D3.2.8 Designing with people inside a driverless vehicle

GATEway Project Trial 1 RCA Workshop Report

Principal Investigator - Professor Dale Harrow
Co Investigator - Rama Gheerawo
Research Associate - Gabriele Meldaikyte
Researcher - Elizabeth Roberts
Project Manager - Dan Phillips

GATEway

Royal College of Art

1. Abstract

What do members of the public think and feel when they are passengers in a working driverless vehicle? 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 Spring 2017 in a central London (UK) borough. The researchers recruited 50 people (mainly Londoners) including drivers, non-drivers and people with additional needs and helped them to experience urban driverless vehicle journeys including a commute, a shopping trip and a leisure journey. Our research showed that people are excited about driverless technology, see it being integrated into a wide range of future vehicles and would like the experience to be practical, comfortable and reliable. The majority of people imagined that driverless vehicles would be publicly provided or shared, with parents being the only user group that preferred to own driverless vehicles in the future. Key areas that people wish designers to focus on include interior comfort, efficiency and emissions, and personal wellbeing.

2. Introduction

2.1. Gateway project

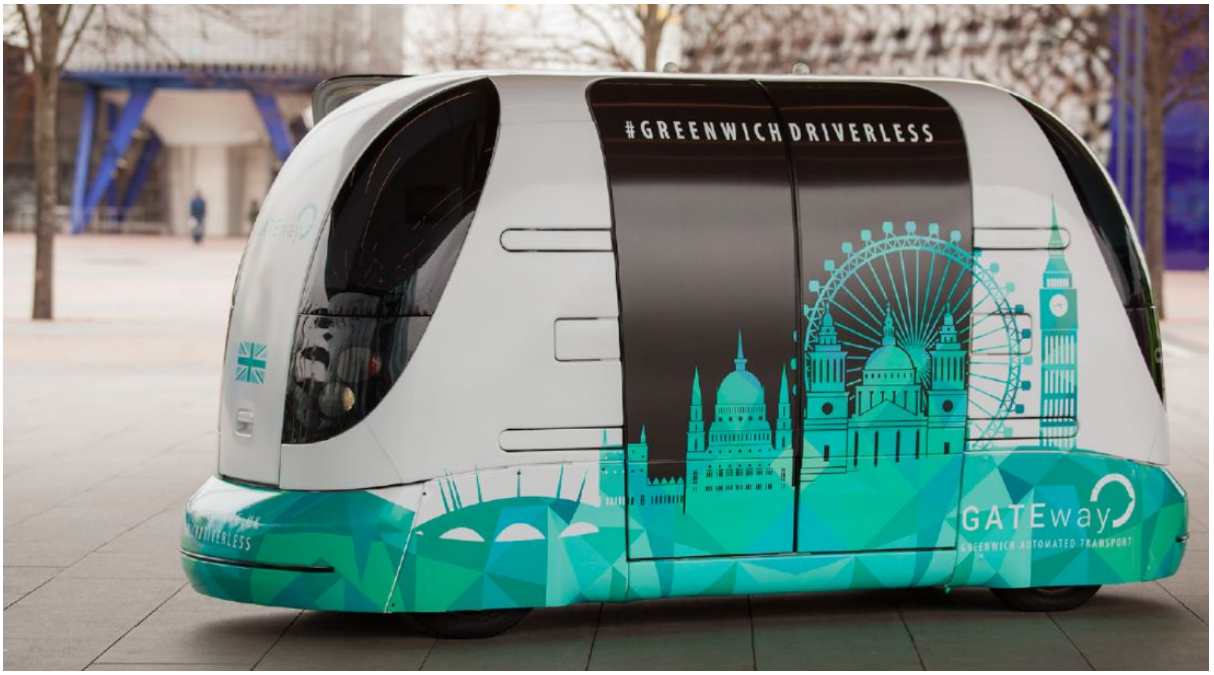

Figure 1: 'Harry' - the prototype autonomous vehicle that was used in the research

The GATEway project is an £8 million project jointly funded by Innovate UK and industry. Led by TRL, the project is investigating public perception, reaction and engagement with a range of driverless vehicles.

