Issue: The issue of the proper governance of data was raised and the requirement for any personal data to be stored according to legal and ethical standards.

Response from meeting: The principle of universal design was raised as relevant in these areas and that standards were therefore required for processing the booking of tickets and managing personal data.

Issue: Stress and anxiety for participants accessing public transport and how it could be reduced was raised as an issue. In particular, auditory “running commentary” for people on public transport was suggested as a cause of stress for some PWD.

“I would say pretty much on almost every trip I will at some point rely on human interaction. When there are no announcements made - you know, ‘the train is arriving on the platform’ - even though I use technology on my phone, inevitably for every trip I will at some point rely on another human being just to fill in the gaps. I think in the ideal world, automation is going to work well and there's a lot of opportunities, but just from my own perspective, it's the random stuff that is my key concern. How do we foresee or plan for these sorts of random situations?”

Response from meeting: It was agreed that “running commentary” caused sensory overload for some PWD. For some people with a brain injury, for example, it can cause significant cognitive overload. This matter needs further attention and research.

Issue: The issue of safe departure for people was raised as an issue. For people with no vision, leaving a vehicle and ensuring their safety was very important. Typically, it was the role of the driver to ensure their safety. In an automated vehicle this will not be the case and probably the responsibility of a remote operator.

Summary and follow-up

The content and discussion for today’s workshop represent critical planning issues for the whole transport system, not just for AVs.

The key issue articulated at today’s meeting is that the transition to automated transport options has the potential to be a difficult and risky undertaking for PWD.

To ensure that PWD can travel safely will depend on many factors such as the accessibility of the platform, the distance between vehicles, timing issues, communication, etc. Operationally there are a range of commercial parties involved in this area that need to agree on matters of principle and planning.

It is agreed that significant work had been invested in developing the documents for this workshop and making them accessible to a wide range of interested parties is an important phase of this project.

Participants at the meeting are therefore encouraged to distribute these documents to people across their organizations and that following this process the documents will be circulated as a final draft.

Phase 2: Industry feedback on the needs of People With Disability

The below tables capture the feedback from the industry. The table includes feedback from 2 manufacturers, 1 industry body, 1 operator and 1 EVTOL representative. One of the manufacturer's feedback included a compliment only for providing the detailed overview with which they fully agreed.

Table 1. Industry feedback overview on Vehicle Design

1. Opportunities: vehicle design Several articles in the Transport Standards relating to the vehicle design and layout apply to CAVs. CAV shuttles that are currently being trialed in Australia are an improvement compared to buses and trams and will meet the requirements of the Transport Standards, such as access pathways, onboard manoeuvring requirements, automated doors and floor space provided. However, there are amendments required, for instance to ensure a standard approach such as wheelchair positioning and there are opportunities where CAVs can take a flagbearer role. <i>WJG 3.4.3: Consistency of essential accessibility features across the whole journey is important. This will be increasingly important as transport providers pursue service improvements in response to technology opportunity, including use of different vehicles for different services in the future.</i>						
Focus area	CAV Principle	Industry Stakeholder	Manufacturer 1	Manufacturer 2	Manufacturer 3	Manufacturer 4
Seating availability	CAV PWD principle With the connected nature of CAV, seating availability does not need to be the concern for PWD as it is today. <i>WJG 3.5: PWD have highlighted that priority seating is often unavailable on busy public transport services, and at times priority seating is also shared with other customers such as parents with prams.</i>	Concept could also apply to air taxis given technology and nature of the services.		Yes, agree in principle, we should work toward a standard or a guideline No, we don't agree because...	Yes, agree in principle, we should work toward a standard or a guideline. Short term (0-2 years)	Yes, agree in principle, we should work toward a standard or a guideline but in most current CAV, adding a wheelchair onboard will block most of the other seats and in current CAV it is still complex to monitor the kind of passengers already onboard (with prams or not), etc.
Seating availability	Opportunity: Agree on position of the priority seat <i>Transport Standard 31.1. Operators must designate at least 2 of the seats provided on their unbooked conveyances as priority seating for passengers with disabilities and other groups in need of special assistance. (for example, the aging).</i>	A standard could apply for this on Air taxis.	If the CAV is a vehicle that is for a single occupant, then the issue of priority seating is mute. If it is a shared vehicle, then the size of the vehicle will dictate the number of priority seats that can be provided. So priority seating depends on the size of the vehicle. A requirement for all vehicles to be accessible may be limiting to the roll out of the technology due to complex factors such as design and fastening for	Agree	Yes, agree. Priority seats should be the closest seats to the door Short term. (0-2 years)	Agree SHORT

			wheelchairs and gophers.			
Seating availability	Opportunity: The connected opportunity is to provide real time data about the availability of seats. As an example, make seat-availability visible online in real time, for instance by placing sensors on seats/use camera to determine availability and allow disability seat reservation.	Concept could also apply to air taxis given technology and nature of the services.	Yes, this is something that should be standard now, the technology is available and could even lead to people reserving a seat on the transport service.	Agree Desirable but not immediately essential.	Might be difficult to implement. Responsibility of everybody to give up seat for PWD Long term (5+ years)	Agree Short term (available now in public transport in Sydney)
Seating availability	Opportunity: Communication and conflict resolution. The remote operator can interfere if someone able, doesn't give up seat for PWD.	Technology, nature of the services – driven on air taxis.		Agree This is probably a key role of a remote operator	Yes, agree Short term (0-2 years)	Agree but remote operators will need an alert from the system or SOS button on board. Initially we recommend having field operators in the area to solve the conflicts as required SHORT. (Can be done but cost issue for PTA and with field operators)
Wheelchairs (see also operations)	Principle: CAVs should provide independence for wheelchair users, i.e., truly not require an attendant to secure the wheelchair, and be simple. Independent and safe use of occupant protection and mobility aid device restraint system - wheelchair tiedown and occupant restraint systems should accommodate low levels of functional mobility /dexterity and provide a high level of safety. <i>Transport Standards 1.22 Safety</i> <i>The Disability Standards do require that all passengers be able to travel with the same level of safety.</i>	Restrain system could be addressed w/o extreme difficulties; to investigate solutions to lift passengers on wheelchairs to the air taxi floor lever.	This is an ongoing design issue that needs to be resolved to make all vehicles more accessible to people in a wheelchair. The CAV will not have a driver but may still require a steward to secure the occupant. A requirement to have a universal fastener for wheelchairs may delay the roll out of CAVs.	Agree This is essential for cost-effective truly driverless operation.	Yes, agree. But complex to install within the vehicle. Midterm (3-5 years)	Yes, agree in principle, we should work toward a standard or a guideline. LONGTERM
	Opportunity: Being able to place the wheelchair with the rear facing driving direction is a step in the right direction, but perhaps insufficiently safe. <i>Transport Standard 9.4.2</i> <i>At least one allocated space must be provided in each bus with less than 33 fixed seats.</i>	Forward/Rear facing passengers are not an issue on air taxis	Not sure about the safety of this vs current state, nor ability to design this into vehicle.	Partially agree Secured placement of wheelchairs is essential for the safety of PWDs and other passengers.	Yes, agree Short term (0-2 years).	Agree. It is a first step but not sufficient for hard breakings, also how can we ensure the wheelchair is in the right direction? LONGTERM

	Opportunity: Universal, manual wheelchair tie downs.	Noted	This would be a useful start and could be progressed now ahead of CAV deployment	Partially agree This will only benefit wheelchair passengers with able companions	Yes, but need a consensus in the industry between manufacturer and supplier Long term (5+ years)	Agree but might need assistance in most cases SHORTTERM
	Opportunity: Automatic securement is ideal.	Noted	Yes, but how likely is it?	Agree This is essential for cost-effective truly driverless operation	Yes, agree in principle short term (0-2 years)	Agree but this hasn't been tested yet LONGTERM
	Opportunity: Clearance for wheelchair or mobility scooter and person to fit and manoeuvre within vehicle. Provide access to a growing variety of wheelchairs and scooters which are getting larger.	Perhaps future development in urban air mobility.	This could be achieved through universal design consideration. For CAV, automation platform is modular, if we use 3D printing, we may be able to adapt the design more readily than the current situation to accommodate different designs of scooters and mobility devices.	Mostly Agree But probably need to limit the size that is required to be accommodated.	Yes, agree in principle, but limited space available in the shuttle. Midterm (3-5 years)	Agree SHORTTERM
	Opportunity: Provide passenger with guidance on how to secure wheelchairs, e.g., identify which type of securement mechanism.	Labels/leaflets typical in air transport.	Passengers may not be able to manage this, based on their level of mobility. Only valid option is universal tie down and lock in with little requirement on the person in the mobility device.	Agree Essential	Yes, agree short term (0-2 years)	Agree but will have impact of the service and generate delays. LONGTERM
	Opportunity: Secure wheelchair AND the person. Movement restrained systems for wheelchairs with the arrangement of seat belts for wheelchair passengers, and the ability to do it effortlessly. For restraints, consider "roll in" systems like Q'STRAIT for users that may be unable to self-secure restraint.	Noted, supported in principle.	Agree. It would be best to identify new system designs rather than nominate existing ones.	I am not sufficiently knowledgeable in this to comment.	Yes agree Midterm (3-5 years)	Agree and will require trained chaperone. LONGTERM
	Opportunity: Allocate space to store mobility aid or to sit a Dog Guide. This includes mobility aids such as crutches and other walking aids	Supported in principle. Concept of animals onboard air taxis to be explored.	The design of the vehicle space allocated to accommodate PWD will need to be based on the client's requirements. A standard design envelope will have to be developed to cater for these	Mostly agree This is highly desirable	Yes, agree dedicated space in the shuttle for wheelchair. Dog can be considered as a passenger Midterm (3-5 years)	Agree LONGTERM

