D3.6 Auto Valet Parking Trial
Design for acceptance and adoption

GATEway Project Trial 2 RCA Workshop Report

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1. Abstract

Research associated with auto valet parking has focussed on the systems, methods and control technology that are required to deliver the service rather than the needs people who might use it. In contrast, this research allows people to experience auto-valet parking in the wild and uses the technology to help us to understand the attitudes and aspirations of people who might benefit from using the service.

35 members of the public experienced travelling in a vehicle that was adapted to support auto valet parking. What did they think and feel about the technology and how might design help to increase acceptance and adoption, while also considering wider issues of social inclusion and environmental quality?

This paper outlines the research activities carried out by the Royal College of Art's Helen Hamlyn Centre and Intelligent Mobility Design Centre as part of the Greenwich Automated Transport Environment research project which took place in December 2017 in a central London (UK) borough.

The research showed that people are positive about auto-valet parking and see it as a service that will save them time, cut stress and accidents, improve their personal safety and increase inclusive mobility. While they generally trusted the technology, some were worried about their loss of control and wanted to make sure that they could choose when and how to use it depending on their needs and the situation at hand. Others wanted the technology to be completely reliable before they adopted it. Many saw auto valet parking as a stepping stone to fully autonomous journeys and were keen to see the technology available everywhere.

Key opportunities include developing auto valet parking interfaces that are multimodal, inclusive and easy to use, giving power to the driver and using technology to support more intelligent journey planning; designing pick up and drop off points that make it easier to access places while integrating opportunities for more sustainable / healthy modes of travel; including auto valet parking systems into car club / hire / ride sharing vehicles to encourage greater vehicle sharing; designing parking and charging facilities that use space more efficiently so that streets can be used for more people-centred activities.

2. Introduction

2.1. Gateway project

The GATEway project is an £8 million project funded by Innovate UK, the Centre for Connected and Autonomous Vehicles and industry. Led by TRL, which has over 50 years' of experience in vehicle automation, the project will investigate public perception, reaction and engagement with a range of different types of autonomous vehicles.

2.2. RCA and HHCD

The Royal College of Art and the Helen Hamlyn Centre for Design is part of a team that is seeking to better understand people's attitudes towards the use of autonomous vehicles and their operation in cities. The Auto-valet parking (AVP) trials and workshops seek to understand the following questions:

- What are people's perceptions and attitudes towards auto-valet parking vehicles that will be important when designing for acceptance and adoption?
- How might the design of auto-valet parking vehicles influence people's perceptions and attitudes to make acceptance and adoption more likely?

2.3. Project brief

The auto valet parking trial will engage with the public by inviting them to take part as 'users' of an automated vehicle. They will have direct experience of the self-drive and valet parking functions. The demonstration will be supported by qualitative and quantitative research activities.

Pre-trial interviews will explore existing opinions on driverless technology, with a specific focus on valet-parking and self-drive services, as well as current opinions on challenges associated with parking, vehicle retrieval and short distance travel in urban areas.

During the trial, groups will be given props and tasks to simulate real world journeys including family trips, leisure, shopping and business commutes.

Post-trial workshops will explore how opinions towards this type of driverless system may have changed, the perceived advantages and disadvantages, willingness to consider AVP and other AV systems in the future. They will also investigate how participants would use valet and self-drive features to support other local activities including picking up relatives or children from school, collecting goods from local providers or collecting prescriptions from the GP.

Pre-trial and post-trial questionnaires will explore specific participant attitudes, beliefs, intentions and opinions on the driverless systems being demonstrated.

Quantitative and qualitative information collected during the research will be presented as well as ways in which design can be used to support adoption and acceptance of these new technologies both at a service level and in detail touch-points and interfaces.

The participant group will include those with additional travel needs, to give a deeper perspective on how AV technology can be made accessible and inclusive for those who have particular needs for a seamless transition at the start and end of their journeys.

It should be noted that due to the nature of the Auto Valet parking vehicle, feedback from TRL's ethics committee and challenges associated with recruiting groups, recruitment was done on an individual rather than group basis, no children were recruited and only one blue badge holder took part in the trials.

The trials were carried out on the Greenwich Peninsula with participants driving from and to Digital Greenwich Mitre Passage office with auto drop off, auto parking and auto pick-up at the O2 Intercontinental hotel.

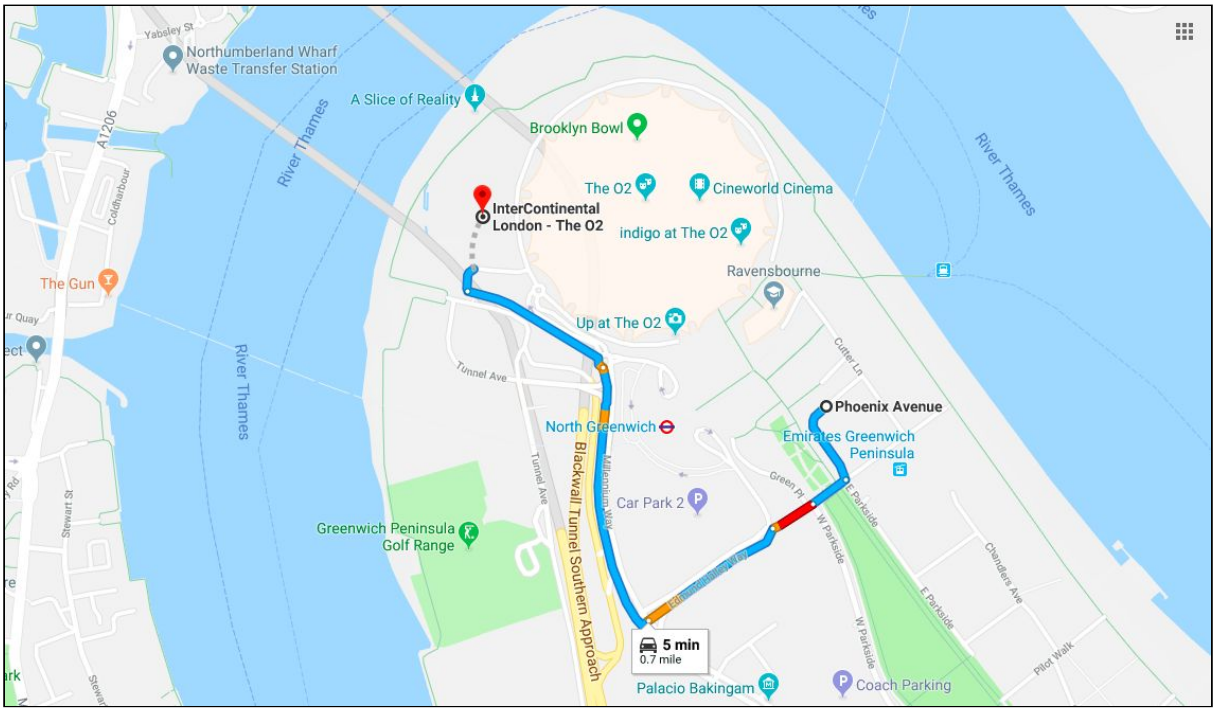


Figure 1: Route for Auto Valet Parking Trial (solid = driven, dotted = auto park zone)

3. What we did

The activities and workshops were divided into fives stages as shown below:

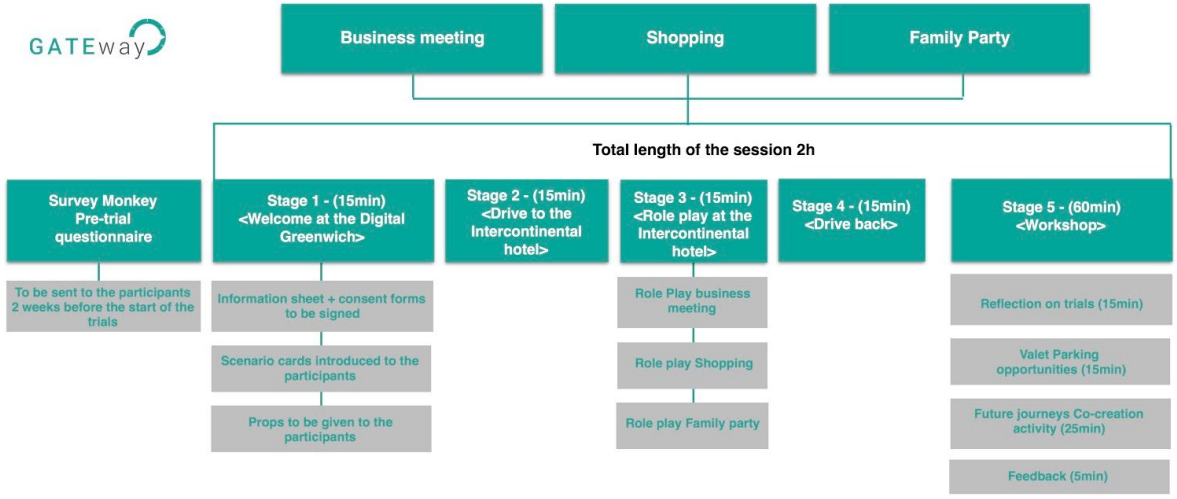


Figure 2: Overview of Trial Activities

Before the trial started, an online survey tool was used so that participants could share their opinions on auto-valet parking, how it might be useful and whether they had any hopes or concerns about the technology.

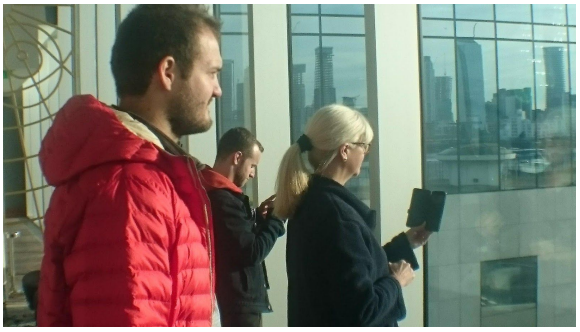
Participants arrived in groups of between 1 and 4, and were given a driving and safety briefing at the Mitre Passage building before one of the participants drove the AVP vehicle (a modified Toyota Prius provided by our technology partner, Gobotix) to the Intercontinental Hotel, about 5 minutes from the starting point.

At the entrance to the Intercontinental, the driver was instructed to stop and the safety driver from Gobotix explained how to use the auto drop off features. The driver activated auto-drop off and the car drove automatically around the hotel forecourt at low speed and stopped at the entrance to the hotel lobby.

Participants were taken upstairs to the hotel bar where they activated the auto-park function and watched the vehicle drive automatically to a designated parking space in the forecourt.

Participants spent a short time evaluating what they liked and disliked about the auto-parking digital interface and experience before using the tablet interface to pick them up. They watched the car drive back to the lobby entrance automatically, returned to the car and drove it manually backed to the start position.

Participant allowing the AVP system to drive automatically to the Intercontinental entrance



Participants watching the car auto-park

Participants writing down thoughts on the experience in the post trial workshop

Placing journey types in a matrix of value versus frequency

Figure 3: Trial environments

The participants used the next hour to share more details about the experience together with their thoughts on journeys where they might use auto-valet parking. They mapped these journeys on a boston grid that asked them to consider whether the auto valet parking scenarios they had created were very valuable, or not, and whether they might use them often or occasionally. Finally they constructed a future journey that makes use of Auto Valet parking technology providing more details about the journey, the vehicle and how they would interact with the service.

At the end of the research participants were asked to describe how they felt about AVP technology and what they learnt during the workshop.