2.2. RCA and HHCD

The Royal College of Art and the Helen Hamlyn Centre for Design is seeking to better understand people's attitudes towards the use of autonomous vehicles (AV) and their operation in cities. The trials and workshop seek to understand the following questions:

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

2.3. Aims

The fully automated passenger shuttles trialled in GATEway Trial 1 provide an opportunity for people to engage with a current form of AV technology to explore what might be required for future design and implementation.

The geographical focus is on the Greenwich peninsula and involves different groups of road users, including people with additional transport needs.

Around 50 people participated in these trials with participants divided into groups of 3, who were each taken on simulated future journeys: to work, shopping or to a party.

The experience was captured through workbooks and then used a post-trial workshop to better understand the practical, social, emotional and physical aspects of the journey.

The final part of the workshop focused on a co-development activity, where participants were asked to look at different aspects of AVs and to design their future dream vehicle.

3. What we did

The research team developed a range of activities to help us to understand people's attitudes and behaviours when they experience a driverless journey. While the vehicle included a safety steward, the environment was set up so that passengers felt immersed in the travel experience, using a physical and audio guide, as well as props to ensure that people focussed on the sorts of activities that they might do in future vehicles rather than on the novel technology itself.

3.1. Introduction

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

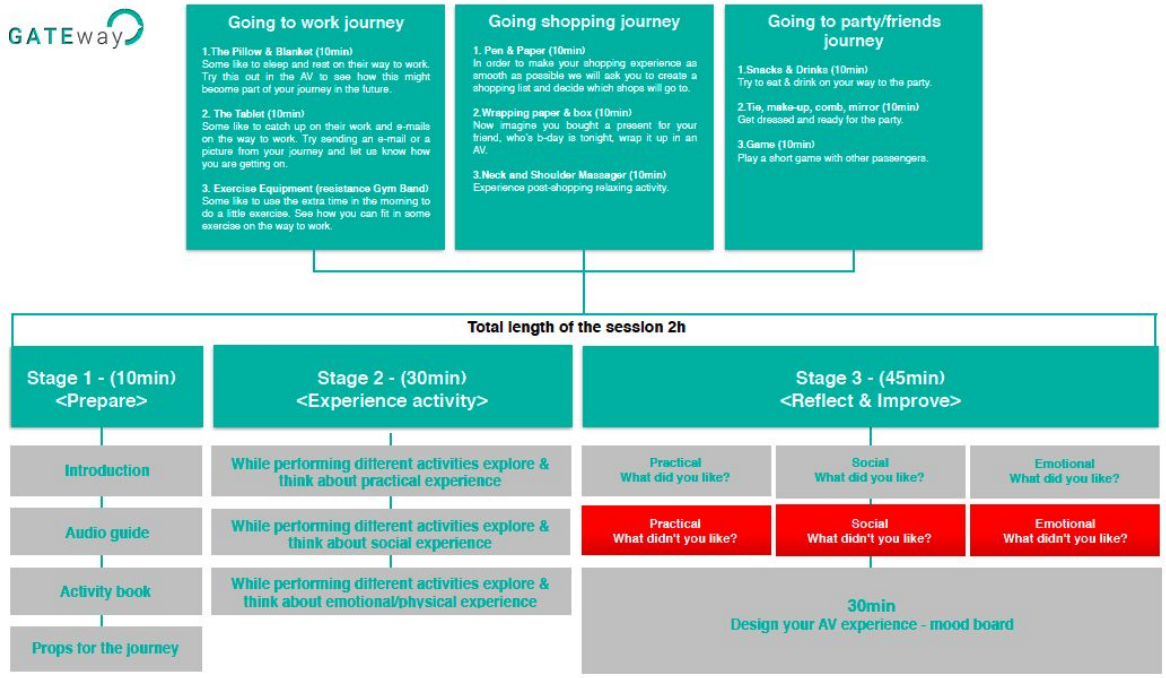

Figure 2: Summary of research activity

The first stage (prepare) included an introduction to the workshop, the use of an audio guide, activity books and props that were used on the journey.