			requirements, including support animals, and mobility aids.			
	Opportunity: Allocate consistent position of this space	Supported	Each vehicle design will be different, best to focus on consistent guidance system to direct people to the available spaces.	Mostly agree This is desirable as broad guideline.	No. already a consensus on the position Midterm. (3-5 years)	Agree LONGTERM
Controls (Design)	<p>Principle: Learn the controls once, apply everywhere.</p> <p><i>WJG: 3.4.3Consistency of essential accessibility features across the whole journey is important. Features such as exit buttons, priority seating and the location of allocated spaces should be as consistent as possible. PWD have highlighted that vehicles can have differences in this regard, such as exit buttons located in different places. These differences can significantly impact on people's ability to travel independently.</i></p>	Aeronautical standards to be applied for labels (and leaflets) on air taxis.	This is critical, but may be limiting based on the desire for manufactures to innovate and develop better user experiences. Minimum design concept may be better, so advanced features can be included.	Agree Controls should be sufficiently standardized to enable easy transition between different vehicles.	Yes, agree in principle, we should work toward a standard or a guideline. Midterm (3-5 years)	Could become a requirement for manufacturers but for the moment design is an important point of differentiation for OEMs.
	Opportunity: All controls are consistent across all modalities - including CAV shuttles. There are: stop buttons, which stops next station and triggers a light and a tone, an emergency button which triggers contact with the remote operator and door open override button.	No controls foreseen except for doors and seats (perhaps communication?) on air taxis.	See above, we don't want to standardise a design, which may limit innovation.	Agree Controls should be sufficiently standardised to enable easy transition between different vehicles.	Yes, agree but will need consensus between manufacturers. Long term (5+ years)	Next station button can only work in regular lines. For on demand services it cannot be applied for instance. OK for the rest LONG TERM
	Opportunity: All controls are consistently positioned	Noted	Instead of consistently positioned, consider consistently identified, by advisory signage.	Agree Controls should be sufficiently standardised to enable easy transition between different vehicles.	Yes, agree Long term (5+ years)	OK it could become a requirement for manufacturers. LONGTERM
	Opportunity: Must be operable by persons of all ranges of motion and strength as well as most levels of cognition.	Agreed for air taxis (with the above clause for controls)	Yes but this can be achieved by tailoring to the requirement of the individual through personal devices rather than in the vehicle. For example the Myki card or similar could have this information on it or an app could	Mostly agree There may be limits of what can be reasonably accommodated.	Yes, agree. But safety concerns if everybody can use it (ex: children) Midterm (3-5 years)	Agree LONGTERM

			tell the person what they need to know rather than having a standard one size fits most solution, that may miss out the most vulnerable.			
	Opportunity: Provide multiple input modes (audio, visual, tactile).	Agreed in principle for air taxis.	Yes agreed also digital to link to personal devices.	Agree This will be essential to accommodate a range of different disability types.	Yes, agree short term (0-2 years)	Agree LONGTERM
	Opportunity: All controls to have braille.	Agreed in principle for air taxis.	Do we need to prescribe audible tones as well as braille?	Agree	Yes, agree. Difficult for tactile screen short term (0-2 years)	Agree LONGTERM
Colours	Principle: The colour scheme of the vehicle helps, not hinders visually and cognitive impaired people.	Agreed in principle for air taxis.	Yes but whom do we base this upon?	Agree	Yes, agree short term (0-2 years)	Agree SHORTTERM
	Opportunity: Contrasting and illuminating colours in the vehicle design to aid visually impaired people to navigate the vehicle.	Aeronautical standards to apply for air taxis.	Is audible message better than colours and signage? Can we consider other guided technology that communicates with the individual through a personal device?	Agree	Yes, agree Midterm (3-5 years)	Agree SHORTTERM
	Opportunity: Agree on symbolic of colours controls and signs, for instance red equals emergency, blue a request to stop, green opening of the doors	Aeronautical standards to apply for air taxis.	Ok but are these not in place now?	Agree	Yes, agree Long term (5+ years)	Agree LONGTERM
	Opportunity: Agree on colours of the grab rails.	Aeronautical standards to apply for air taxis.	See above	Agree	Yes, agree guideline Midterm (3-5 years)	Agree LONGTERM
	Opportunity: Agree on colours of wayfinding signs and messages	Aeronautical standards to apply for air taxis.	See above	Agree	Yes, agree guideline Long term (5+ years)	Agree SHORTTERM
Seating design	Principle: The seating design – height, shape and material - matters for PWD whose needs are to be taken into account.	Aeronautical standards to apply for air taxis.	Agreed	Agree	Yes, agree for size but it is public transportation comfort. Long term (5+ years)	Agree SHORTTERM
	Opportunity: For example, curved designs provide more support than flat designs.	Noted. Aeronautical standards to apply for air taxis.	Not sure about this, but 3D printing may allow more versatile design.	Agree	Yes agree, but short distance trip. Long term (5+ years)	Agree SHORTTERM
	Opportunity: Pull down chairs need to be easy to pull down.	Noted. Aeronautical standards to apply for air taxis.	Is this still going to be standard? Are they not now? This is a near term issue of current	Agree	Yes agree, but not too easy for safety reasons. short term (0-2 years)	Agree SHORTTERM

			design that should be addressed not necessarily CAV related.			
	<p>Opportunity: Seatbelt design needs to be flexible to accommodate a variety of people including children.</p> <p><i>Transport Standards: 1.22 Safety: (3) Regulations that require passengers to wear safety belts apply equally to all passengers</i></p>	Noted. Aeronautical standards to apply for air taxis.	Is this not the case now? Will also CAV require seatbelts, buses don't now?	Agree	Yes agree Midterm (3-5 years)	Agree LONGTERM
Handles and support	<p>Principle: PWD should be able to reach out for support rails and handles instinctively, handles and bars should be implemented in a consistent fashion across makes and models.</p> <p><i>Transport Standards 11.2.1: Handrails must be placed along an access path wherever passengers are likely to require additional support or passive guidance. Handrails must be placed along an access path wherever passengers are likely to require additional support or passive guidance. Grabrails that comply with AS1428.2 (1992) Clause 10.2, Grabrails, must be provided in all allocated spaces.</i></p>	Noted. Aeronautical standards to apply for air taxis. Certain features might not exist on certain air taxis given their limited size. To be explored.	Note the comments about limiting innovation and design, by requiring standard design requirements. Need to just require that this is present, where and how it is integrated is up to the designer.	Agree	Yes, agree in principle, we should work toward a guideline. Midterm (3-5 years)	May be possible for some items Design is an important point of differentiation for OEM Rigid requirements may stifle innovation and improvement. LONGTERM
	Opportunity: Handrails and other supportive infrastructure are positioned consistently across makes and models in easily accessible locations such as the door and towards and near accessible seats.	Noted. Aeronautical standards to apply for air taxis.	Again let's not be overly prescriptive about the design, more to focus of the supporting requirements at doors etc.	Agree	No, it will need a consensus between manufacturers design. But a guideline on where to position the infrastructure Midterm. (3-5 years)	Agree SHORTTERM
Signage	Principle: PWD should be able to view signs and announcements from their wheelchair or seats even if the shuttle is crowded with standing	Noted. Aeronautical standards to apply for air taxis. Also, no standing passengers	Do we need to rely on traditional signs and messages, could this not be a personal message to the individual, on a personal	Agree But may be difficult to achieve.	Yes, agree in principle, we should work toward a standard or a guideline Midterm (3-5 years)	May not be practical but at least visible from specified location in vehicle. Multiple alternative media for communications

	passengers or when it is dark or very bright.	foreseen therein yet.	device or access card?			should be made available.
	Opportunity: Agree on contrast standards and anti-glare screens	Noted. Aeronautical standards to apply for air taxis.	Ok	Agree	Yes, agree in principle Midterm (3-5 years)	Agree for passenger information SHORTTERM
	Opportunity: Leverage communication technology to deliver the same on multiple platforms.	Noted. Aeronautical standards to apply for air taxis.	Yes definitely an area of focus.	Agree This may provide a mechanism to overcome sign visibility issues	Yes, agree in principle Midterm (3-5 years)	Agree SHORTTERM

Table 9. Industry feedback overview on need of PWD – Monitoring and direct assistance

2. Opportunities: Monitoring and direct assistance

Many PWD rely on direct assistance when using public transport. However, given that presence of a human driver will diminish or disappear with CAVs, 'direct assistance' may not be available and the Standards that include the direct assistance options will need to be met without it. In addition, some functions typically performed by the driver and important to PWD have not been included in the Standards. Most industry representatives will deploy remote monitoring, which requires specification and consistency. There are situations where new solutions may be needed to fill the void of a human on board.