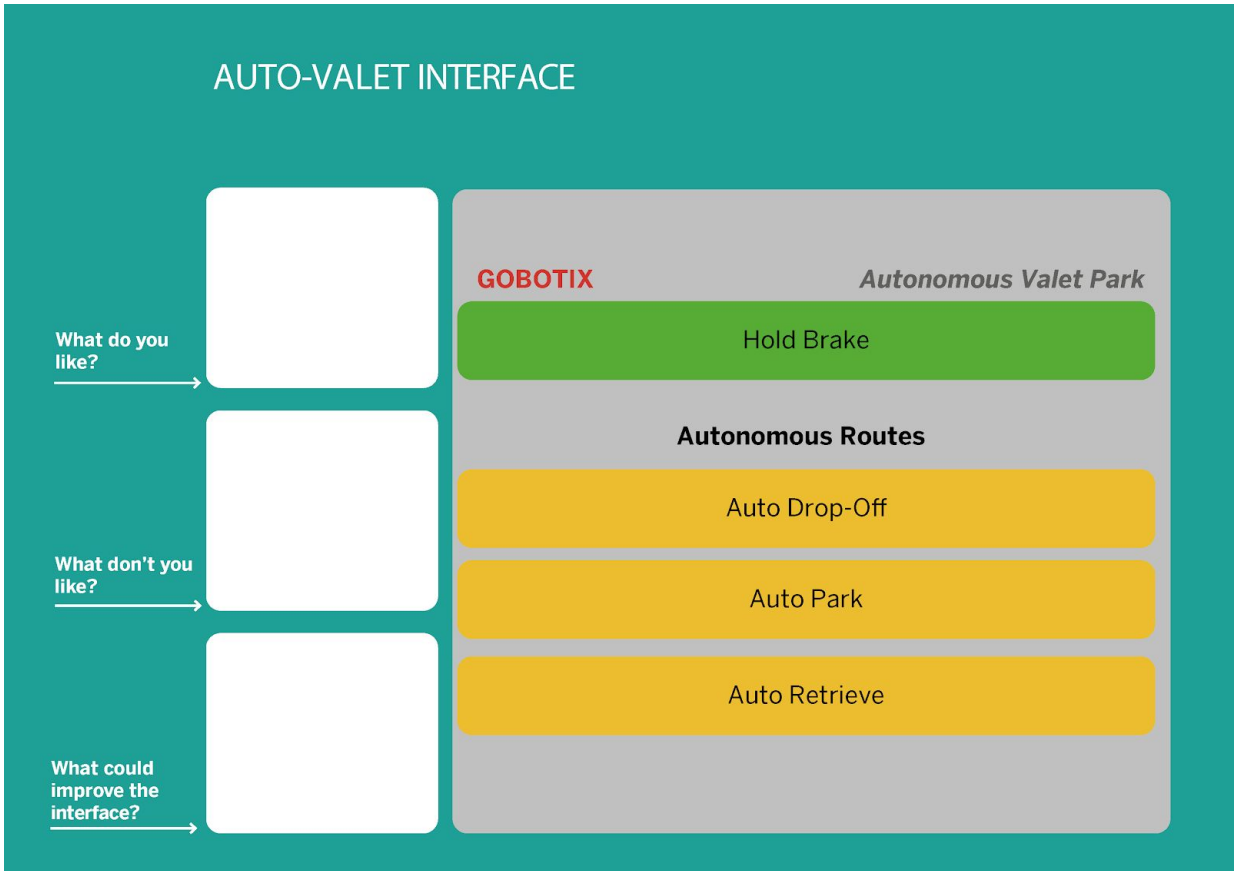


Figure 4: Auto Valet Interface (which was provided to each group on a tablet application)

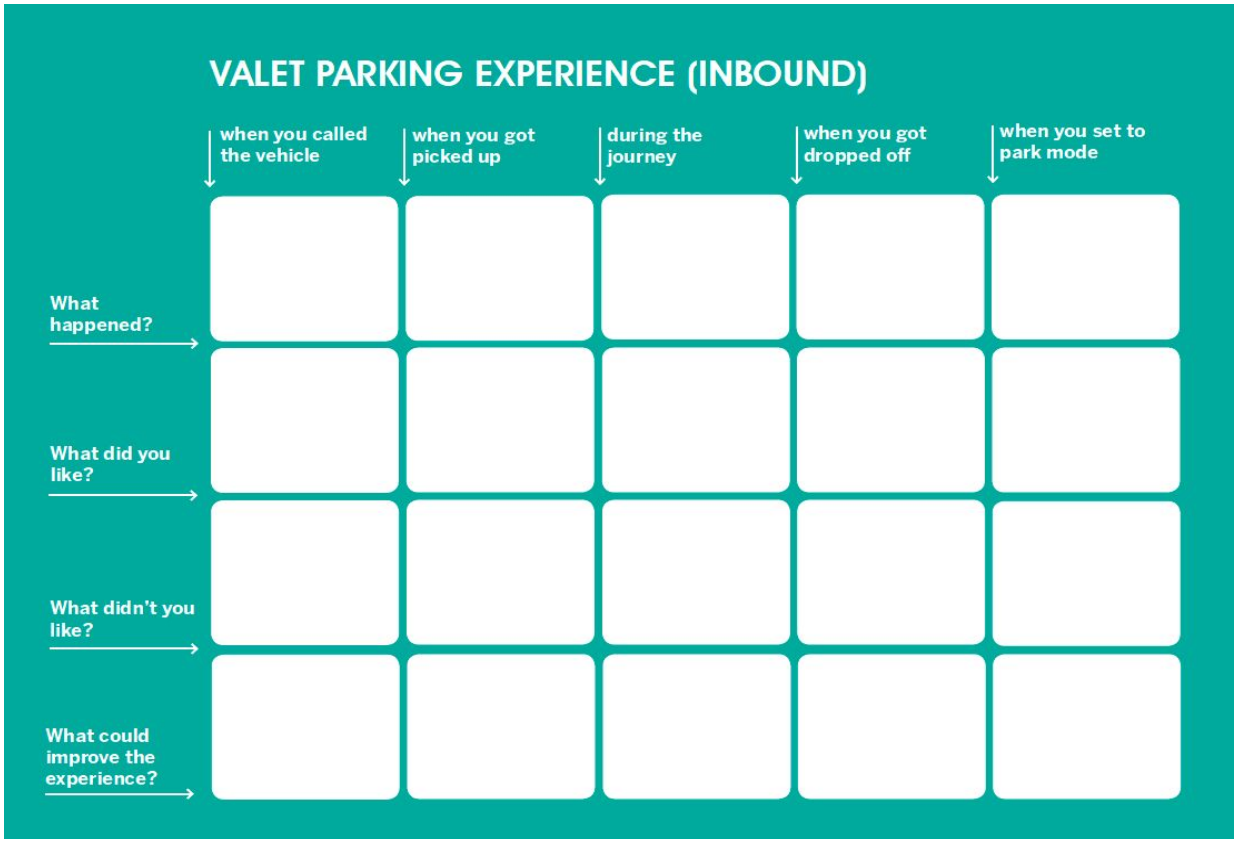


Figure 5: Auto Valet Experience - likes, dislikes and improvements at each stage in the journey

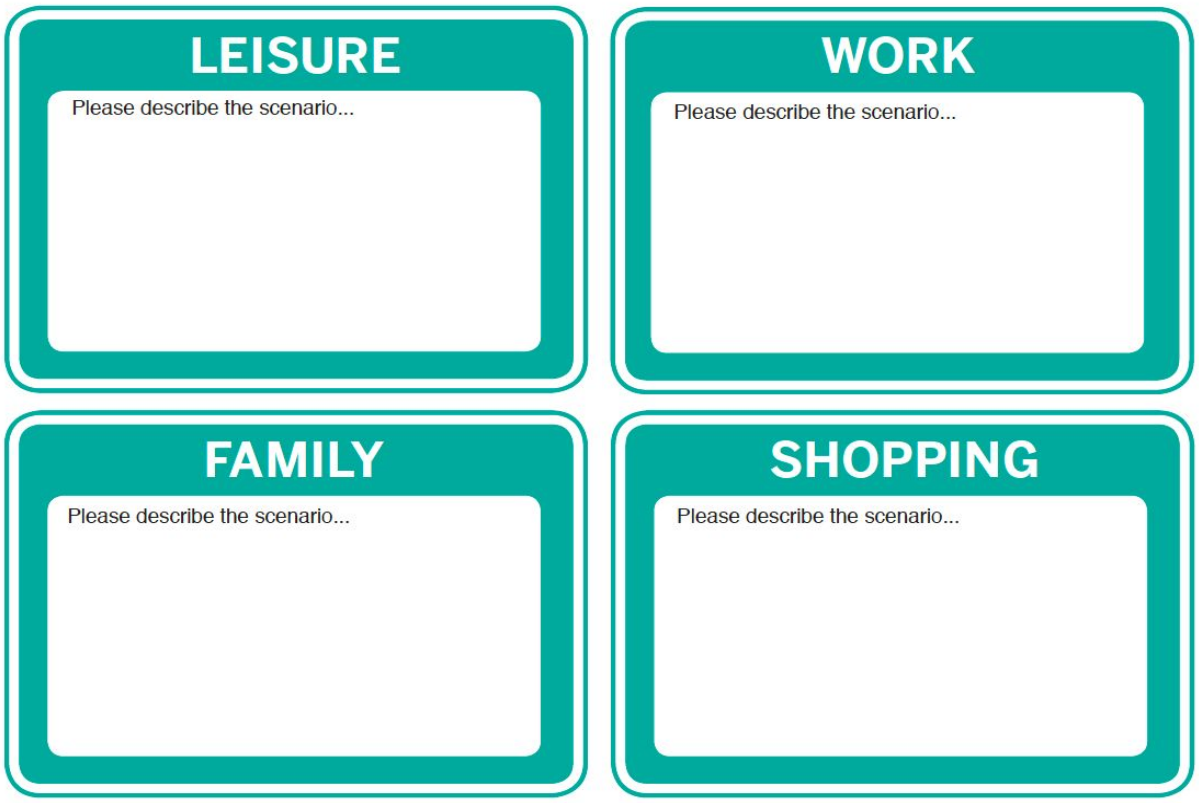


Figure 6: Auto Valet Scenario cards - Leisure, Work, Family, Shopping (and Other)

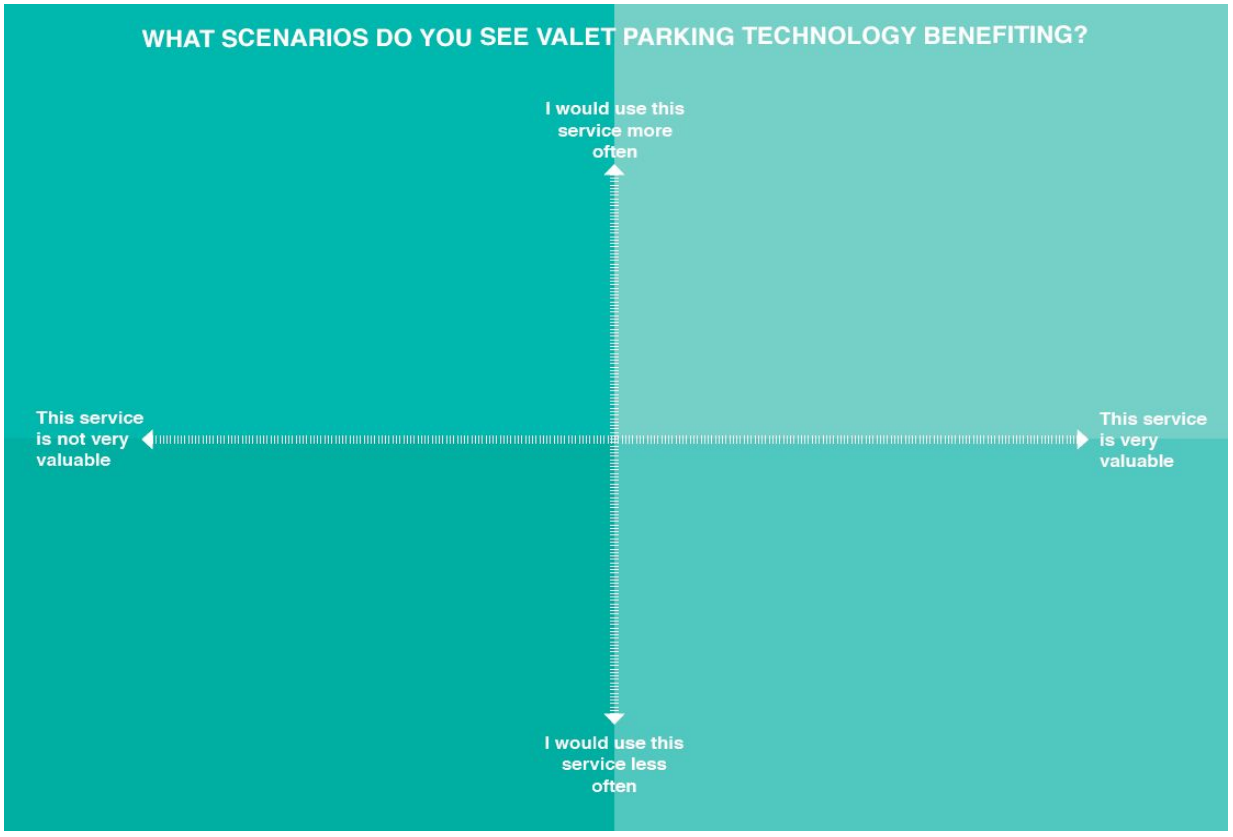


Figure 7: Auto Valet - Boston Grid (Service value vs service frequency)