The second stage (experience) focused on capturing the experience during a 30 minute ride in a shuttle, while the third stage (reflect and improve) allowed participants to share thoughts on the experience and design a future journey and vehicle.

3.2 Driverless Vehicle Experience

During the driverless vehicle experience participants were given the opportunity to experience one of three journeys including going to work, going shopping and going to a party. Each journey included three activities as well as experiencing the vehicle and journey itself. Props, workbooks and audio guides helped participants to carry out these activities and gave them an opportunity to capture practical, social and emotional/physical aspects of the experience.

Going to work

The ‘going to work' experience included ‘doing some work’, exercising or meditating, and having a nap. The scenarios and props are shown below:

The Tablet

“Some like to catch up on emails on the way to work. Try sending an email or a picture from your journey and let us know how you are getting on.”

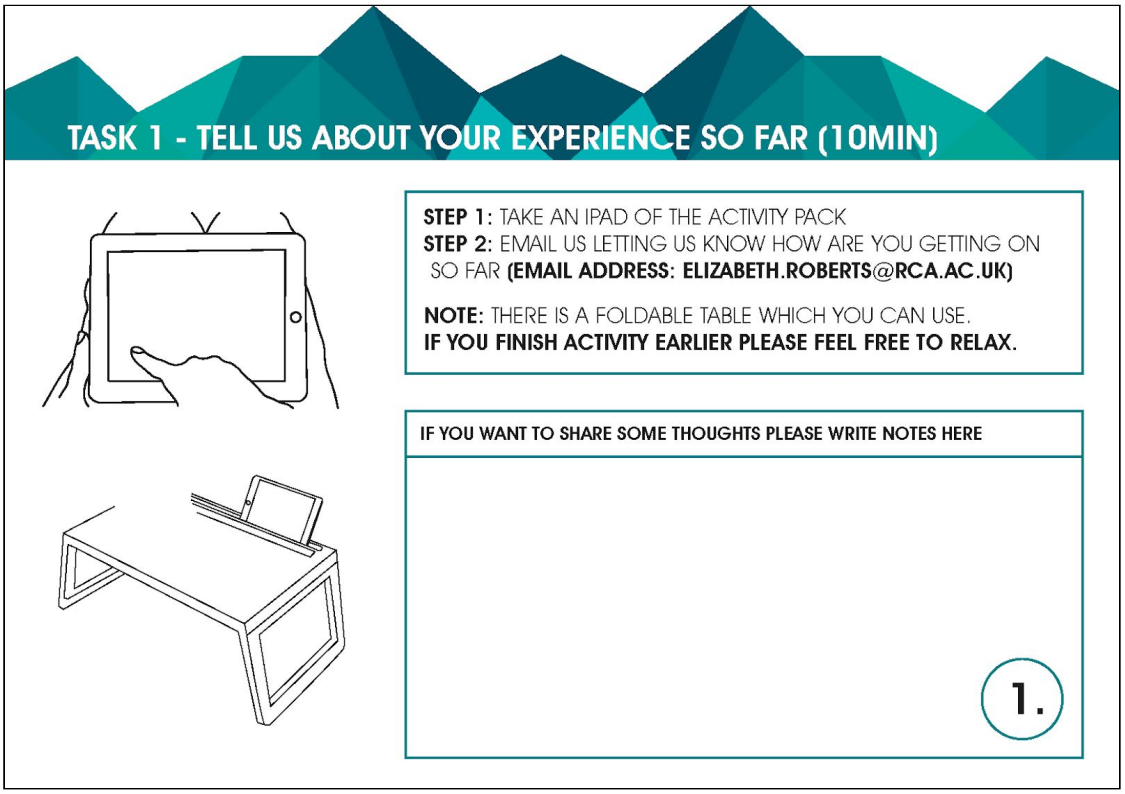

Figure 3: Commute Task 1 - Send an email

Exercise Equipment

“Some like to use extra time in the morning to do a little exercise. See how you can fit in some exercise on your journey to work.”