Focus area	CAV Principle	Industry Stakeholder	Manufacturer 1	Manufacturer 2	Manufacturer 3	Manufacturer 4
Direct assistance	<p>Principle: A driver's role is diverse and complex. The CAV experience is set to become more seamless and have less friction, however, not all the functions of a human driver can be automated. When there is no human directly at hand, other forms of assistance may be required.</p> <p><i>WJG 3.4.1 Limit the need for assistance Wherever possible, planners and designers should aim to eliminate the need for ramps and accessibility aides when people enter and exit a public transport vehicle.</i></p>	To be further explored on air taxis.	The opportunity from AV is to repurpose the driver to be a steward to interact with the passenger. Carers report that if rather than driving they could support the client it would be a better use of their time. This means the carer's role is enhanced rather than diminished from AV.	Agree Need to focus on transitioning as much of this role as possible to a remote operator.	Yes, agree in principle, we should work toward a standard or a guideline. short term (0-2 years)	Agree
	Opportunity: A driver can identify the passenger [Card used by deaf-blind people] and the place that they need to alight. A remote operator can help solve boarding, payment and destination setting.					
		Noted, air taxis technology could offer different solutions depending on the type of transportation.	We really need to understand more about the service offering at the start and end of the journey. If the start can take place somewhere that the rider is familiar, then they don't need support at this location. But the end of trip support person	Agree	Yes, agree in principle short term (0-2 years)	Agree SHORTTERM

			can also be the start of trip support person, if the trip commences somewhere other than the riders place of residence.			
Opportunity: Passenger safety monitoring during trip. The driver of a vehicle is often attributed with the responsibility to look after the passengers' safety, including PWD. This can be done by the remote operator.	Noted, air taxis technology could offer different solutions depending on the type of transportation.	A driver now is focused primarily on the task of driving, not looking after the passenger. This is done subsequently if there is an issue. A carer who does not have to drive, can focus on the passenger and maybe avoid the incident occurring in the first place.	Agree	Yes, agree in principle short term (0-2 years)	No, this has to be managed by the system (AI might help to identify dangerous situations). But switching a driver by a remote operator is an economic nonsense, as they are often even more expensive. Remote operators will have to take care of several vehicles at a time, and then will need system alerts to intervene (like in automated subways for instance).	
Opportunity: Resolving conflicts/requesting access when an able-bodied person is occupying that space (or a mother with a pram). Also resolving social tensions, e.g. when another passenger is afraid of a Dog Guide. This can be monitored by the remote operator, however, also requires a contingency plan. WJG 3.4 Fellow passengers and staff are courteous and respond to requests for assistance from people with disability.	Aviation law should be referred to for seating, including transportation of animals.	This rarely happens now and will require more resources and staff to police it. Reserving a space is a way around this, also having some digital alert to say that the space is booked may stop the need to ask someone to vacate the space for another person.	Agree	Yes, agree in principle. Role of the transport operator. short term (0-2 years)	Once again, we do not recommend to put this role in the remote operators hands as they will only have limited control of the situation. A link with a field operator might be a good solution if a conflict occurs.	
Opportunity: Emergencies – Presence of reliable and consistent emergency plans and emergency communication methods for PWD can be agreed. WJG: 3.7 People with disability are no more impacted by a disruption than their fellow travellers. 3.7.1 Disruption management planning processes should be implemented so that any change to the environment within the vicinity of public transport infrastructure is assessed to determine its	Aviation law should apply for air taxis' emergency procedures.	Knowing how many people are on the public transport with a disability will assist to activate the support required to address the emergency. The right equipment and guidance to suit the individual. This can be done now for existing transit passengers with a disability.	Agree	Yes, agree in principle short term (0-2 years)	Agree SHORTTERM	

	<i>impact on accessibility. This should not presume any degree of familiarity with the environment and be equally accessible to a new, intermittent, regular and overseas user.</i>					
	<p>Opportunity: Communicate/educate about contingency plans so that there is no delay for PWD in finding out what's going on.</p> <p><i>WJG: 3.7.2 Communication Ideally communications systems need to integrate the disruption notification across the whole journey and its parts—journey start to end and back to the start again. In practical terms, this would integrate notification of pathway disruptions due to council road works, or utility company works, which result in public transport system and interchange disruptions.</i></p> <p><i>3.5.7 Real time information Alerts, particularly in relation to safety matters, need to be provided in formats that ensure all users receive necessary information. For example, a person with a significant hearing impairment will need a visual alert, as standard audio alerts will not work</i></p>	Agreed in principle, to be further explored.	This is difficult in practice as some PWD may be infrequent users of a service and this will mean that they will have to be retrained. It is best that this resides with the operator to have plans in place to address the needs of all passengers for emergencies. Knowing how many people and if there are PWD and what type of disability will be useful for operators to manage this risk as required.	Agree	Yes, agree in principle. Role of the transport operator. short term (0-2 years)	Agree SHORTTERM
	Opportunity: The remote operator and public safety officials and personnel are trained for emergency situations associating PWD.	Agreed in principle, references within aviation law to be searched for.	This should be required now and is an extension of existing practices.	Agree	Yes, agree in principle. First responders training already exists. short term (0-2 years)	Agree SHORTTERM
	Opportunity: Subsidized smart phones or other payment and communication facilities available during the trip to communicate with caregivers or for emergency purposes.	Noted, to be further explored.	It may be that the smart card or phone that provides access to the CAV also has this capability, Subsidy may not be required as it already exists through current support services, or the cost of the device is recouped from increased patronage from PWD.	Agree	Yes, agree in principle. short term (0-2 years)	Agree SHORTTERM
	Opportunity: Customer service There is a role for stewards in the CAV	Noted, to be further explored while developing the	Absolutely there is	Mostly agree Ideally have stewards at key	Yes, agree in principle short term (0-2 years)	Yes, if stewards = chaperones, they have a strong role in our vision of

	<p>service model</p> <p><i>WJG 3.3.6: People with disability highlighted the importance of having customer service staff available to assist them, especially in busy, complex environments. For stops/stations that aren't staffed, help points should be available for more than just emergency situations, and clear contacts provided for those who need help and assistance.</i></p>	<p>whole air taxis transportation concept.</p>		<p>busy/complex stops rather than one on every vehicle.</p>		<p>PWD specific vehicles. In the global CAV service model, we differentiate chaperones (with no driving role) and field operators (with driving roles) in charge of interventions when the remote operators ask them.</p> <p>SHORTTERM</p>
	<p>Opportunity: Whole Journey customer service will be a necessity.</p> <p><i>WJG 3.7: Hard infrastructure generally provides a framework that commuters can travel within independently. It includes facilities (bathrooms, seating etc.) and signage to assist them along their journey. But the soft 'people' infrastructure is also key to a successful journey. Customer service staff, drivers and other support people often make or break the travel experience</i></p>	<p>Noted, to be further explored while developing the whole air taxis transportation concept.</p>	<p>Yes, as it should be now.</p>	<p>Agree</p>	<p>Yes, agree in principle. Different players with a specific role short term (0-2 years)</p>	<p>Agree – part of broader PTA network design.</p> <p>SHORTTERM</p>
	<p>Opportunity: CAV operators to consider how to provide staffed platforms or provide staff assistance 'on demand'</p>	<p>Noted, to be further explored while developing the whole air taxis transportation concept (i.e. what kind of city services are planned?).</p>	<p>Repurposing drivers to these roles may be an option, in the short term. Longer term the remote monitoring system may address this and associated sensors at the stops and on the vehicles</p>	<p>Agree</p>	<p>Yes, agree in principle.. Midterm (3-5 years)</p>	<p>PTA specification item (agree it would be better).</p> <p>SHORTTERM</p>

Table 10. Industry feedback overview on Human Machine Interface.

3. Opportunities: Human Machine Interface

Given that the face-to-face interaction with a human driver will disappear or diminish, the need for truly and universally accessible communications increases.