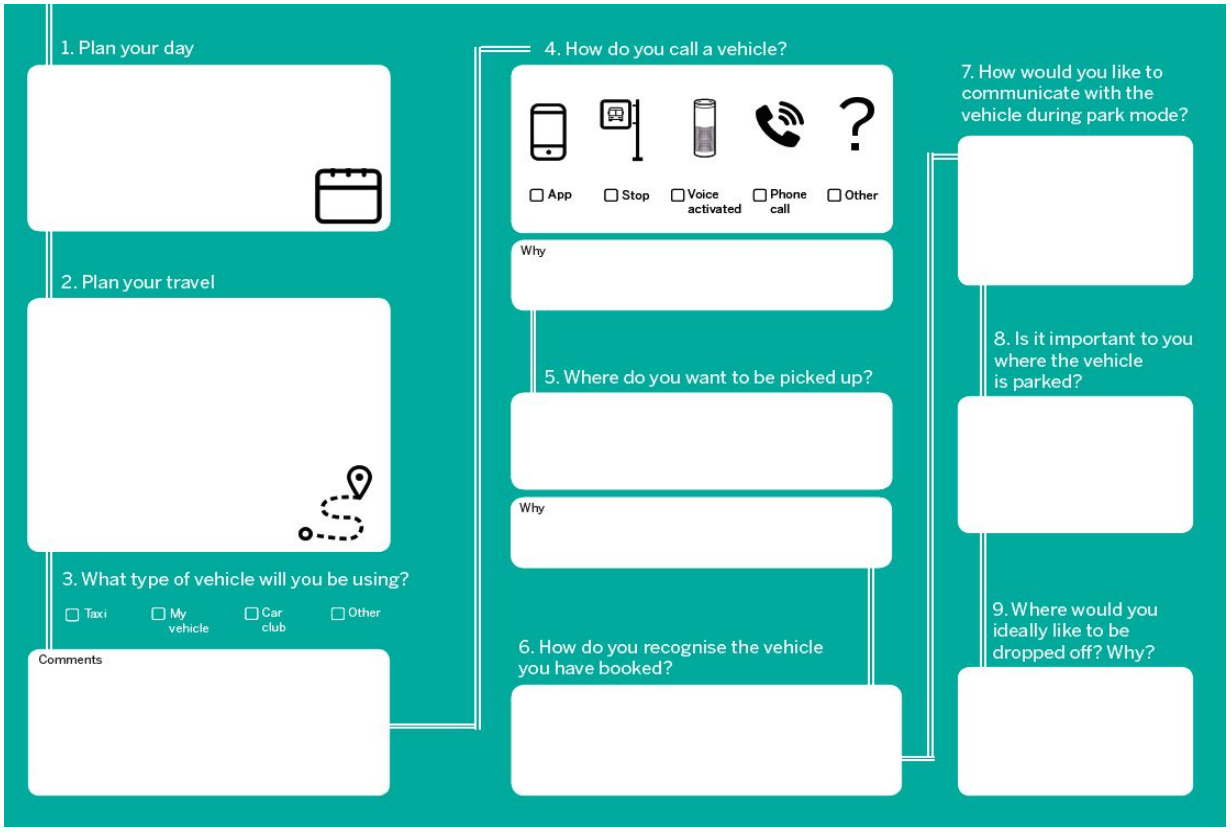


Figure 8: Designing a future Auto Valet Parking Journey

4. What we learnt

4.1. Pre-trial Questionnaire

Before the trial, participants told us what they knew about Valet parking technology, how they felt about it, whether they had used the technology before and how they imagined the experience might feel. They were also asked in which situations they might use AVP, how it might be helpful and, finally, whether they had any hopes or concerns around the vehicle parking by itself.

Participants knowledge of AVP varied from nothing to a comprehensive description of the technology and its potential benefits but most had little or no prior experience.

"Nothing", "Nothing much", "Not really sure"
"I know this is a helpful technology created to avoid the stress of parking."
"..The advantage .. is that this will improve traffic congestion as the person can be dropped off in front of their destination and the car would park itself. In addition Valet parking technology should take up less space than traditional lots therefore improving ROI for car park companies"

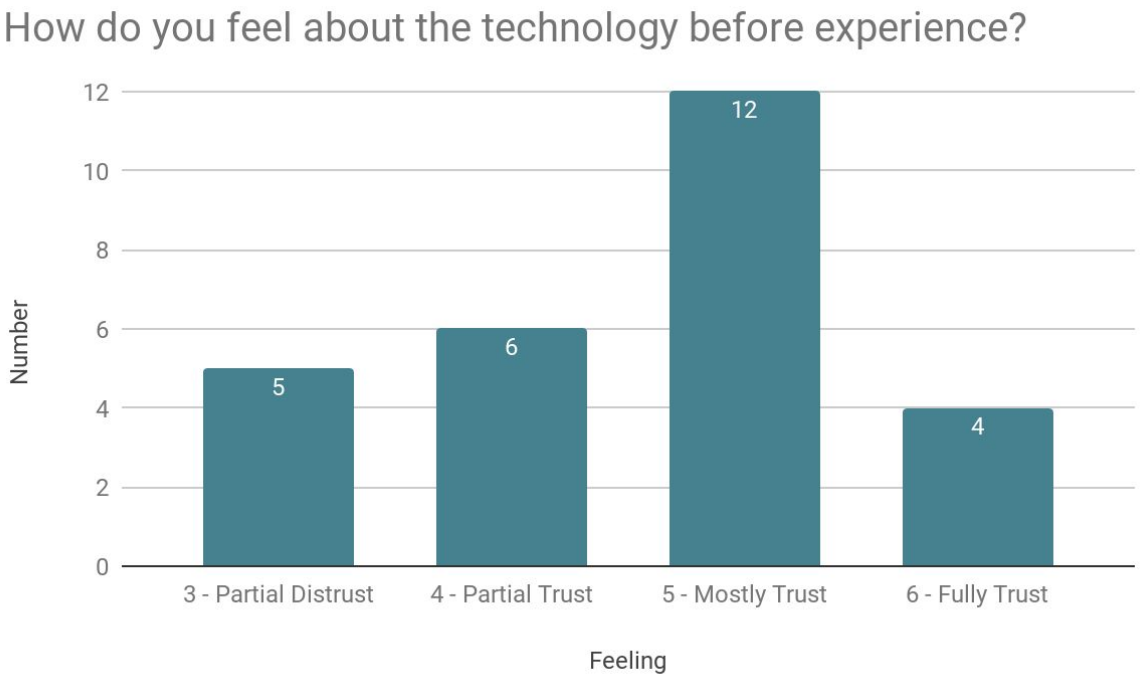


Figure 9: Feelings about AVP before the trial

Of the 27 people who answered this question before and after the trial, most had some level of trust but some were unsure. Those that expressed partial distrust did so because they hadn't seen the technology work or felt that it was in its early stages.

"I would like to believe that it can work 100% of the time - but am interested to see if that goal is attainable. Trust in the system is of course paramount."
"I need to fully understand how the technology works."
"Never seen it/used it so won't trust it until then"

Those who fully trusted the technology did so because they believed in "*technology*" or that it wouldn't be implemented *"without proper trials and testing"*

None of the participants had experienced AVP although one mentioned a test drive of a prius that could '*self park*'.

People mentioned a variety of situations where AVP would be valuable from shopping, busy cities and concerts to visits with children, vulnerable adults or people with additional needs:

- Places
    - Shopping, Workplace, Multi-storey car-parks, Hospitals, Hotels, Airports, Concerts, School Runs, Tight spaces. Etc
    - Visiting somewhere for the first time.
    - Town centres with small parking spaces and narrow streets.
    - Home visits for caregivers.
- People
    - With children, the elderly, disabled or vulnerable adults.
    - For everyone when it's raining or carrying heavy things.
- Time saving
    - Finding spaces in busy cities/towns.
    - Hire cars that return themselves to the hire company

Benefits that they shared included the following:

"Reduce traffic in densely populated/visited areas"
"Reduce my chances of having an accident with another parked car"
"It should ... be safer as … most people are terrible drivers"
"..part of a wider self driving car revolution to reduce need for car parking spaces in city centres…"
"It will help businesses with time savings, but the cost might be too expensive to really represent an opportunity"
"As the population ages it will become more necessary for efficiency and efficacy"
"Could also be useful for coming back from the pub if someone is over limit…"

When asked about their hopes for AVP they mentioned the value of self parking for car share clubs, time saving associated with searching for parking spaces, the hope that it works at least as well as a human driver and that they can do other things in the car while the vehicle parks itself.

In contrast, their concerns included damage and security of the car while it is away from the driver, reliance on the technology to help me find my parked vehicle, safety for pedestrians, other road users and occupants, the vehicle's ability to decipher localised parking rules and regulations and the complexity of urban environments that make it hard for a robot to make a decision.

Those with less trust in the technology wanted to be 100% sure about the system before they would feel safe; wanted to know what would happen if the technology failed to work; had concerns about technology slowing down the parking process; an inability to detect objects and hazards ahead; and a concern that AVP would be implemented as a luxury feature on vehicles with an internal combustion engine, so encouraging continued ownership rather than sharing.

Those with high levels of trust in the technology hope that vehicles will reduce stress, save time, park properly and avoid cyber attacks. They were concerned to make sure that it was able to read street signs (including signs put up by people in front of their homes) and support the needs of the less able first as this will help to give them more independence.

4.2. Auto Valet Parking Interface and experience

The experience itself had a small effect on people's feelings towards AVP technology with five people increasing their trust and five people decreasing their trust in the technology. Overall people trusted the technology more than distrusted it but there were still concerns around the detailed design of the interface and the physical experience of the prototype vehicle and service.

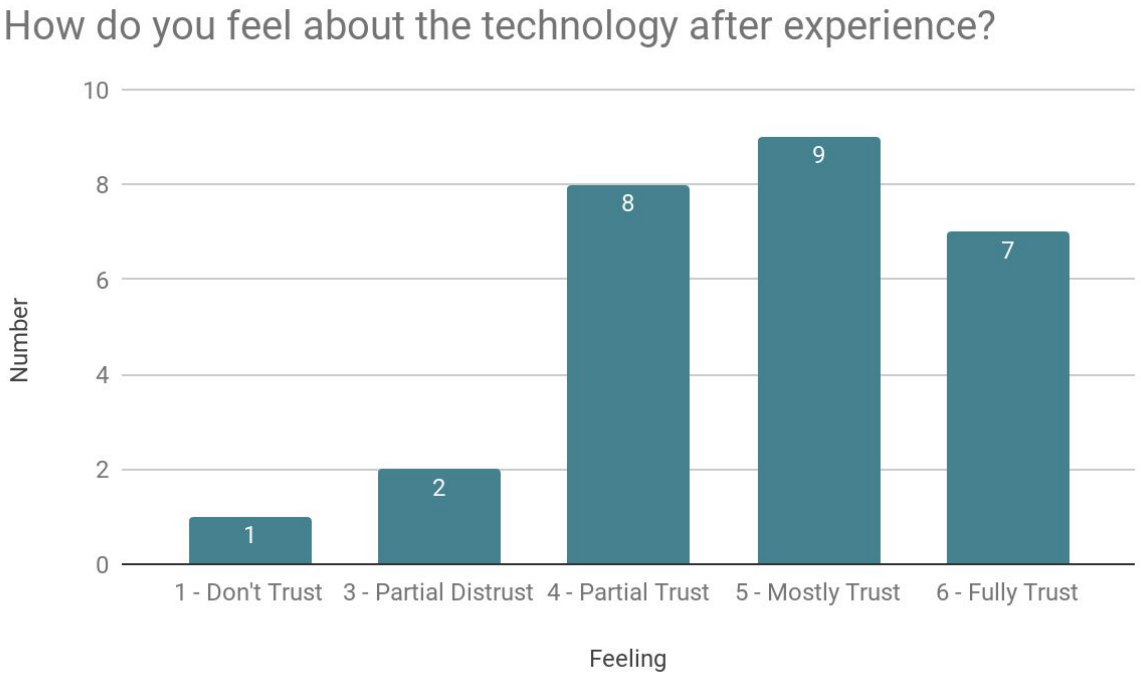


Figure 10: Feelings about AVP after the trial and workshop

Participants felt that the AVP experience could be improved through a number of technical and environmental features. These included the following:

- While in the vehicle:
    - The system volunteers to take control at the approach to the car park by verbal warning giving you the ability to refuse.
    - Smoother steering + breaking.
    - Clearer instruction that car is in auto-drive
    - Visual/voice confirmations
- While away from the vehicle:
    - Notification of car parking action being complete + info on car location
    - Would like to see car parking in more complicated situations
    - Feedback on screen to check that everything is progressing
    - Uber style map where can see the car.
    - Feedback that car moving, parked, switched off, alarm set, etc.

When thinking about the AVP interface, participants liked the clarity and simplicity of the interface, the fact that it was relatively easy to understand and there were not too many options.

“Clear large text. Clear what each one does. Giving three good instructions”
“Large simple buttons. Colour coding”
“Ease of function. Simple, what is needed to action”
“Easy to understand works well and takes car to desired place”
“Not too many options - less overwhelming”

They didn’t like some of the terminology and colours, the mechanism for going into ‘autodrop off mode’, the lack of personal control and personalisation, and the potential to accidentally press the wrong button.

“Hold brake is unfamiliar concept. Routine involving brake pedal also unfamiliar, but I think it would be easy to pick up”
“Only one scenario - not enough personal control to retrieve”
“Colour choice for me green indicates Go, not stop or break”, “Grey background, white would be preferable”
“Options are too close to each other - it is possible to push wrong button. Instead of simple press, it could be a motion done like that (slide something) or in squares”
“All 3 buttons displayed, you only need the relevant ones. Would leave more room for the contextual information”
“Remove Auto - weird language”
“Icon design to be added. Also needs bigger lettering for old people”, “Doesn’t have any symbols”, “Doesn’t really give a lot of information. Don’t understand hold brake”

They would like the interface to be on their own mobile phone; have a visual representation of each function, not just written; for the interface to follow the journey rather than presenting all options together; to provide a countdown so they know when they will arrive and when the car will get to them; plus additional levels of information / control such as revealing the vehicles location or allowing the driver to choose where the vehicle parks.

In addition, participants wanted more control of the pick up process; to choose where and when the vehicle would pick them up; to open the door and the boot if useful (eg with children or shopping); and to welcome you back when you are in the vehicle, perhaps also suggesting next steps.