Focus area	CAV Principle	Industry Stakeholder	Manufacturer 1	Manufacturer 2	Manufacturer 3	Manufacturer 4
Touch screen	<p>Principle: Everyone should be able to easily interact with the service. The 'touch screen' in current shuttle designs raises many concerns.</p> <p><i>WJG 3.1.7 : Web Content Accessibility</i></p>	<p>Noted, agreed for safety purposes when these could not be easily detectable by the ground</p>	<p>The technology is under development, this will improve as demand increases. Agree that everyone should be able to interact with the system.</p>	<p>Agree Will need to accommodate a range of ability levels.</p>	<p>Yes, agree in principle. Today's screen is reserved to the safety operator.</p>	<p>Yes, we agree, but touch screens are mostly used by safety drivers</p>

	<i>Guidelines21 (WCAG) are an internationally recognised standard that document how to make web content more accessible for people with disability. There are 12 guidelines organised under four principles: perceivable, operable, understandable, and robust. Journey planning tools should meet each of these.</i>	operator, to be further explored for air taxis. Below opportunities make sense.			HMI will be important. Concerns raised for safety measures. short term (0-2 years)	in most CAV. Other solutions need to be identified to communicate .
	Opportunity: All touchscreens are placed at the same (accessible) height, have the same dimensions and the same user interface.		Do we still need a touch screen if we have messaging and personal devices, including a card to access the service, that may have some way of communicating with the PWD?	Agree	No, will depend on the design of the vehicle	Yes, if applicable. In public transit CAV touchscreens are less required for passengers
	Opportunity: Screens that are placed on the platform and can take inputs prior to boarding the shuttle.		Perimeter sensors and guidance technology may address this in a different way. These can be tailored messages or they could be open announcements and messaging for all passengers not only PWD.	Agree	Yes, agree in principle short term (0-2 years)	Agree – SHORTTERM
	Opportunity: Screens that are 'glare' resistant.		Yes	Agree	Yes, agree in principle. short term (0-2 years)	Agree SHORTTERM
	Opportunity: Provide a variety of communication methods apart from touch screens, such as voice activation commands, etc.		Yes agreed	Agree	Yes, agree in principle but cybersecurity or RGD concerns. Midterm (3-5 years)	Agree SHORTTERM
	Opportunity: Have the ability to contact the remote operator when not able to operate the touch screen (either in the vehicle or outside the vehicle).		Agreed, remote monitoring should be available across all of these CAV services.	Agree	Yes, agree in principle. short term (0-2 years)	Agree SHORTTERM
Controls (Functionality)	Principle: Controls enable the journey and provide assurance. The driver of trams and buses sometimes perform the role of a control – e.g., stopping at a particular stop because the driver knows the person needs to get off. PWD should be able to assume that the same controls are present at the places where they expect them.	Agreed in principle as far as feasible (could be part of a contract between the municipality and the service supplier). To be further explored for feasibility on air taxi while air mobility concept develops.	This is a big generalisation. I think this will be replaced with a booking service that provides information on entry and departure point.	Agree	No, vehicle control will be reserved to authorized people. However, an emergency button can put the vehicle in safety mode. The remote operator can also do it.	Only applicable in certain conditions. In tram and buses, the driver takes the responsibility to let passenger exit outside regular stations. This cannot be done in a CAV as the operator is in charge of the safety of the passengers and need to make sure that the exit is safe before to open the doors
	Opportunity: Must be consistent across vehicles of various makes/brands: - stop next stop		This requirement should be there but not overly prescriptive on how this	Agree	No, it will depend on the vehicle	Agree

	<p>- emergency door open</p> <p>- speak to operator</p>		<p>information is delivered to the passengers. Design of these can be tailored as required to improve the existing signage and audible advice.</p>		<p>design but there is a consensus today.</p>	<p>(PTA specification item)</p> <p>LONGTERM</p>
	<p>Opportunity: Provide a means for passengers to signal an emergency situation using multimodal input (e.g., voice, button). Multiple emergency buttons fixed at different heights throughout the vehicle. This feature is particularly important if the passenger is travelling alone.</p>	<p>This is not only applicable to PWD.</p>	<p>Who currently responds to these events now, how are they activated? We are not suggesting that CAV will diminish this, just because a human driver may or may not be driving. Driver currently may not have the skills to deal with all emergencies and may not be able to respond as quickly as other passengers around the person.</p>	<p>Agree</p>	<p>Yes, agree in principle short term (0-2 years)</p>	<p>Agree</p> <p>SHORTTERM</p>
	<p>Opportunity: Provide a way for PWD to obtain feedback from the control, that the control has recognized input (sound, light, message, etc.).</p>	<p>Agreed in principle.</p>	<p>Yes</p>	<p>Agree</p>	<p>No, vehicle control will be reserved to authorized people. However, an emergency button can put the vehicle in safety mode. The remote operator can also do it.</p>	<p>Agree</p> <p>SHORTTERM</p>
<p>Communication of trip progress and other announcements</p>	<p>Principle:</p> <p>When CAVs are not taking a fixed predictable route, understanding trip progress becomes even more essential than it is today. The availability of crucial information by multi modal platforms means, especially during alerts, that the PWD can respond in sync with the other passengers.</p> <p><i>Transport Standards 27.4: If information cannot be supplied in a passenger's preferred format, equivalent access must be given by direct assistance. All passengers must be given the same level of access to information on their whereabouts during a public transport journey.</i></p> <p><i>WJG 3.4.2 Audible announcements: The importance of communication increases as routes become more complex, such as when stops are frequent (for example, 300 metres apart), as does the difficulty in using audible announcements. Apps such as the Stop Announcer (NSW)38</i></p>	<p>Agreed in principle when related to safety. To be further explored for applicability on air taxi while air mobility concept develops.</p>	<p>Agreed.</p>	<p>Agree</p>	<p>Yes, agree. Screen onboard to inform on trip update. Role of the remote operator as well.</p>	<p>Agree</p> <p>SHORTTERM</p>
	<p>Opportunity: Tuneable and multi-modal interfaces for persons with sensory disabilities to receive trip progress communications, hearing loop, and other real time wireless communications.</p>		<p>Agreed. Sensors and personal communications through existing devices or an access card may be an option in the future, careful to not be too prescriptive of how to do this, rather the need for this.</p>	<p>Agree</p>	<p>Yes, agree in principle Long term (5+ years)</p>	<p>Agree nice to have</p> <p>SHORTTERM</p>

	Opportunity: Placement of screens with trip progress visible to all passengers. Line of sight issue for those in wheelchairs when seated in a vehicle which inhibits the passenger's ability to understand where they are going, particularly when other passengers are standing.		Consider the role of personal tailored information on the route of the vehicle, similar to a tracking map for rideshare now.	Agree	Yes, agree in principle. short term (0-2 years)	Agree – in principle SHORTTERM
	Opportunity: Clear audio and visual announcements of vehicle departing, trip destination and progress.	T/O and Landing phases to be clearly announced on air taxis for safety purposes. Ref. to aviation law.	Yes this should continue but not be the only way to advise of this.	Agree	Yes, agree in principle short term (0-2 years)	Agree SHORTTERM
	Opportunity: Driver can identify the passenger [Card used by deaf-blind people] and the place that they need to alight.		How would the driver identify these people? How do they do so now. This is not always the role for a driver, it is the role of a steward.	Agree Although not necessarily the 'driver' – could be the vehicle or the remote operator	Yes, agree in principle. short term (0-2 years)	Agree SHORTTERM
	Opportunity: Acknowledgement that the passenger is on the right vehicle.		The rider should be guided as best possible to the right vehicle and entry point as well as the seat.	Agree	Yes, agree in principle. short term (0-2 years)	Agree SHORTTERM
Auditory	Principle: PWD who can't see or who can't see the sign boards, rely on auditory messages to understand the actions the vehicle takes, and they need to take. <i>WIG: The importance of communication increases as routes become more complex, such when stops are frequent (for example, 300 metres apart), as does the difficulty in using audible announcements. Apps such as the Stop Announcer</i> <i>Transport Standards 25.2: People who are deaf or have a hearing impairment must be able to receive a message equivalent to the message received by people without a hearing impairment</i>	Refer to aviation law for air taxis.		Agree	Yes, agree in principle	Agree in principle SHORTTERM
	Opportunity: All auditory messages and sounds are consistent across various vehicles.		Yes	Agree	No but a guideline to follow.	Design is an important point of differentiation for OEM Rigid requirements may stifle innovation and improvement.
	Opportunity: Non-audio interfaces for people with auditory disabilities (e.g.: providing Assistive Listening Devices (ALDs), Augmentative and Alternative Communication devices (AAC) and using alternative devices such as sound, light, vibrations or combination of all those).		Yes	Agree	Yes, agree in principle. Long term (5+ years)	Agree SHORTTERM
Planning, hailing, paying, booking	Principle: Hailing, booking, and paying/entering a vehicle without a driver is a concern, as at the moment, for buses, they are regularly scheduled and PWD rely on the driver to see them waiting on the platform.	e.g. Huber and other forms of air taxi /urban air transportation to address.		Agree	Yes, agree in principle.	Agree. Depending on the service the PTA wants to provide,

	<p><i>WJG 3.1: Increase the confidence of public transport users that their journey will be seamless and safe. Providing a richer set of information/data in journey planning tools in range of formats.</i></p> <p><i>Transport Standards part 25: For passengers who have difficulties with standard fare payment systems, operators and providers must offer a form of payment that meets equivalent access principles</i></p> <p><i>WJG 3.3.8 Ticketing - electronic ticketing Digital connectivity and big data: the increasing digitalisation of transport information, and services is leading to techno-reliance and reduced staffing levels both on public transport ticketing services (with the introduction of driverless trains for instance) as well as the introduction of new transport modes such as car-sharing services and autonomous vehicles</i></p>					<p>solutions exist Hail button at a station, mobile application, etc.</p> <p>SHORTTERM</p>
	<p>Opportunity: Planning: PWD specific data filtering options to get the necessary information quickly: e.g., platform accessibility, Dog Guide toilets, steep hills for wheelchairs, etc.</p> <p><i>WJG 3.2.1 Transparent information about accessing stops/stations/terminals</i></p>		Agreed see previous feedback on how this can be achieved.	Agree	Yes, agree in principle. Long term (5+ years)	Agree SHORTTERM
	<p>Opportunity: Provide real time information</p> <p><i>WJG 3.3.3: For people with hearing impairments, there should be visual indications of the arrival of a train or bus, particularly in high traffic situations such as larger train stations. For example, whenever a train approaches a platform, flashing lights could indicate the train's imminent arrival</i></p>		Yes	Agree	Yes, agree in principle Midterm (3-5 years)	Agree
	<p>Opportunity: Provide accessible apps or other means to hail the vehicle. This would help notify the vehicle that a person with disability is at a particular station thus prepare to stop.</p>		Yes agree	Agree	Yes, agree in principle. short term (0-2 years)	Agree SHORTTERM
	<p>Opportunity: Extended communication with the vehicle prior to boarding, beyond hailing e.g.: Indicating that wheelchair user is attempting to board will allow time for the vehicle to prepare to board the passenger such as starting to extend the ramp.</p>		Agreed	Agree	Yes, agree in principle short term (0-2 years)	Agree but for wheelchairs, we recommend to use PWD specific vehicles with assistance. SHORTTERM
	<p>Opportunity: Contactless or toolless payment options would address a friction point for many PWD</p>		Agreed	Agree	Yes, agree in principle short term (0-2 years)	Agree but PTA networkwide item
Identify correct vehicle and boarding location	<p>Principle: The mobility options available are set to become more fluid. To identify the correct vehicle and boarding location is already a concern today.</p> <p><i>WJG 3.5.2 Wayfinding This could include for example a range of communication and accessibility features such as Braille, audio loops, sound and lighting with 'changing places' premium toilets nearby⁴⁰ This includes looking for known landmarks, knowledge from previous experiences at that (or a similar) location, indicators such as signage or tactile ground surface indicators (TGSIs), maps, apps, sounds,</i></p>	Perhaps not an issue for air taxi but for general urban air transportation.		Agree	Yes, agree in principle	Agree – but this is a PTA network wide item

	<p><i>textures, contrasts, temperature, interaction with other people (including customer service staff) and other cues.</i></p> <p><i>PWD may rely heavily on some of these cues and find others to be of no use. For example, a person who is blind or has low vision may find they rely heavily on sounds, texture, temperature and TGSIs to navigate their way.</i></p>					
	Opportunity: Integrate vehicles with digital wayfinding solutions so that the vehicle, the doors, and front and back of the vehicle can be found		Agreed	Agree	Yes, agree in principle. Midterm (3-5 years)	Agree SHORTTERM
Payment	<p>Principle: The less physical efforts in the process, the better – even swiping a card can be too much for some PWD</p>	Perhaps not an issue for air taxi but for general urban air transportation.	Agreed	Agree	Yes, agree in principle	Agree – but this is a PTA network wide item LONGTERM
	Opportunity: Seamless payment options – such as auto identification of the passenger without swiping a Myki card, easy recharging of the card.		Agreed	Agree	Yes, agree in principle. short term (0-2 years)	Agree – but this is a PTA network wide item. LONGTERM
	Opportunity: Payment methods may be limited, consider options for unbanked (e.g., CVS offers a service).		A variety of options can be considered here. Let industry innovate in this area.	Agree	Yes, agree in principle Midterm (3-5 years)	Agree – but this is a PTA network wide item. LONGTERM
No reliance on smart phones	<p>Principle: Even with accessible apps, some PWD can't use phones at all.</p>	To be further explored.				Agree
	Opportunity: Provide options for those who do not or cannot use a digital app (affordability, skill, intellectual capacity, memory issues) such as control button access to remote operators.		Sensors may resolve this, but the fall back will have to be the remote monitoring centre or steward, in the short term.	Agree	Yes, agree in principle Midterm (3-5 years)	Agree SHORTTERM
Privacy	<p>Principle: There is an understanding that the exchange of information can be valuable, for instance for reserving a seat, however, PWD have poor past experiences with providing identity and information on their disability and in some cases have had negative experiences as a result of sharing personal information.</p>	Noted. Opportunity supported.	Security and privacy protocols will be required by all CAV service operators.		Yes, agree in principle	Agree
	Opportunity: Ensure that data is used and treated as per an industry accepted and relevant legal standard.		Agreed but do not constrain the sharing of data if the customer allows it to achieve a safer, more tailored and reliable experience	Agree	Yes, agree in principle (RGPD) short term (0-2 years)	Agree SHORTTERM
Reducing stress and anxiety	<p>Principle: For some PWD the absence of a driver increases the level of anxiety (Air taxis in particular). Reducing stress and anxiety in general related to travel in autonomous public transport services.</p>	Noted. This is not only related to PWD. Public acceptance of air taxis will take time. To be further explored.	Air taxis will be an issue for all road users, not just PWD. This service is in its very early infancy and significantly higher and faster returns will come from CAVs on road than focusing on air taxis. The cost of these may be prohibitive for most of the population any way.		Yes, agree in principle.	Agree LONGTERM
	Opportunity: Optional, detailed travel commentary or progress updates.		Same as for other modes of travel.	Agree	Yes, agree in principle short term (0-2 years)	Agree LONGTERM
	Opportunity: Collaborate between PWD and Industry in order to identify further sources of anxiety.		ADVI public acceptance survey may provide insights into consumer issues and concerns with	Agree	Yes, agree in principle short term (0-2 years)	Agree LONGTERM

			all AV. Consider harvesting this data or including specific questions in this survey for future waves of data collection.			
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Table 11. Industry feedback overview on Vehicle operations.

4. Opportunities: Vehicle operations CAVs have an opportunity, and in some cases a necessity, to standardize operational aspects.					
Focus area	CAV Principle	Industry Stakeholder	Manufacturer 1	Manufacturer 2	Manufacturer 3
Easy entry and exit practices	Principle: While access is also covered in the design section, there are operational aspects as well that present a clear opportunity for CAV. CAVs should provide easy access experience, without the need for direct assistance.	Principle agreed. Technology might offer different solutions. Given the anticipated costs, introduction of standards (e.g. for ramps) could be an advantage.	Agree		Agree we recommend accessible platforms and automatic ramps when necessary.
	Opportunity: Given the automated nature of CAVs, parking distance between the vehicle and the platform can be standardised, allowing for a defined maximum gap.		Agree	Yes, agree in principle Midterm (3-5 years)	Agree
	Opportunity: If level platform access can't be assured, automated ramps or lifts should be available.		Agree	Yes, agree in principle short term (0-2 years)	Agree
	Opportunity: Lifts and ramps need to be able to cater to variety of assistive vehicles (size-wise and capacity-wise) that should be available at the boarding locations.		Agree Will need to be agreed standard maximum size.	Yes, agree. There are norms to follows (ADA US, EU etc) short term (0-2 years)	Agree
	Opportunity: Extended communication with the vehicle prior to boarding, beyond hailing. E.g. Indicating that wheelchair user is attempting to board will allow time for the vehicle to prepare to board the passenger, such as starting to extend the ramp.		Agree	Yes, agree in principle short term (0-2 years)	Agree but we recommend PWD specific CAV for wheelchairs as it might take time to secure them on board.
Safe departure	Principle: A driver can take the passenger's needs into account (in trams, buses, ferries and to an extent trains and airplanes). How will CAV ensure the same?	Principle agreed. Technology might offer different solutions. Air law should be implemented.			need chaperones
	Opportunity: Vehicle does not depart until passenger is ready, as determined by the remote operator or HMI to accommodate users (audio and/ or non- visual methods for communication) and using motion sensors to provide with some additional time to enter or exit the vehicle.		Agree	Yes, agree in principle Midterm (3-5 years)	Agree – in principle but needs further work to develop feasible.