4.3. Auto Valet Parking Scenarios

Participants shared journeys where AVP could help in their daily lives. To assist with this process, they were given a choice of 5 scenario cards - work, leisure, family, shopping and one for other situations. Once they had filled in their scenario cards they placed them on a boston grid that allowed them to identify whether AVP would be used more or less often and whether it would be valuable or not valuable. A summary of the scenario types and their value / frequency of use is shown on the table below:

Types of scenarios	1 I would use this service **less often, not valuable**	2 I would use this service **more often**, but **not valuable**	3 I would use this service **less often, very valuable**	4 I would use this service **more often, very valuable**	TOTAL (no. of scenario cards)
Family scenarios	**6**	**5**	**10**	**10**	**31**
Leisure scenarios	**4**	**4**	**5**	**21**	**34**
Work scenarios	**2**	**2**	**11**	**10**	**25**
Shopping scenarios	**1**	**7**	**7**	**16**	**31**
Other scenarios	**8**	**6**	**15**	**30**	**59**

Figure 11: Grid showing value and frequency of use for different types of journey

As can be seen, participants put 50% of the scenarios in the ‘valuable and often’ quadrant with the least in the ‘often but not valuable quadrant’. While leisure and shopping scenarios were most frequently place in the often and valuable quadrant, participants also created a significant number of other scenarios (33% of all journey types), although many of these could have been included in the other categories. In all the scenario types, people included variations where the car was able to drive in autonomous mode for the whole journey.

An overview of the scenario types are shown in the following sections.

4.3.1. Leisure Journeys

Popular leisure trips included visiting local places, such as going to the gym, theatre, cinema, church or a restaurant, where parking might be difficult, restricted or in an area where people haven't been before. Participants also mentioned parking challenges at concerts or when visiting holiday resorts like a ski village where parking near to the entrance or lift is now hard or impossible.

Benefits included less wasted time, not needing to find your car in a large car park, as well as reductions in human error from bad parking. People also thought that self parking cars would use land more efficiently as they can park closer together.

"Using the car as an alternative to a taxi, allowing me, friends or relatives to enjoy a drink and then come home"
"Arriving at an event, vehicle would definitely find more affordable parking than what's available at the venue"
"Skiing.Would be nice to drive to the mountain and then be able to get dropped off at entrance & car park itself."
"Going for a football game with friends getting dropped of by the entrance"
"Going to visit friends. Drop car without hassle. No need for knowledge of an area"
"Going for a dinner in a restaurant where there is no way to parking due to the narrow streets where the restaurant is located"
"When meeting with friends I often have to spend fair time to find parking space. This sometimes makes me late for time critical things we have planned on a short notice"

4.3.2. Shopping Journeys

Participants imagined that AVP would be more helpful on trips to large shopping centres and supermarkets which have large car parks. The main benefit was walking shorter distances with heavy shopping but some participants also imagined you could get your goods loaded into your car by shop employees as well. They were concerned about the amount of space available for picking up, dropping off and loading vehicles and imagined that these spaces might need to be redesigned so that this could be done in a more orderly fashion - for example with IKEA style loading bays or with airport style pick up and drop off lanes.

People also imagined additional vehicle services while the car was parked including cleaning and charging.

“Xmas shopping at places like Bluewater where parking can take ages”
“Vehicle could come to shop exit to allow loading shopping bags in”
“I want to have certainty about how quickly I will be picked up when shopping centres and town car parks are busy”
“Groceries. Drive to the stand. Push button on phone/etc. park the car. Go grocery shopping. Redeem car with button. Load groceries. Drive home.”
“Click and collect. integrated in major supermarkets - employees will fill up your car with goods and then it is brought back”
“Driven to entrance of building, car parks itself. Car might also be able to send itself off to charge in case of EVs collection takes place at preselected time with option to remotely postpone. Buildings may take this into account with IKEA style collection bays.”

4.3.3. Family Journeys

When discussing family journeys, some participants imagined that the whole journey might be autonomous so that they could spend more time with each other rather than concentrating on the road.

They saw AVP being particularly useful when travelling with children or the elderly as it means that they can get out of the vehicle closer to their destination and stay together for longer. This might include getting out of the car with your child on the school run and then letting the car drive away in search of a parking spot, or getting out at a hospital or care home and taking your elderly relative indoors without delay. People also mentioned trips to airports and holiday resorts where parking is often far away from the entrance or exit.

“Could look after teenager learning to park cars by providing guidance”
“Going to the beach/day trip with family. Long distance (e.g. Brighton) Can play in the car/not drive and then arrive at destination.”
“Having the car being able to take over when parents get too distracted driving children."
“To pick up children or elderly relatives to be able to talk and be available”
“Being used as a taxi service for children. Going deliver and collect kids from activities and places not visited before or having to collect at a time when lots of parents are there so traffic is very busy and drop off nearby where it is safer would be great”
“Picking up an elderly relative from a care home and bring them home”
“VP capable car avoid parking in front of people's drives/garages”
“For going on camping trips often have to park far away from tent”

4.3.4. Work Journeys

Work scenarios included commutes to a railway station, parking at business parks or large office complexes, as well as foreign travel and mobile working that requires constant stopping and starting in busy areas such as a postman doing multiple drops.

AVP helps to reduce wasted time and stress associated with catching trains, avoiding bad weather, transporting large equipment to or from the office or dealing with travel in a foreign country. People wanted the technology to sync with daily schedules and other modes of transport so that it might save them time and avoid missed connections.

“Last part of commute/shuttle between main travel method and destination auto drop off"
“Arriving at work, it's raining, I am late for meeting. To be able to not think about parking.”
“Arrive at the meeting - click auto park - car drives around until it finds parking space. After meeting press pick up and it will come to me. Auto pay for parking”
“Going for an important meeting and being late due to heavy traffic"
“Train at station is at set time, car will be able to notify when to leave and park when at the station”

4.3.5. Other Journeys

Other scenarios mentioned by our participants included emergencies, hospital appointments or being late for a meeting. People also identified opportunities to help those with additional needs or even those who cannot drive. This last point testifies to the fact that many participants saw Auto-valet parking as a stepping stone to fully autonomous travel. Many of these journeys could have been included in other categories but the additional option allowed people to share other hopes and concerns.

“If there's an emergency and I have to run somewhere, can get car to park itself”
“Elderly parents can be more mobile”
“In any situation when the weather is bad, and you don't want to walk around”
“After it drops me off somewhere, I can send it to pick up a family member”
“I am bad at parking. I would probably use this to park everyday”
“My little cousin who doesn't have licence would love this technology”
“To obey speed limits and road safety”
“In emergency for young people or those without driving licences"
“I’m much less physically able, so can use it when visiting any public space”
“Hospital visit - parking is always impossible. Drop off and collection would be really useful”
“If cars are able to find a parking space and use it autonomously, is there still the same need for private ownership, especially if fully - self driving cars become norm?”
“As car club member I can drive a car and request it to drive itself to my current location, so I don't have to look for it"
“My main concern - a night at the pub. Drop - off, recall and auto drop - off at home. A thought for the future”
“Could act as a bus/taxi service running between a hard to reach location to the closest transport hub”
“Car can be summoned and sent away in coordination with optional connected additions (like automatic garage doors, driveways, gates and things that help in the maintenance of the vehicle)"

4.4. Future Auto Valet Parking Journeys

Once participants had shared their scenarios, they developed a future journey that included AVP services. They chose a typical journey, explained the type of vehicle they would use and described how they imagined interacting with the car on their trip.

The majority chose to redesign leisure trips such as going to a festival or travelling to a new town. This was followed by shopping, taking the kids to school, going to work or going to a local train station.

“Go to supermarket on the way home”
"Go to work in London”
“On a sunday going to church leaving home at 9.30 am. Going to pick up other church members”
“Drop daughter off at school, go to work, pick daughter from school and then go home”
“Blind person going to work and coming home”
“2022. Cars fully autonomous. Car needs to be able to control garage door. Thursday. All day art club + shopping”
“I am travelling to board a flight at a south england airport 2020.”
“Firstly would take my mom shopping in peckham, which has a big car park and you can usually spend 1.5h there but we usually spend more. Car to move and park to another location.”

4.4.1. Owning or sharing an AVP vehicle

Once they had chosen a journey type, they decided whether they owned, shared or hired a vehicle for the trip.

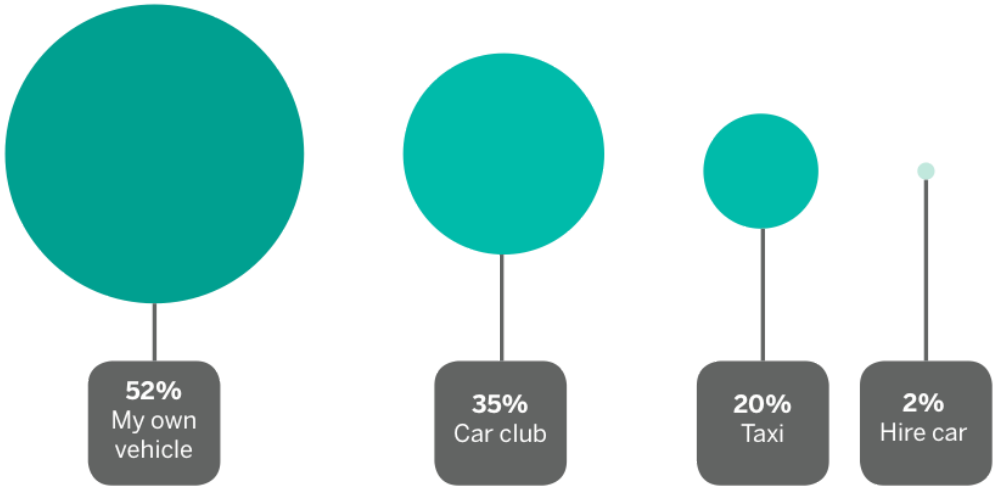


Figure 12: Future Ownership of AVP vehicles

As can be seen over half imagined they would continue to own an AVP car, with 35% imagining it would be a car club vehicle and the rest imagining it would be some form of taxi service or a hire car. People who wanted to own the vehicle, did so because they thought it was cheaper; an older person would like to use their own car as it was more reliable, available and cleaner; they have full control or that its more comfortable.

Those using a shared vehicle thought that a ‘car as a service would be more useful’ or that the service could be ‘shared by the whole family’

Taxis were chosen by participants who imagined fully autonomous journeys where “owning a vehicle is not important as long as the vehicle is clean and pleasant to use” or “nothing own / serviced, owned, managed by someone else”

4.4.2. Calling the vehicle

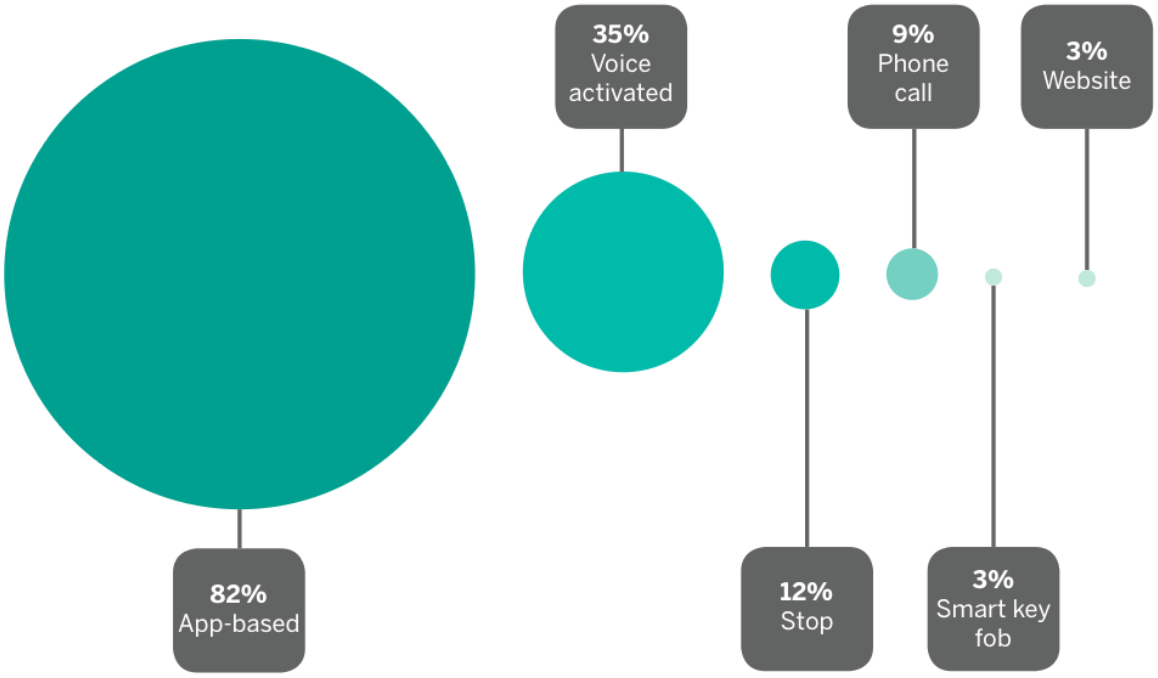


Figure 13: Calling an AVP vehicle

Over 80% imagined calling the vehicle through an app. This option was chosen because it was the most familiar and perceived as user friendly. Other reasons included speed, accurate location tracking and privacy, although some worried about the battery running out or losing their smartphone.

The second choice was voice activation as this meant they could call the phone without using a phone and they could continue to multitask. A few people commented that voice activation was not always accurate as it depended on understanding a person's accent.

4.4.3. Pick up and drop off points

Most people wanted to be picked up and dropped off directly outside the chosen location and wished to be picked up ‘immediately’. Some recognised that this might not be possible and would wait upto 15 minutes to be picked up and to meet the vehicle in a position that was safe and as close as possible to their location. The main factors affecting this choice were weather conditions, what clothes they were wearing and whether they were with children, elderly people or carrying heavy belongings.

4.4.4. Recognising your AVP vehicle

Those who owned the vehicle were confident that they would be able to recognise their own car, by its condition, number plate or colour.

Taxi, car club or hired car participants mentioned some interesting ideas on ways of reassuring them where the vehicle is parked on a busy street. These included visual communication through headlights, a digital or physical sign board with a confirmation number or image as well as the ability to locate the vehicle on a map through an app.

4.4.5. Communicate with your parked AVP vehicle

Participants preferred using a smartphone to communicate with their vehicle, either through an app or a text service. They wanted to know where the car was parked, be able to observe the vehicle from a distance or control its parking location. Other interesting ideas included being able to control the car using voice or facial recognition especially if your hands were full.

4.4.6. Importance of parking location

60% wanted to know where the vehicle had parked both for security reasons and to know how long it will take to retrieve the car. The other 40% were not worried where it was parked provided that it was safe and secure.

5. Design Response

In order to illustrate the benefits and opportunities of Auto Valet parking technology the researchers have developed a number of current and future journeys showing how AVP can enhance the experience for a variety of people. They also show how a future interface might be developed to help people to interact with an AVP assisted vehicle.

5.1. Leisure Journey

In this leisure journey researchers imagine friends going on a weekend away, where they will be hiring a car and traveling to an unfamiliar city. The current journey includes the challenges of finding the hire car in a large airport and the struggles associated with parking in an unfamiliar town. In a future AVP assisted journey, the car hire vehicle can drive around the airport unassisted and it can also navigate to the hotel's car park allowing our travellers more time to get ready for their evening out.

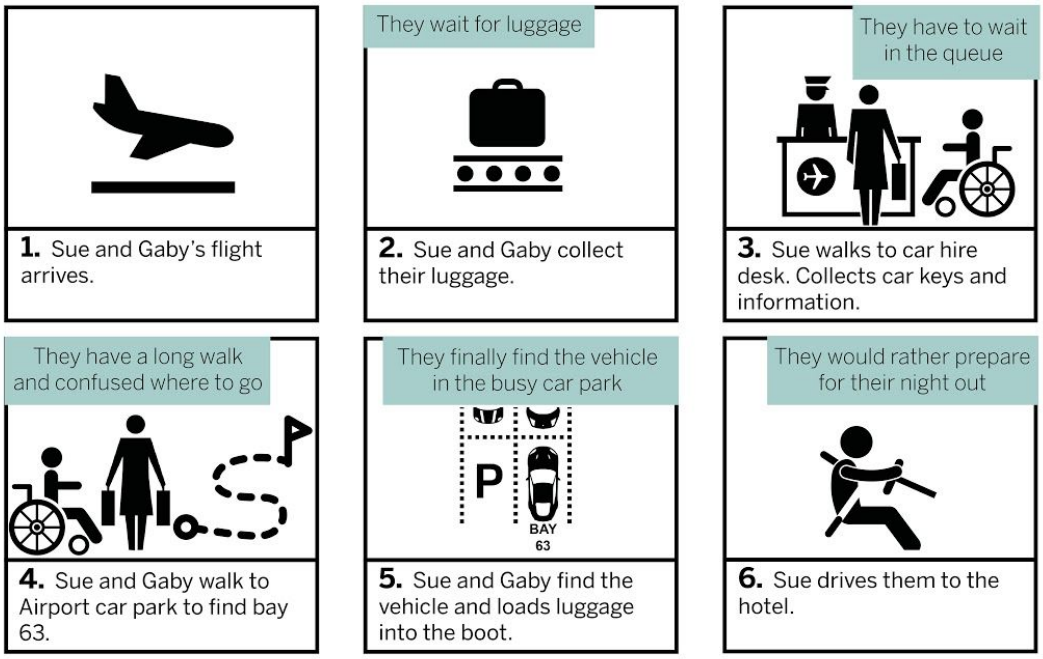


Fig 14: NOW: Two friends travel from the airport on a short break

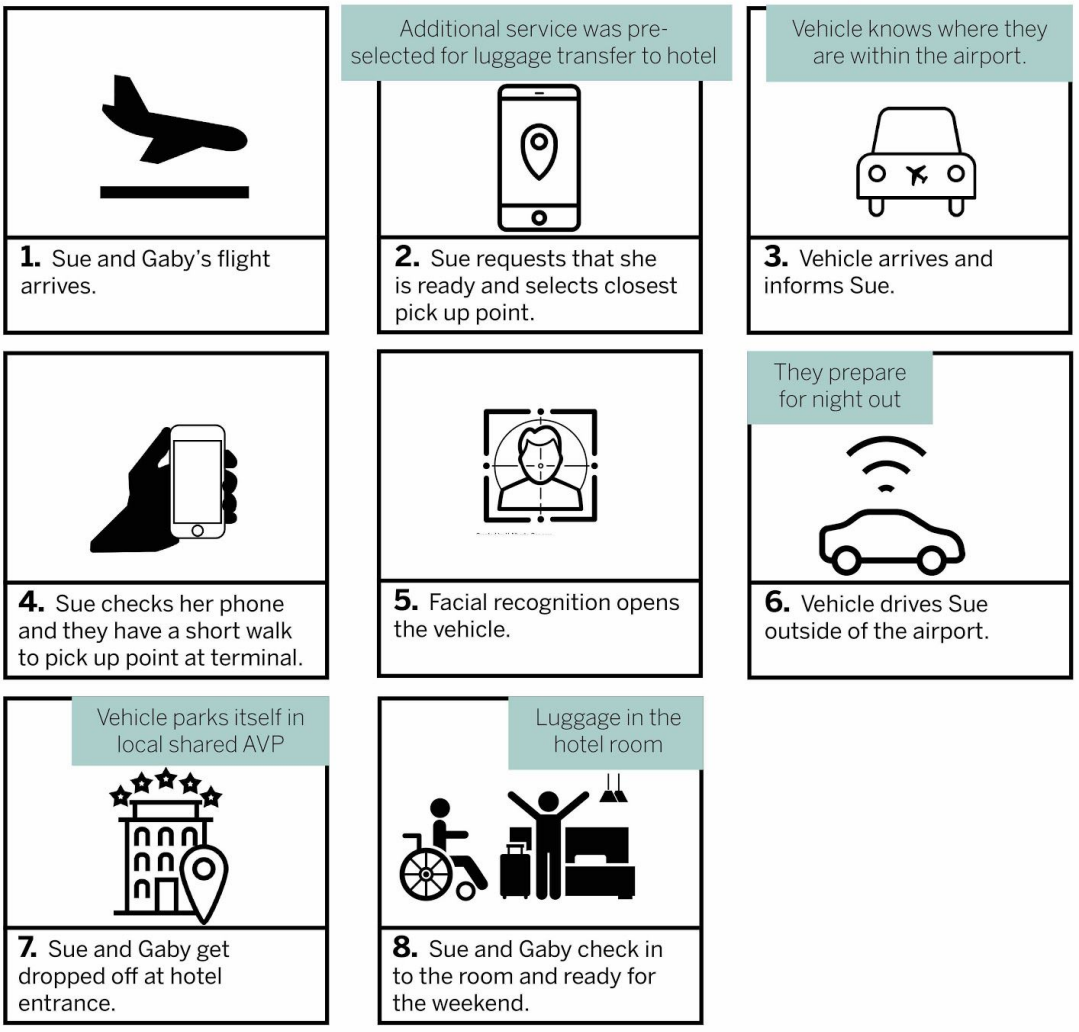


Fig 15: FUTURE: Two friends travel from the airport on a short break with Auto Valet Parking

5.2. Shopping Journey

In a future shopping journey, the researchers examined the current experience of shopping at a large shopping centre and the challenges that an older person might experience during the day. These include the concern they have around walking through a large and relatively dark multi-story carpark, challenges of parking in a narrow space and the complexities of carrying Christmas shopping back to the car at the end of the day. In the future, they will be able to drop off the car at the entrance to the car-park, pay a little extra to have their shopping delivered directly to the car by shop assistants, and spend a little bit more time having coffee with a friend before meeting the car, already packed with their shopping, at the exit from the shopping centre.

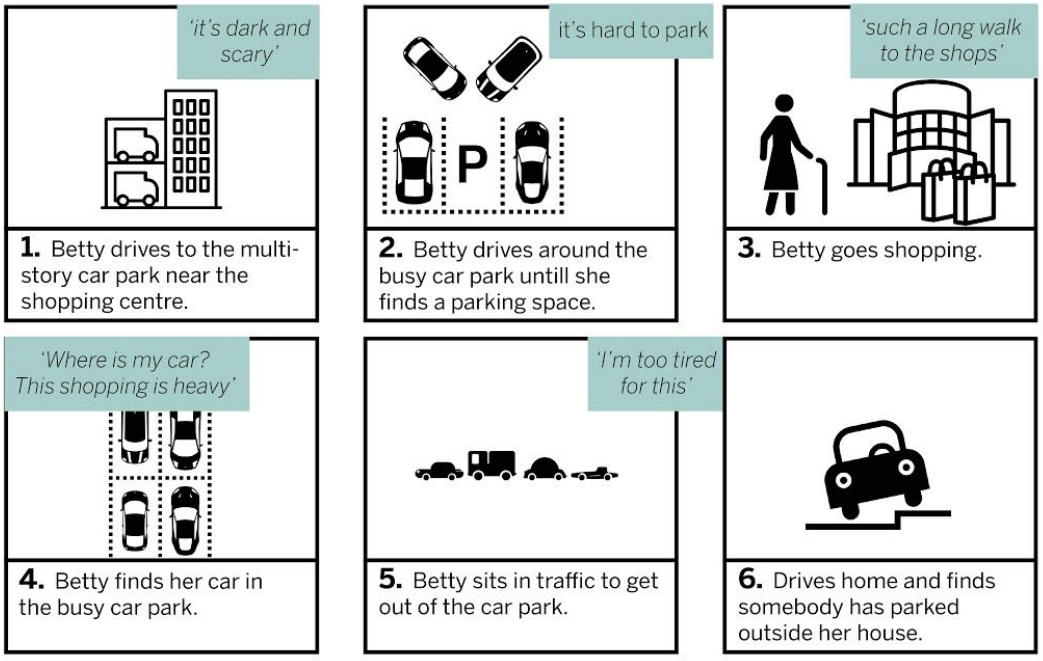


Fig 16: NOW: An older person's trip to the shopping centre

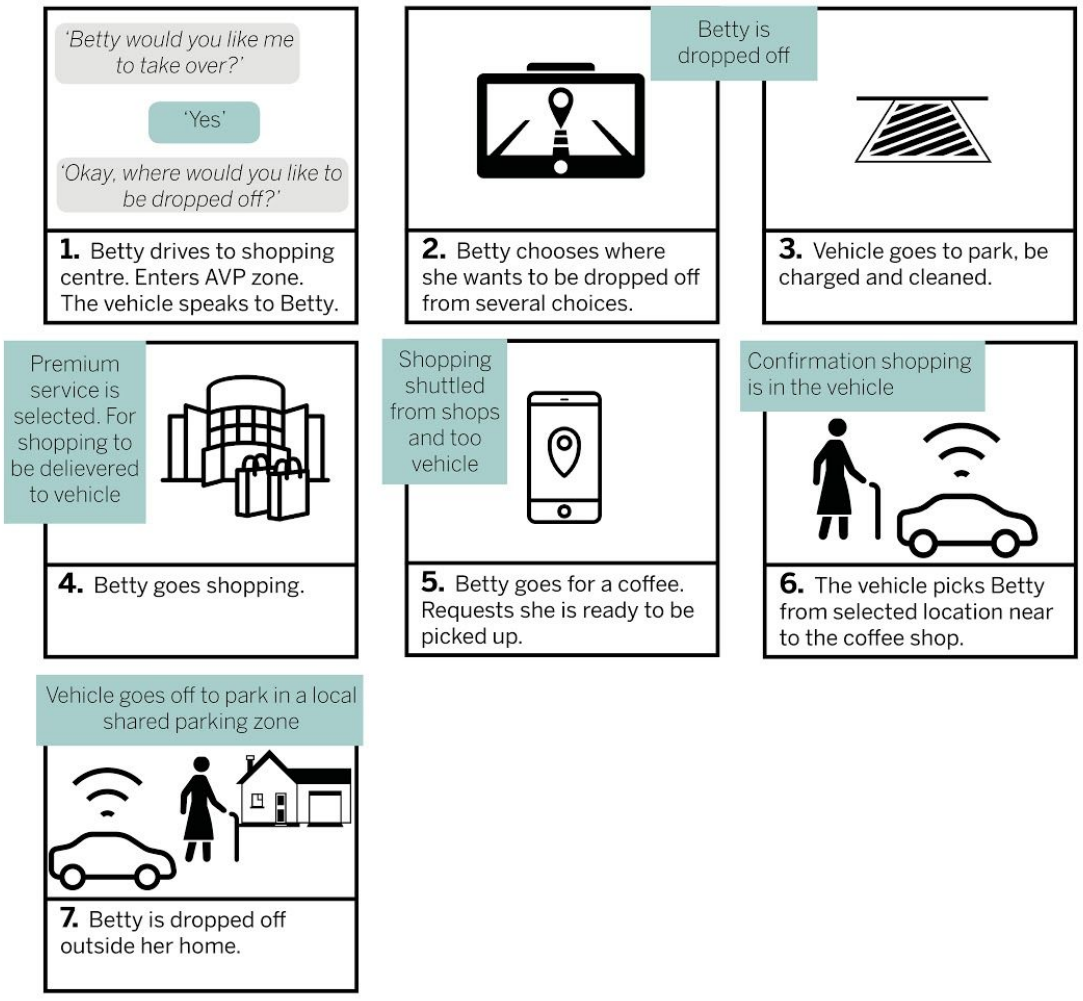


Fig 17: FUTURE: An older person's trip to the shopping centre with Auto Valet Parking