Safe vehicle movements	Principle: CAV have a unique opportunity to deliver a consistent travelling experience.	Not only for PWD. RPAS design certification requirements for design limit G factors. Operationally limit bank and pitch angles in relation to speed for normal manoeuvring.			Agree
	Opportunity: Agree on maximum g-force – except for emergency procedures.		Agree	Yes, agree in principle Midterm (3-5 years)	Agree
Easy Transfer	Principle: One of the promises of CAV is to provide easy transfer between multimodal services (e.g., rideshare to bus to train). <i>WJG 3.5 Transfers need to be efficient as delays may cause customers to miss their next service, or a specific accessible service, impacting their confidence and level of stress.</i> <i>WJG: 3.5.4 Journey planning needs to be supported by tools that identify where lifts, escalators, ramps and assistance are available. This should also consider the need for a different route or use of an alternative entrance/exit at an interchange.</i>	Principle agreed. Further opportunities to be also explored.	Agree		Agree – but this is a PTA network wide item
	Opportunity Drop off at a location where there are accessible doors, direct accessible pathways and considers space and safety.		Agree	Yes, agree in principle (PTA or PTO role) Midterm (3-5 years)	Agree
	Opportunity The connected aspect of CAV offers Opportunity to help identify the best pathway for next destination during trip.		Agree	Yes, agree in principle (PTA or PTO role) Midterm (3-5 years)	Agree

Preparation materials: People With Disability

Thank you for participating in this study of Connected Automated Vehicles (CAVs). We hope to learn more about the challenges and opportunities that CAVs represent as well as obtain a response to initial proposals to regulate the industry.

CAV technologies are advancing more quickly than governments can regulate. People with disabilities have high expectations of CAVs. However, development of standards and regulations – especially for PWD, who need the technology the most – risks falling behind.

We will explore the following questions, challenges and opportunities.

- Examine if and how CAV modes and services can be incorporated into the Disability Standards for Accessible Public Transport 2002 (Transport Standards) to deliver access to our cities and regions for PWD.
- Clarify the extent to which the current Transport Standards can integrate CAVs and associated technologies.
- Assess the requirements that PWD will have with these emerging technologies and inform the defining of a framework.
- Recommend amendments that can be implemented through the current reform process to the Transport Standards.

Workshop Introduction

Thank you for agreeing to help update the Disability Standards for Accessible Public Transport 2002 (Transport Standards).

On behalf of the Department of Infrastructure, Transport, Regional Development and Communications (the Department), we appreciate your participation.

We want to learn more about your concerns with regards to a key feature of the future of public transport: CAVs, sometimes referred to as 'driverless vehicles'.

In this document we explain:

- Process and purpose of each step
- Preparation: We will provide you with the information you need about CAVs

If you have any questions, please feel free to reach out to Erik van Vulpen (e.vanvulpen@latrobe.edu.au)

Workshop Process and Methodology

Process

To summarize your Participant Information Statement, this project consists of two-steps:

1. In February 2021, we would like to talk to you about your concerns and expectations when it comes to CAVs in Public Transport. The purpose of this first step is to generate a long list of items and issues that PWD may encounter with these new forms of Public Transport. This will take the form of an online focus group, for which we ask you to familiarize yourself with the basic concepts of Connected Automated Vehicles – see below.
2. In May 2021, we would like to talk to you again, in order to receive feedback on our draft proposals. Some of the issues you raise will be straightforward and easy to integrate into the Disability Standards, others will not be so straightforward and may for instance need more investigation, more technical development or they may need

alternative solutions, and this is what we would like to talk to you about. After we speak to you in person, we may send you iterations based on another round of industry engagement.

Methodology

The result that we are looking for in the first workshop in February is essentially a list of issues or opportunities – whether small or big doesn’t matter at this stage – that PWD may encounter with CAVs. We would like to populate the below table.

Table 12: Method of identifying issues, disabilities impacted, phase of journey impacted and the pathway to solution. Columns 1, 2 and 4 have been intentionally left empty as these columns will be filled during the course of the project. Column 3 is a breakdown of the Whole Journey concept.

What is the issue?	Which disabilities are impacted?	Which phase of the journey is impacted?	Pathway to solution (if known)?
		3.1 Pre-journey planning	
		3.2 Journey start and end	
		3.3 Public transport stop/station: the dedicated locations where public transport services operate to and from.	
		3.4 Public transport service: the conveyance that enables the journey, the ‘on board experience’, as well as the scheduling/routing of services.	
		3.5 Interchange: places where service or mode transfers take place.	
		3.6 Return journey planning: reversing the journey for the return to origin or an onward journey to another place.	
		3.7 Disruption to business-as-usual: this includes planned and unplanned disruption to public transport services or along the journey start and end sections	
		3.8 Supporting infrastructure: this supports the journey and includes mid and end of trip infrastructure such as toilets, drinking fountains, wayfinding and seating.	

It is NOT the objective to solve the issues in this session. Some of these issues are fairly complex and require more effort and time than we have in this session. We really want to get all the issues and opportunities on the table first.

In the workshop we will evaluate three horizons:

- The current scenario now: 5 years
- Mid-term scenario: 5 – 10 years
- Long term scenario: 10 years plus

In the second workshop in May 2021, after consultation with industry – we would like to hear your feedback to some of the solutions and proposals to include in the standards. If solutions aren't technologically feasible (yet), we will include the issue and the pathway to the solution in the 'Whole of Journey' guide which is the governments' intention statement.

Question and answers: Connected Automated Vehicles

In this document, we will provide you with information about CAVs: What will be different from public transport as you now know it?

The fact that there will be no driver in such a vehicle is not the only change; the way people interact with the vehicle and the way the service is delivered will also change and in the following paragraphs we will summarize these changes so that you can tell us what issues and opportunities you expect for people with your specific disability.

An online information session that explains the contents of this document and allows for questions will be organized. The rest of the document is written in a question-and-answer format.

*Question: What are Connected **and** Automated Vehicles?*

Answer: This is the industry term – often abbreviated CAV - for vehicles that are electric, can drive with limited or without any input of a human driver and exchange data.

Question: Is it only about vehicles?

Answer: The term 'Vehicles' can include more than cars and buses only, as boats, drones, trains, scooters, trams, air taxis and even wheelchairs, can become autonomous. Specifically, we will pay attention to shuttles (small buses) in this study as well as the arrival of personal drones and Vertical Take-off And Landing (VTOL) as these two forms are imminent or already deployed.

Question: What does the term 'autonomous' mean?

Answer: Autonomous means that cars or buses can operate in any situation on roadways without requiring actions or input by a driver. This is accomplished through a mix of radar and other sensing technology that allows the car to sense and "see" its environment. The sensor and radar are input for the decisions that need to be made: the vehicle can 'think'. The decision made needs to result in an action of the vehicle, such as braking, swerving, etc. where the vehicle 'acts'.

Thanks to the Lidar and other sensors the vehicle is able to make decisions that a human driver is both currently responsible for, and actions that they may not be capable of performing. In the future, for example, an AV may be able to sense a car around the corner and prepare to stop, while a human driver would not be able to react until the car has crossed onto the road.

Question: What does connected mean?

Answer: Connected vehicles can "talk to" each other, the roads they use, and even to pedestrians and cyclist who have mobile devices. Using wireless technologies, these communications support a range of applications that focus on safety, mobility and environmental benefits. Connected vehicles have the ability to continually transmit vehicle position, direction, and speed. These communications will enable safety functions, such as collision avoidance and work zone warnings, as well as applications to improve mobility and the environment, such as providing optimal travel speeds to make the green lights ahead. Connected vehicles will also be able to serve as data collectors and anonymously transmit traffic and road condition information to support roadway operations.

Question: How do connected vehicles work?

Answer: Connected vehicles rely on a range of communications systems including dedicated short-range communications (DSRC), global navigation satellite systems (GNSS), cellular technology, and even satellite radio. Additionally, many vehicles today are already "connected" through cellular technology.

Question: When will we be able to experience CAV's?

Answer: We are experiencing some 'autonomous technologies' already. There are many semi-autonomous features in cars today, such as adaptive cruise control, lane departure assist and warnings, automatic braking, and collision notification. However, these features still require the driver to have continuous input and actions in order for the car to operate safely. The ultimate goal is for vehicles to be fully autonomous – meaning they can drive anywhere completely without input from humans, but this future is at least one or two decades away from where we are now. In the meantime, we have been seeing a gradual deployment of highly automated vehicles. These vehicles are pre-programmed to follow certain routes but can make autonomous decisions on these routes. A little bit like a vehicle on virtual tram rails. We will be able to see these deployed in exceedingly complex traffic environments and routes in the next few years. Below we will describe what a typical vehicle looks like and what its features are.

Question: What does a typical autonomous shuttle look like today?

Answer: Small autonomous shuttles that can carry 10 – 12 passengers seated operate on fixed routes with very limited traffic interaction today. For example, on industry complexes, sports parks and airports.