5.3. Family Journey

In our future family trip, the researchers consider the challenges of parking at a busy seaside resort and the impact of multiple cars on the congestion and pollution on the town and its streets. Currently the family might drive to the carpark that is closest to the beach, queuing in traffic and struggling with the children and their daypacks. In the future the AVP-assisted vehicle can coordinate its schedule with an autonomous park and ride bus at the outskirts of the resort. The family can drop off adjacent to the park and ride bus stop, carry their things a short distance and be taken directly into town in one of a fleet of small electric and autonomous buses, which will drop them close to the beach.

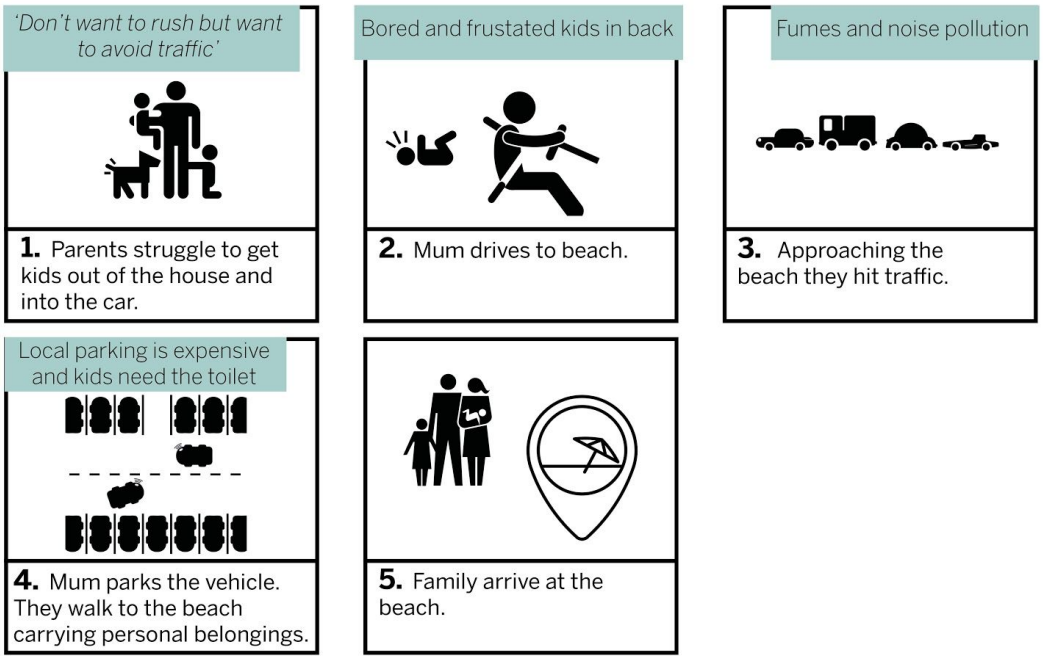


Fig 18: NOW: A family trip to the beach with Auto Valet Parking

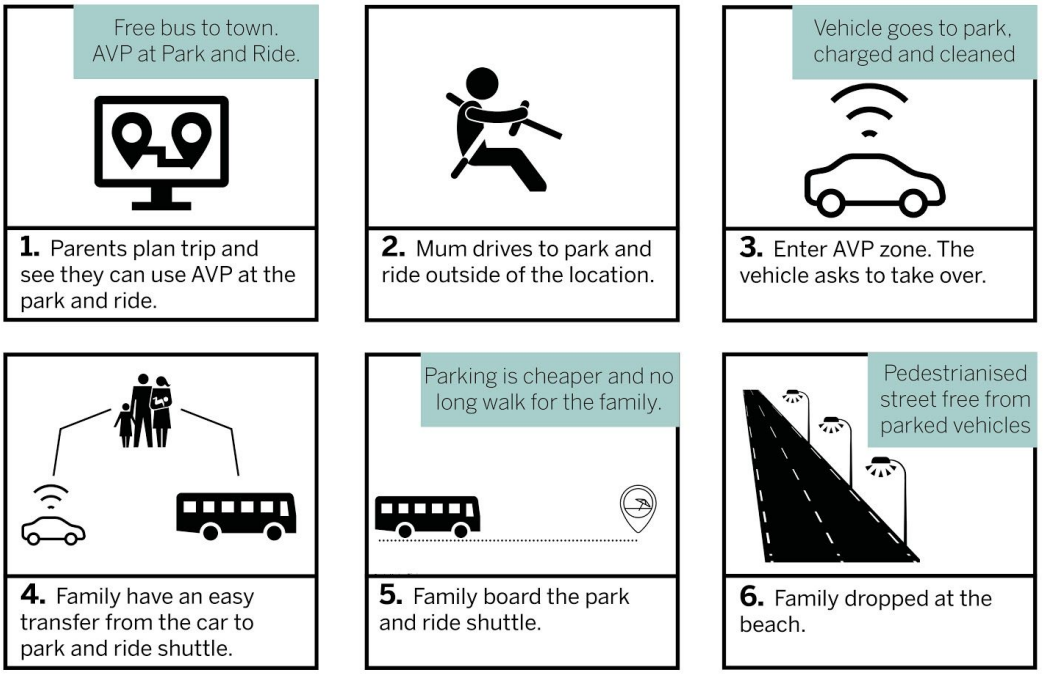


Fig 19: FUTURE: A family trip to the beach with Auto Valet Parking

5.4. Work Journey

Our future commute shows how AVP can be integrated with car club and ride sharing technology as well as future parking and charging services to reduce suburban traffic while also making the journey to the station and into the city more time efficient, social and cost effective. While current journeys include multiple single occupancy cars driving to the station and struggling to park in the crowded station car park, a future scenario shows how a car club user can offer their car for sharing on the trip to the station and the vehicle can then be parked, charged and maintained (or even hired out during the day), while the passengers can commute into the city together.

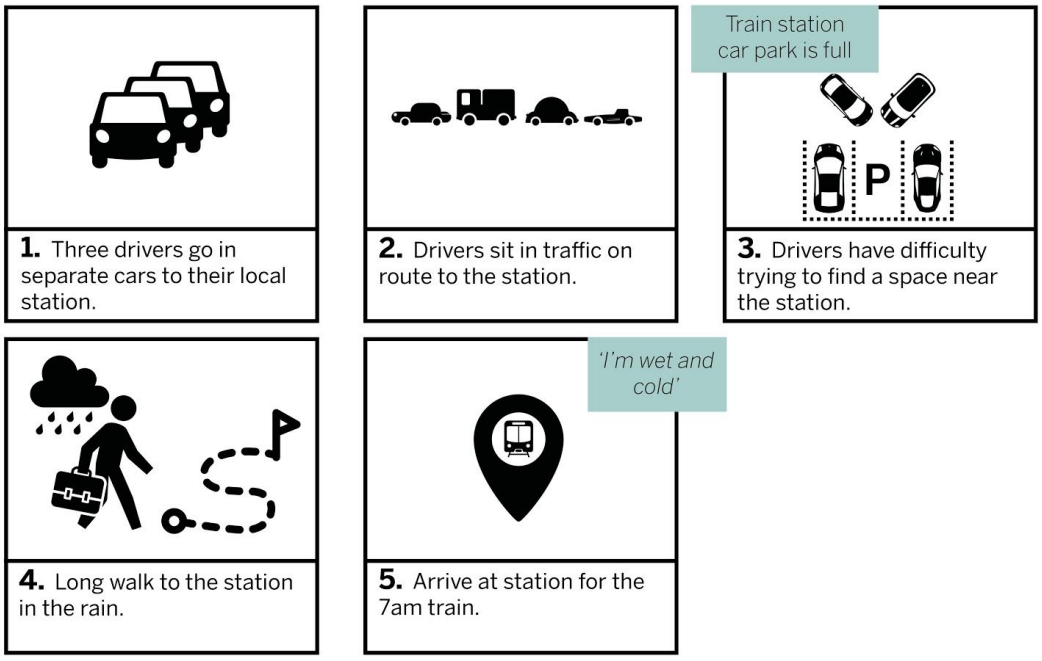


Fig 20: NOW: A commute to the suburban train station

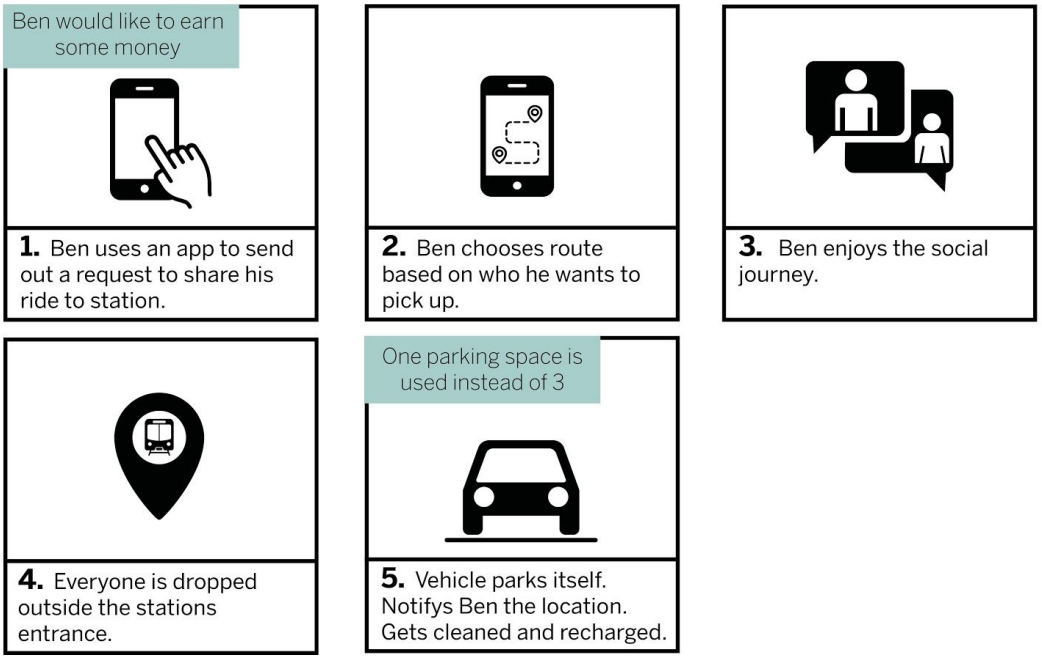


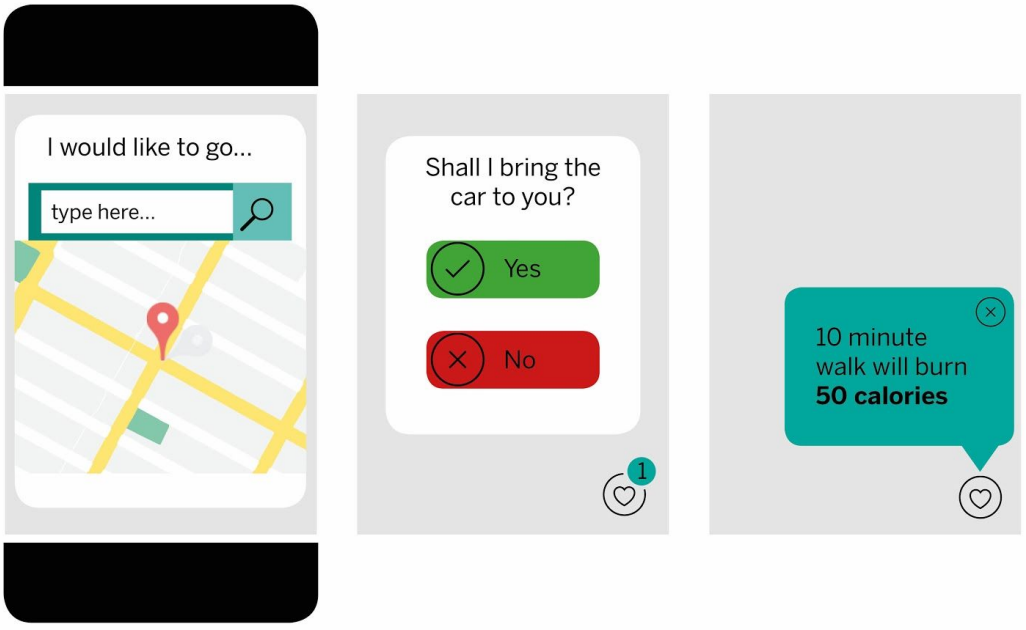
Fig 21: FUTURE: A commute to the suburban train station with Auto Valet Parking

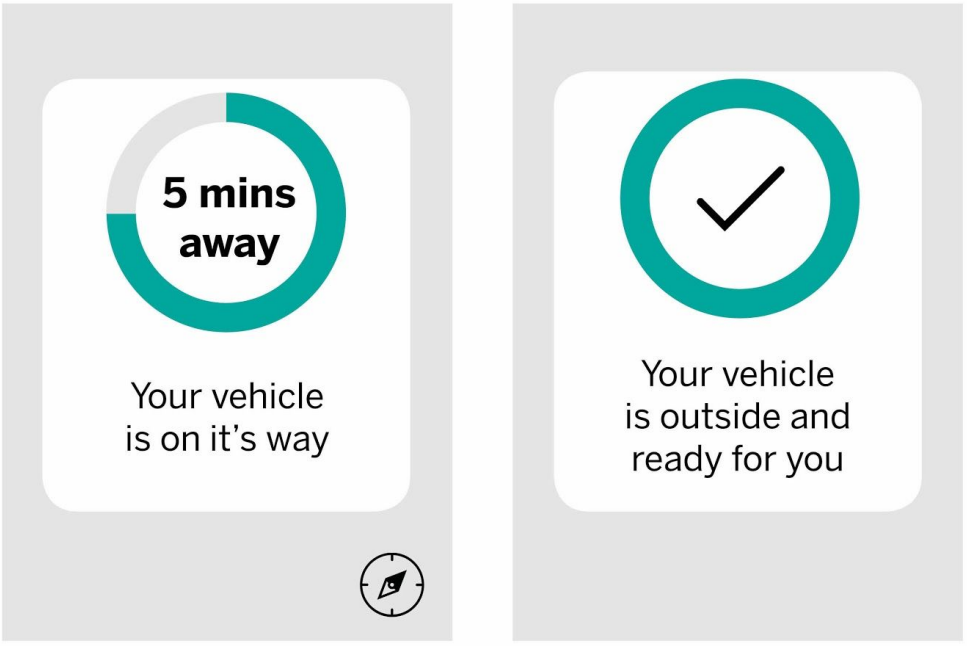
5.5. Future AVP interface

While the prototype interface was usable, our participants wanted a multi-modal interface that allowed them to communicate with the vehicle through their mobile, through voice and via the car's inbuilt control systems. They also wanted a guided and interactive experience that was more granular, gave them control over decisions and linked to external services like parking, charging, transport interchanges and personal schedules. The following interface screens are preliminary and highlight some of the key opportunities on a typical journey from deciding on the destination to parking and retrieving the vehicle.

Key opportunities included:

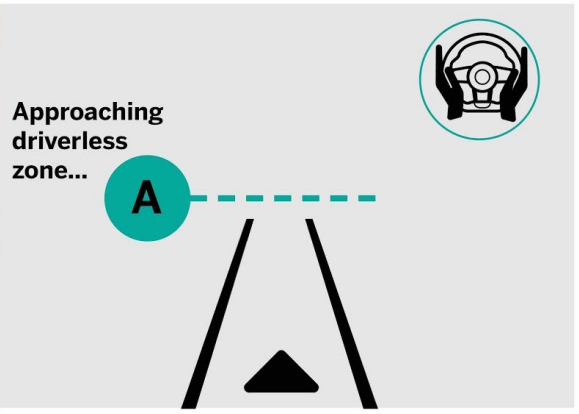
- Multi-modal interface
- Human and accessible experience (for example, the language used and amount of information on the screen)
- Price options to choose parking location
- Ability to track vehicle location and notifications on how far away the vehicle is
- Display the route it is taking
- A button to activate autopilot instead of using the pedals (i.e. brake function)
- In specific scenario activate and deactivate the vehicle controls (i.e. boot, door and headlights)
- System can locate where you are and respond based on your location
- Coloured coded and icons for visual representation
- Buttons clearly separated to avoid errors
- Confirmation when stage is complete (for example, when to let go of the steering wheel so the wheel doesn't get wiped out of the persons hands)



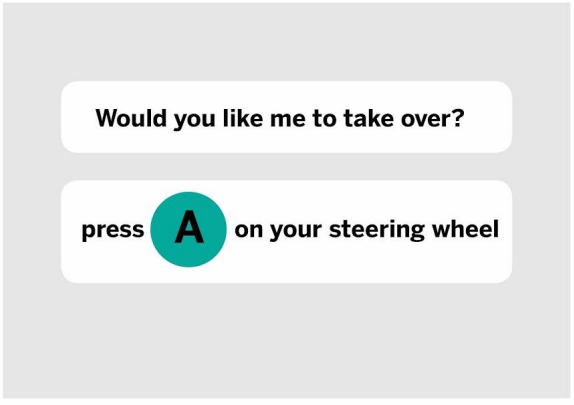


Step 1: Deciding on destination and retrieving vehicle. Application can provide integrated health tips and other services.

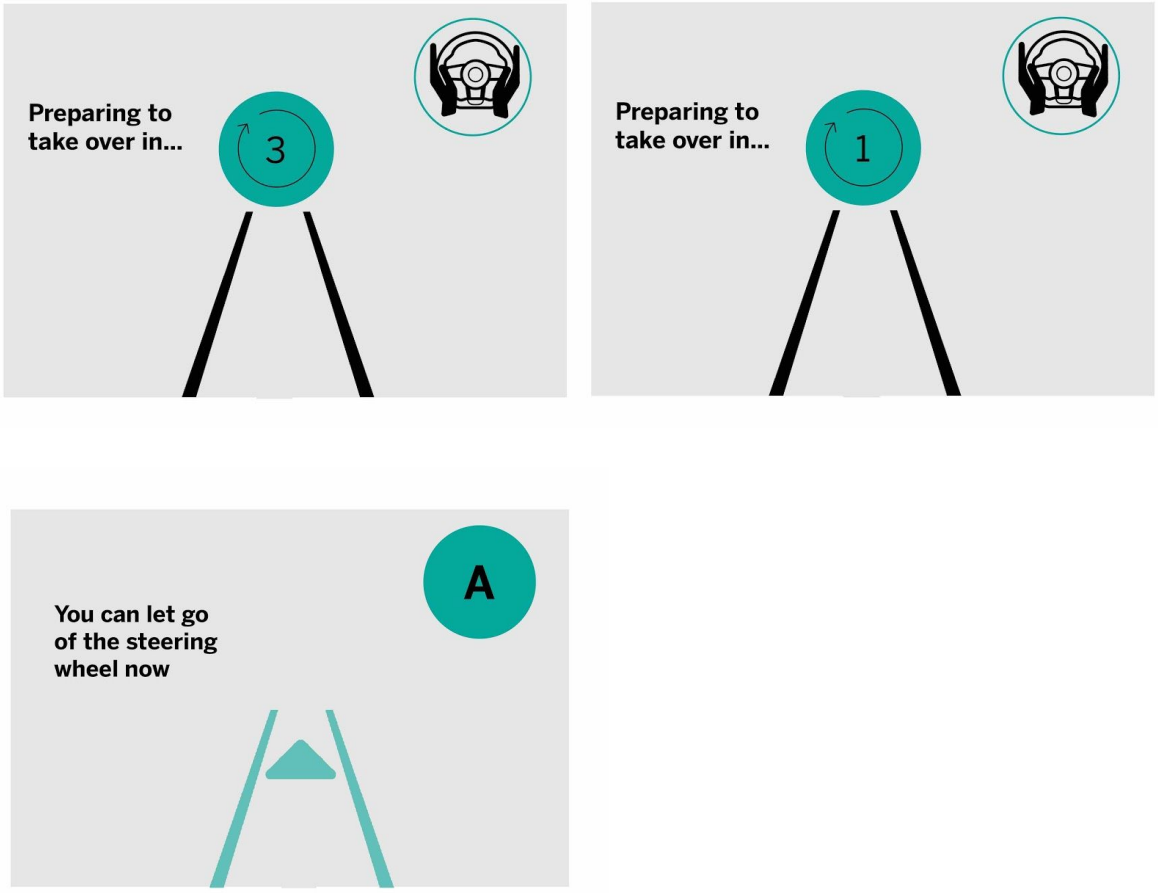
Step 2: Driving to Destination - Head up display shows navigation and confirms that the driver is in control.



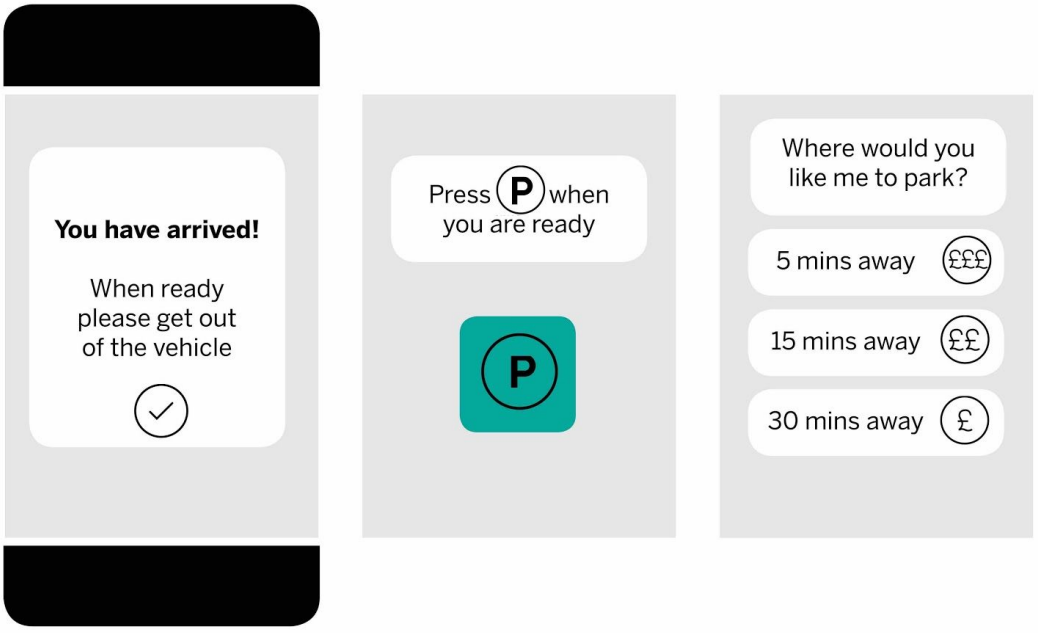
Step 3: Approaching Driverless Zone - Head up display advises driver that they are about to enter a driverless zone.



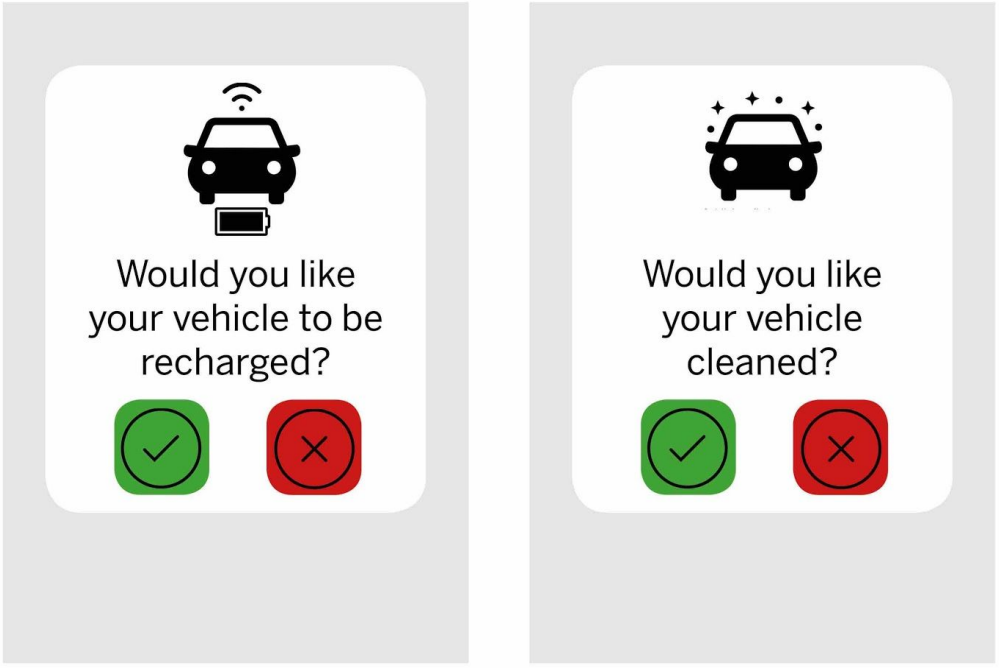
Step 4: Vehicle asks driver if they would like the vehicle to take over driving in driverless zone. This can use hardware, soft-buttons and voice activation.