These shuttles are designed differently because there is no driver, no steering wheel and no brakepad. The front of the vehicles often looks the same as the back.

Though there are many manufacturers who develop unique vehicles, at the moment the typical configuration of an Autonomous Shuttle is as follows:

1. The vehicle looks different because there is no drivers' seat, no engine hood, no visible space for the small electric engine nor a clear front or back of the vehicle. It has small wheels (so they don't take up passenger space), large windows and measures about 4-6 metres long and 2 metres wide.
2. The doors are similar to train doors; Two half doors that fold open providing a broad entry to the vehicle. The doors are situated over the entire side of the vehicle, in between the wheels. The total width of the opening exceeds 1 meter
3. The door can be opened by pushing a button which is placed approximately 1metre in height. The door will also automatically open to board or alight passengers.
4. On the inside of the vehicle, on each side of the door at about hip height of a standing person, there are red coloured emergency handles which force the door to open in case of an emergency, or there are buttons at near the floor that have the same function.
5. The shuttle adjusts its height to the height of the platform so that if there is a platform, it is accessible for wheelchairs.
6. Most vehicles can steer with the front AND the rear wheels. This means that the vehicle can almost move sideways. The benefit of this ability – called 'crabbing' – is that the shuttle can park very close to the side curb.
7. Some vehicles will have an automatic ramp which will extend from the bottom of the door opening electronically on the push of a button outside the vehicle. Some ramps roll out electronically and then form a slight angle (according to the current disability standards which describe a maximum slope of 1 to 8).
8. There are no rows with seats. Instead, seats are placed along the front of the vehicle, the rear of the vehicle and the side that does not have a door. A good number of these seats are foldable seats (jump seats).
9. Some shuttles have seats with seat belts.
10. The seating arrangement leaves space in the middle of the vehicle of an estimated 4 square metres.

11. There are one or two touch screens that provide route information and messages. These are situated at shoulder height of a standing person. These can be used to tell the shuttle where to go and where to stop.
12. Additional sign boards are either placed high in the vehicle to provide messages and route information.
13. There are vertical handlebars at the four corners of the vehicle and ceiling mounted loop style grips similar to those in trains and trams.
14. Some vehicles have a designated place for wheelchairs and offer possibility to place the wheelchair with the back towards an internal wall of fold up seats in the driving direction so that the wheelchair will not topple when there is sudden braking.
15. The shuttle will make a sound when it leaves and when it arrives at a stop. It can announce the names of stopping locations but since the routes at the moment are fixed, and the customers normally get on and off at the same stops, this functionality is most often muted.
16. The speed with which the vehicle operates (including the speed of acceleration) can be set and, at the moment, is between 25 and 40 km per hour.
17. A camera allows a centrally located person – the operator - to monitor the shuttle from a distance.
18. Buttons at multiple locations of the shuttle will allow for contact with the operator.
19. A separate emergency button is found in some vehicles at the sides. This will halt the vehicle when it is safe to do so.
20. In some shuttles there are buttons with medical emergency stops that can be programmed to alert the operator but also to not stop, but instead, drive to a designated location.
21. Several LED lighting points (in some cases up to 15) will ensure a bright experience at night.
22. Airconditioning is on board.
23. Fire extinguisher(s) are on board visibly placed.
24. Electric shuttles drive with very low levels of noise.
25. Some shuttles are experimenting with 'white noise' in order to accommodate people who are vision impaired, so that they can hear the vehicle coming.
26. The vehicles have cameras to detect if people are boarding and the vehicle can be programmed to wait until there is no-one standing in front of the door.



Figure 1. Interior of a typical shuttle (Navya) showing the seats at the front and rear end plus jump seats along the side.



Figure 2. Interior of a typical shuttle (Navya) showing the seating arrangement, doors and handlebars.



Figure 3. Exterior of a typical shuttle (2getthere) showing that the vehicle has very small wheels, two large outward folding glass doors on the side and is mostly designed for standing passengers as there is a relatively large open floor space.

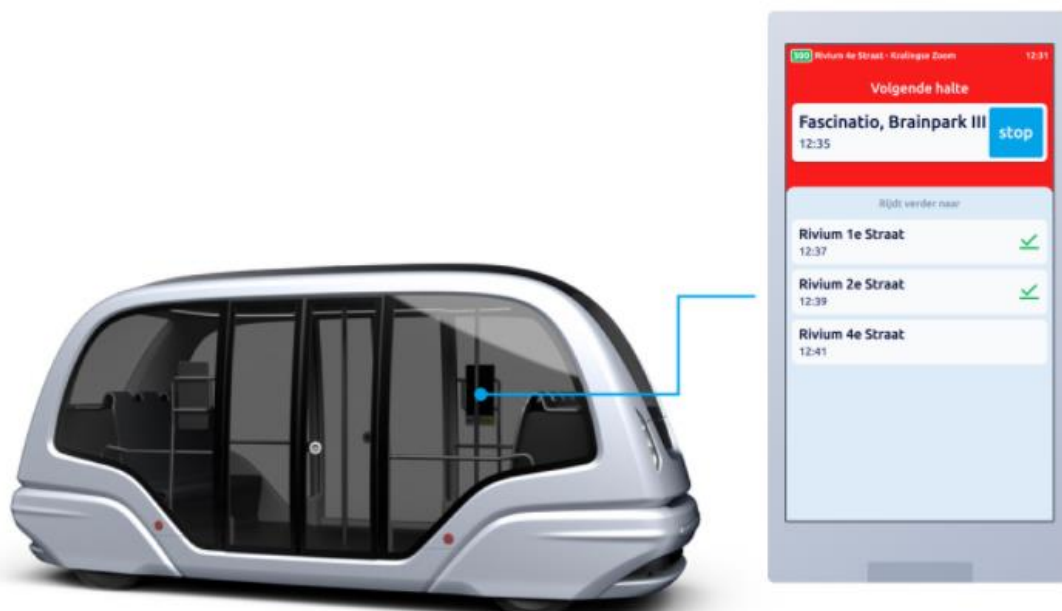


Figure 4. shows an example of the touch screen design and menus for passengers to choose their stop. The touchscreen highlights the next step as well as the stops that are already selected by passengers for the shuttle to stop.



Figure 5. Exterior of a typical shuttle showing that the vehicle (Ohmio) has very small wheels, two large outward folding glass doors on the side and is mostly designed for standing passengers as there is a relatively large open floor space.



Figure 6. Exterior of a typical shuttle showing that the vehicle (Easymile) has very small wheels, two large outward folding glass doors on the side and is mostly designed for standing passengers as there is a relatively large open floor space.

Question: What have the manufacturers of CAV shuttles prepared for PWD to date?

Answer: Current provisions for PWD in the below:

1. For all disabilities
 - A camera will observe people's well-being. The anticipated service model is that a central operator monitors the vehicle and in case of a need for urgent assistance is able to mobilize or dispatch an assistant.
2. For wheelchairs users
 - The shuttle can adjust its height to become level with a platform
 - In most vehicles there will be an automatic ramp if there is no platform
 - The floor space allows for manoeuvring (no rows of chairs, similar to a wheelchair space currently in trams and trains)
 - 4 handlebars
 - Some shuttles allow for wheelchairs to sit with their back to the driving direction supported by a small 'wall' to avoid toppling
3. For people with other physical disability
 - The buttons and handlebars are all accessible from a height of 1 meter.
4. For people with a vision impairment or who are blind
 - Buttons have braille
 - Some operators are trailing 'vibrating buttons' so people with a vision impairment can find them easily
 - Audible start and stop signs
 - White noise to enable hearing the shuttle arriving and leaving
 - Stops can be announced (but given the fixed routes at the moment, usually they are not)
 - The signs are clear and relatively large
5. For people with a hearing impairment or who are deaf
 - Large touch screen with clear graphic interface to show route and destination stops
 - Additional digital signboards displaying messages and route information
6. People with a cognitive disability
 - The vehicle is silent
 - The signs and sounds are clear

Question: What will change in the next 5 years?

Answer: 3 key factors will change in the next 5 years:

1. The level of traffic interaction.
 - a) First horizon

First we will see autonomous vehicles in sports parks, airports, business precincts with low level of traffic interaction.
 - b) Mid-term horizon

In the next five years it is likely that shuttles will be able to handle higher levels of traffic complexity as well, for instance first on regional routes. The question is if the regulators will have been able to solve all the regulatory requirements to allow these vehicles on public roads within the coming few years.
 - c) Third horizon

Vehicles are able to 'roam' the streets freely and entirely independently of humans. This is not likely to materialize in the next 10 or 20 years.

2. The level of automation

a) First horizon

The level of automation will be high – which means that the shuttle operates under specific conditions without the need for human interaction. The route is still pre-programmed and will become more variable – so they can drive from A to E, not only from A to E via B, C and D.

b) Mid-term horizon

The level of automation will be high – which means that the shuttle operates under specific conditions without the need for human interaction. The route is still pre-programmed and will become more variable – so they can drive from A to E, not only from A to E via B, C and D.

c) Third horizon

Full automation, where the vehicle has full autonomy to choose the best route will still be at least one or two decades away.

3. The user experience

a) First horizon

The level of automation and variability of the route has significant implications for PWD, because it requires interaction with the vehicle. The most basic user experience of an Autonomous Shuttle is comparable to the elevator. The shuttle takes a fixed route and stops at all stops. The next stage is for passengers to choose their stop using an interactive display. In that case the shuttle also needs to be 'hailed'. This can be done by the shuttle 'seeing' that someone is present at a stop, assuming it is a passenger. Other operators are planning for a display at the platform adjacent to the street, which the passenger can use to select their destination and triggers the right shuttle to stop. Hailing by using the smartphone is a third option. When shuttles take a variable route - for example from A to E, not passing B, C and D – the complexity increases again for PWD because not only needs the destination to be selected, but the right destination also needs to be recognized. This scenario is being implemented on industry precincts at the moment.

b) Mid-term horizon

The above user experience will be deployed in increasingly complex traffic situations, and increasingly valuable use cases, for instance from home to a train station.

c) Third horizon

The ultimate, long term, scenario is when shuttles are fully autonomous and can choose ANY route and ANY destination. This means that there is no timetable, no fixed route, no dedicated stops. This represents a significant opportunity but also a challenge for PWD in terms of having to be able to manage and direct the AV. The last complex challenge - for the regulator at least – is when the boundaries between private vehicles and public vehicles blur. If passengers can publicly book and share someone else's private vehicle, how will that be regulated? Sharing vehicles is essential in order to reduce the number vehicles on the road, but there are numerous regulatory and technical issues to be resolved and is not expected to be deployed in the next 20 – 30 years.

Question: What are the benefits of CAV?

Answer: Most experts agree on four key benefits:

1. Improved road safety - automated vehicles have the potential to significantly reduce crashes by mitigating human error and other factors that contribute to crashes such as driver fatigue and distraction. Connected vehicle technology can enhance an automated vehicle's ability to detect and respond to perceived hazards.
2. Increased network efficiency - CAVs are expected to improve traffic flow and create more predictable journeys through a more integrated transport network.
3. Increased productivity - an integrated transport network would significantly improve business productivity through more efficient travel. AVs would allow people to be more productive by using the travel time to do other things instead of driving.
4. Increased energy efficiency – a more integrated road network would greatly reduce energy consumption through more efficient vehicles and driving and would remove the need for traditional infrastructure.

Question: What are the benefits of CAV for PWD?

Answer: This is what we look like to hear from you, but below is what many experts agree on:

1. First horizon
In the short term, lower cost of operation can facilitate greater density of public transport. There will be public transport on routes available where this was previously not viable.
2. Mid-term horizon
The connected aspect of CAVs has the potential to provide additional benefits, e.g., to adapt the service when the vehicle knows that there are PWD on board – for instance lowering the acceleration - or to provide a guaranteed connection between the shuttle and the next mode of operation (for instance a train) by communicating the total route to the other vehicle.
3. Third horizon
Full automation has the potential to provide freedom and independence for PWD by providing individual pods or easy to book shared modes of transport that can be entered and directed to go anywhere by any PWD.

Question and answers: Air Taxis

Question: What are Air taxis?

Answer: Even as autonomous vehicles are being seen at street level, many aviation and technology leaders see the future of urban transportation in the skies. In working to unlock this third dimension, companies are looking to lift people and products above and beyond roadway congestion and save significant amounts of time. They believe is that air taxis will become as cheap as normal transport options and hence accessible to a wide audience, not just the elite. As in cities there is no space for runways, these vehicles all take-off and land vertically, which is why they are called Vertical Take Off and Landing (VTOL). Many of these VTOL still have a pilot, but most companies are working towards autonomy. The term Autonomous Aerial Vehicle (AAV) is often used, or the term A-VTOL when they are autonomous.

Question: What are the timelines for Air taxis?

Answer: Please refer to the three points below:

1. First horizon
In China the first successful trials have been conducted with an autonomous VTOL and in Melbourne the contract to start operating air taxis has been awarded, which means that Melbourne could be among the first cities to see VTOL in operation. However, VTOL is a technology that isn't as mature as autonomous vehicles. Most of the manufacturers still have significant challenges to overcome before being able to operate. These challenges include safety and regulation but also battery life and noise reduction. Despite

these challenges, it is expected that in the next 2 or 3 years these VTOL will operate in some cities by 2023 or 2025 with very small (one or two person aircrafts) on simple point to point routes.

2. Mid-term horizon

With time, the complexity of routes will increase. Batteries and the efficiency of the engines will allow the VTOL to cover greater distances and carry more people. Unmanned vehicles that are operated from ground level or fly automated will be introduced. This will reduce the price of a flight.

3. Third horizon

The vision is to add air mobility as a common form of public transport that is accessible to anyone.

Question: What does an Air Taxi look like?

Answer: The difference from helicopters as we know them is that the new generation of Air taxis are electrically powered and have many small rotors and electric engines instead of one fuel driven engine. Some the VTOL have the propellers below the small cabin – almost making it look like a ‘magic carpet’ that carries the cabin, some of the concepts have the propellers above the little cabin.



Figure 7. Joby S4 (The buyer of Uber elevate) has 6 propellers and wings.

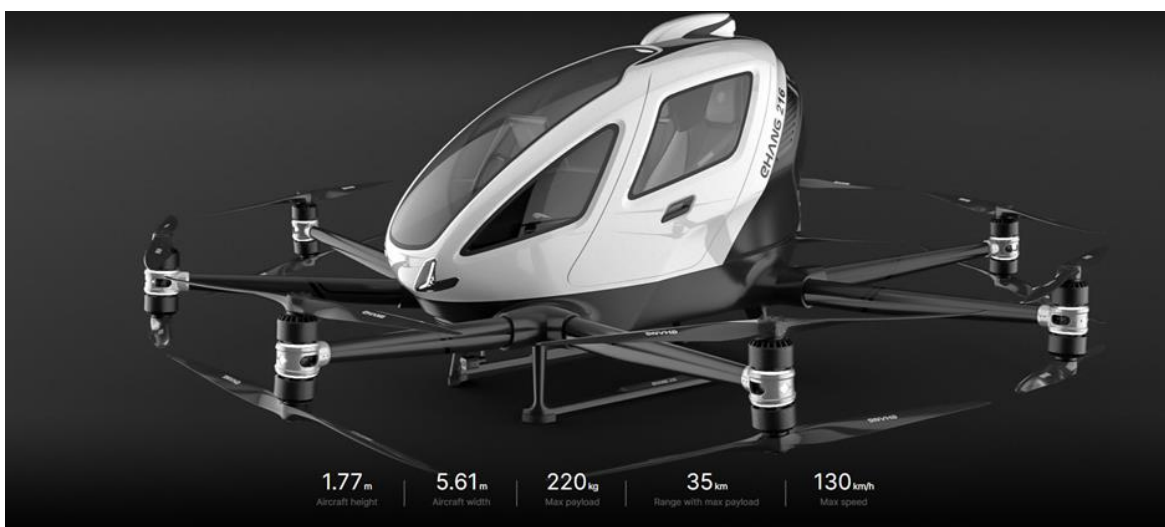


Figure 8. E-Hang's fully propeller driven VTOL.

Question: Are Air taxi's accessible for PWD?

Answer: According to the intentions of the manufacturers, yes, however, practically speaking at this moment accessibility would require certainly significant assistance in order to safely reach the platform, board the vehicle, etc. We have not identified a VTOL with a space to carry a wheelchair. The chairs usually have safety features, for instance mitigating a bumpy landing, so to provide that for people in wheelchairs will be a challenge.

Question: What are the benefits of Air taxis for PWD?


Answer: Please refer to the points below:

1. First horizon
In the short term, the benefits will be limited as the technology still is not ready. Accessibility for PWD will require human assistance in order to reach the platform, and hence the cost of the service will be a question mark
2. Mid-term horizon
On the longer run, VTOL have the potential to provide mobility will be very useful for people with a variety of particular disabilities. E.g., people that have limited capacity to endure lengthy trips or are unable to change between modes of transport.
3. Third horizon
Just with CAVs, full automation of VTOL has the potential to provide freedom and independence for PWD by providing individual pods or easy to book shared modes of transport that can be entered and directed to go anywhere by any person with a disability.

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A low-angle, close-up shot of a person's legs from the knees down, walking on a paved surface. The person is wearing dark, possibly black, trousers and black lace-up shoes. A white cane with a red tip is visible on the left side of the frame, touching the ground. The ground consists of light-colored rectangular paving stones, some of which have a raised, textured pattern. In the background, there are blurred horizontal lines, suggesting a crosswalk or a similar patterned surface. The overall lighting is soft and even.

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