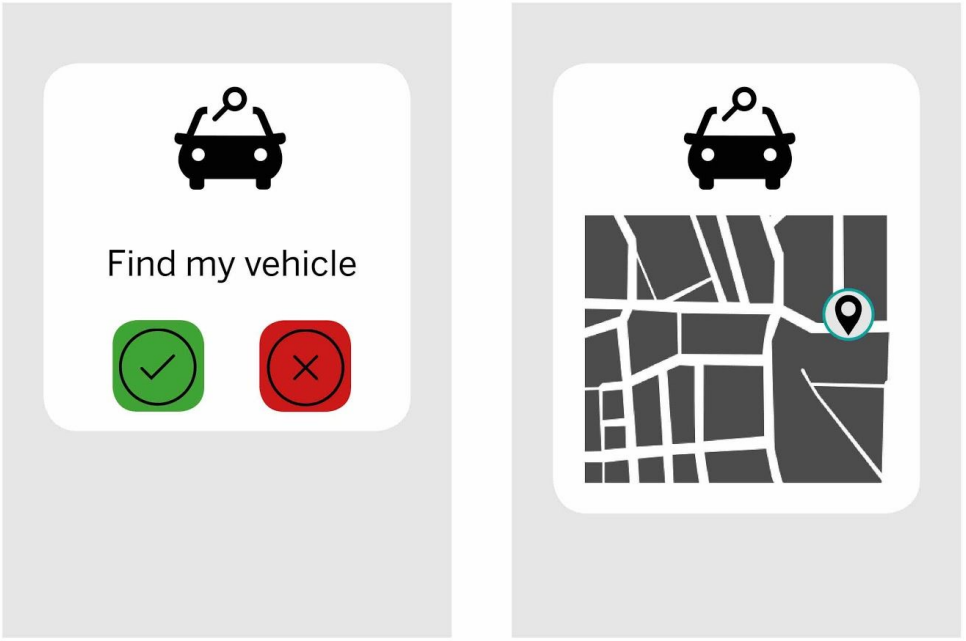
Step 5: Handing over control to the vehicle. Simple countdown system prepares driver to hand over control to the vehicle.



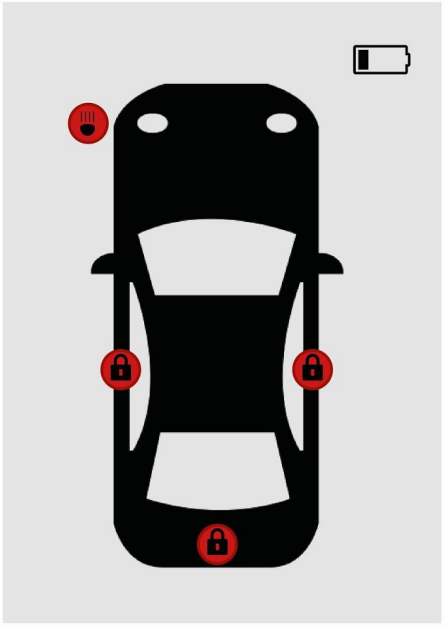
Step 6: Arriving at your destination and choosing your parking location



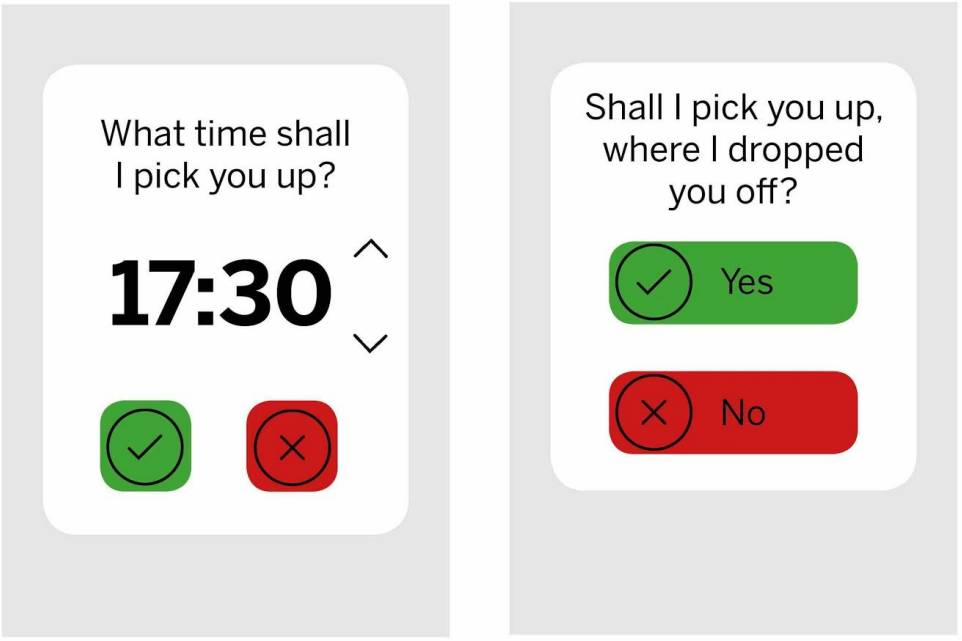
Step 7: Choosing additional services such as vehicle charging and cleaning



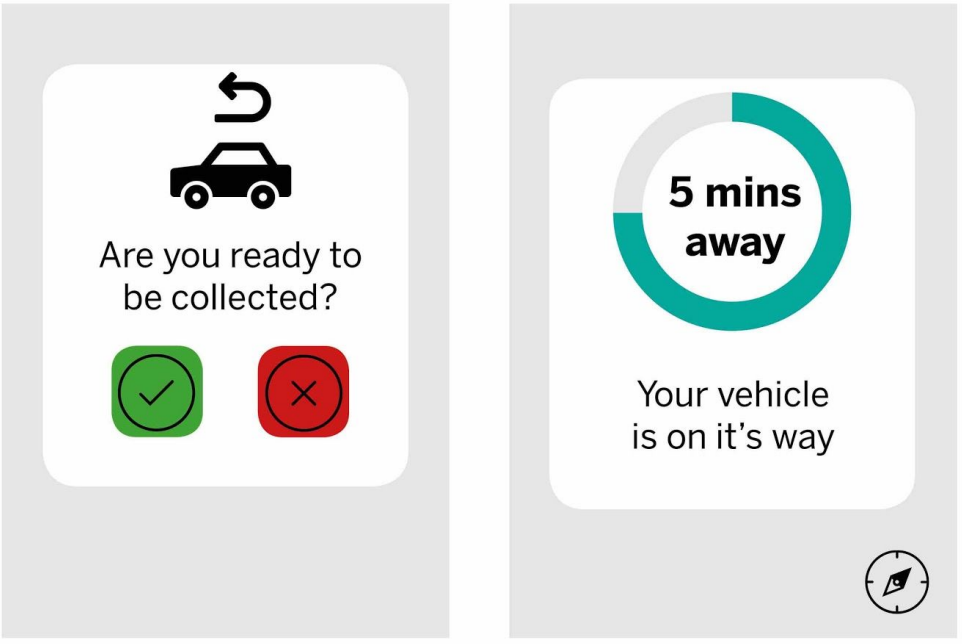
Step 8: Locating your parked vehicle.



Step 9: Control car functions remotely



Step 10: Choose pick up time and location



Step 11: Confirmation of vehicle return and time until pick up

Fig 22: Future AVP interface and touchpoints

6. Conclusions and next steps

Auto valet parking was seen by our participants as a valuable service that would improve the quality of their travel experience, save them time and potentially encourage them to use their vehicles more often. It can provide more inclusive personal transport by helping those with additional needs to access more places and take journeys that they currently find difficult or impossible. For a significant group of people it may increase their preference to make use of shared mobility services such as car clubs and, for many, it paves the way for fully autonomous travel.

The key benefits of AVP technology are 'saving and managing time', 'providing more inclusive travel', and 'increasing safety within vehicles and in public spaces'. People also believe that it will reduce stress. While some worry about the loss of control, others have more trust in technology than people.

Save and Manage Time	*"The more time I save the better."* *"I'd also like a delay button as I have a very young daughter who takes more time than expected"* *""Fire and Forget" at train stations and big shopping complexes"*
Safety in vehicle and in public spaces	*"Many people are apprehensive about using multi storey car parks, especially at night and if they are alone. Valet parking would deal with that problem at a stroke"*
Inclusive	*"It'll be very valuable if it helps people, like my father who, are disabled. There will then be more space and access for everyone"*
Stress Reduction	*"...if every vehicle obeyed the rules of the road I would feel much less stressed... "*
Trust	*"I trust technology more than a load of crazy human beings"*
Loss of Control	*"My husband would hate to lose control but I love the restrictions"* *"I love driving but there are times when I'm just glad to handover and be out of control"*

While there are many opportunities associated with AVP technology there are also a number of challenges that need to be considered.

Opportunities include:

- Developing auto valet parking interfaces that are multimodal, inclusive and easy to use, giving power to the driver and using technology to support more intelligent journey planning
- Designing pickup and drop off points that make it easier to access places while integrating opportunities for more sustainable / healthy modes of travel
- Including auto valet parking systems into car club / hire / ride sharing vehicles to encourage greater vehicle sharing
- Designing parking and charging facilities that use space more efficiently so that streets can be used for more people-centred activities.
- Integrating additional services into AVP so that providers can deliver additional services while the car is parking or parked.
- Ensuring that AVP technology assists with inclusive mobility by replacing/supplementing limited blue badge bays with improved AVP drop off and pick up areas that are integrated with local off street parking.

Challenges include:

- Ensuring that AVP technology does not lead to greater numbers of people driving in congested towns.
- Setting standards for driverless zones so that people are aware of when they enter and leave a driverless areas and any ‘automatic valet parking’ equipped vehicle can drive and park safely within these zones without human interference.
- Careful consideration of pick up and drop off zones so that they do not increase the space required for maneuvering and parking vehicles compared with existing layouts.

Next steps include working with manufacturers, local authorities and organisations that provide parking as part of their service to share these findings and see how AVP can be developed, piloted and trialled in various environments and with different members of the public. While there is a strong likelihood that these services will be first integrated into premium vehicles and environments its important that the opportunities and challenges that have been identified help public and private organisations to realise the benefits for a wider range of people, situations and the wider public good.

7. Appendix

7.1. Team

The team comprised designers and researchers from the Royal College of Art's Intelligent Mobility Design Centre, the School of Design and the Helen Hamlyn Centre for Design

RCA Project Directors
Prof Dale Harrow
Rama Gheerawo

RCA Project Manager
Dan Phillips

RCA Project Researchers
Gabriele Meldaikyte
Elizabeth Roberts

7.2. Partners

Project partners include:

- TRL: the project lead and research partner. TRL has been working on automated vehicles for more than 50 years.
- The Royal Borough of Greenwich: the local authority and smart city partner, providing the venue for the trial and looking at the wider implications for city authorities.
- DG Cities: is facilitating the Greenwich trials and local stakeholder engagement. It will also be looking at the interdependencies between connected and AVs, the design of the built environment and smart mobility services and the role of cities in accelerating take-up.
- RSA (Royal Sun Alliance): is working to understand how automated vehicles might disrupt the motor insurance market and will support the risk mitigation strategy.
- Shell: is focused on understanding how automated vehicles will impact its existing business models.
- O2: is focused on understanding the networking implications of automated vehicles and the impact they will have on its business and consumers connectivity needs.
- The University of Greenwich: is undertaking research to extend its world renowned pedestrian modelling capability to consider interactions with automated vehicles.
- Imperial College: is considering the cybersecurity implications of the specific trials and wider implementation of connected, automated vehicles.
- Royal College of Art: is drawing on its internationally recognised expertise in stakeholder engagement in relation to vehicle design to provide detailed insights into stakeholder attitudes to vehicle automation.
- Commonplace: is providing innovative sentiment mapping techniques that analyse social media to measure users' response to experience of automated vehicles. Residents and visitors to Greenwich Peninsula are invited to leave feedback of their experiences and observations of interacting with the driverless shuttles via an interactive map.
- Gobotix: is delivering the demonstrations of vehicle teleoperation and support to the automated vehicle trials.
- Westfield Sportscars: is responsible for the procurement and build of the shuttle vehicles and overall systems integration.
- Heathrow: is responsible for the design, testing and engineering of the GATEway shuttle vehicles and their control software.
- Oxbotica: is developing the sensor technology and software to support the safe operation of the shuttle vehicles.

7.3. Acknowledgements

The GATEway project is joint-funded by government and industry. It has received £5.5 million in funding from the Department for Transport (DfT) and the Department for Business, Innovation & Skills (BIS) through Innovate UK and is supported by the Centre for Connected and Autonomous Vehicles (CCAV), which is the UK government policy unit set up to drive the governments activity on connected and autonomous vehicles. This funding is supported by an additional £2.5 million from the commercial organisations within the GATEway consortium.