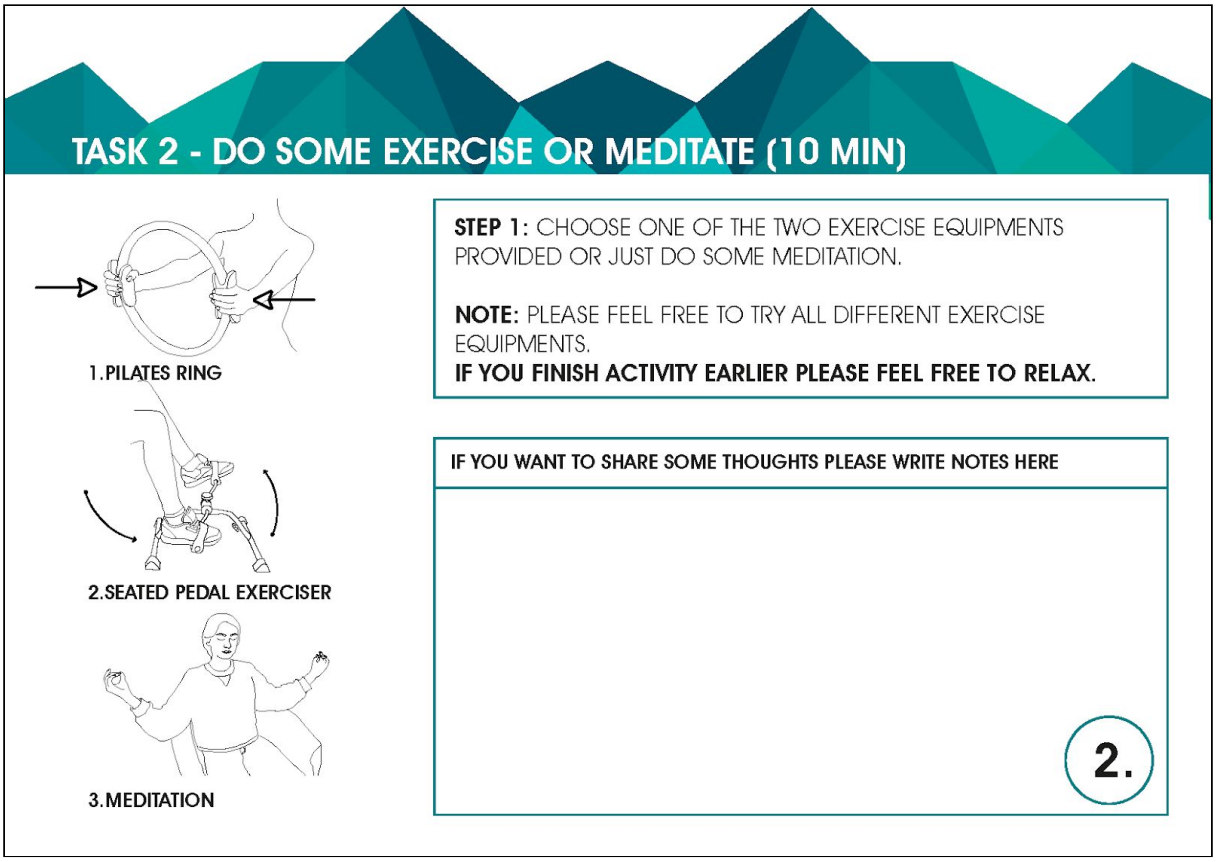

Figure 4: Commute Task 2 - Do exercise or meditate

The Pillow & Blanket

“Some like to sleep and rest on the way to work. Try this out in the AV to see how this might become part of your journey in the future.”

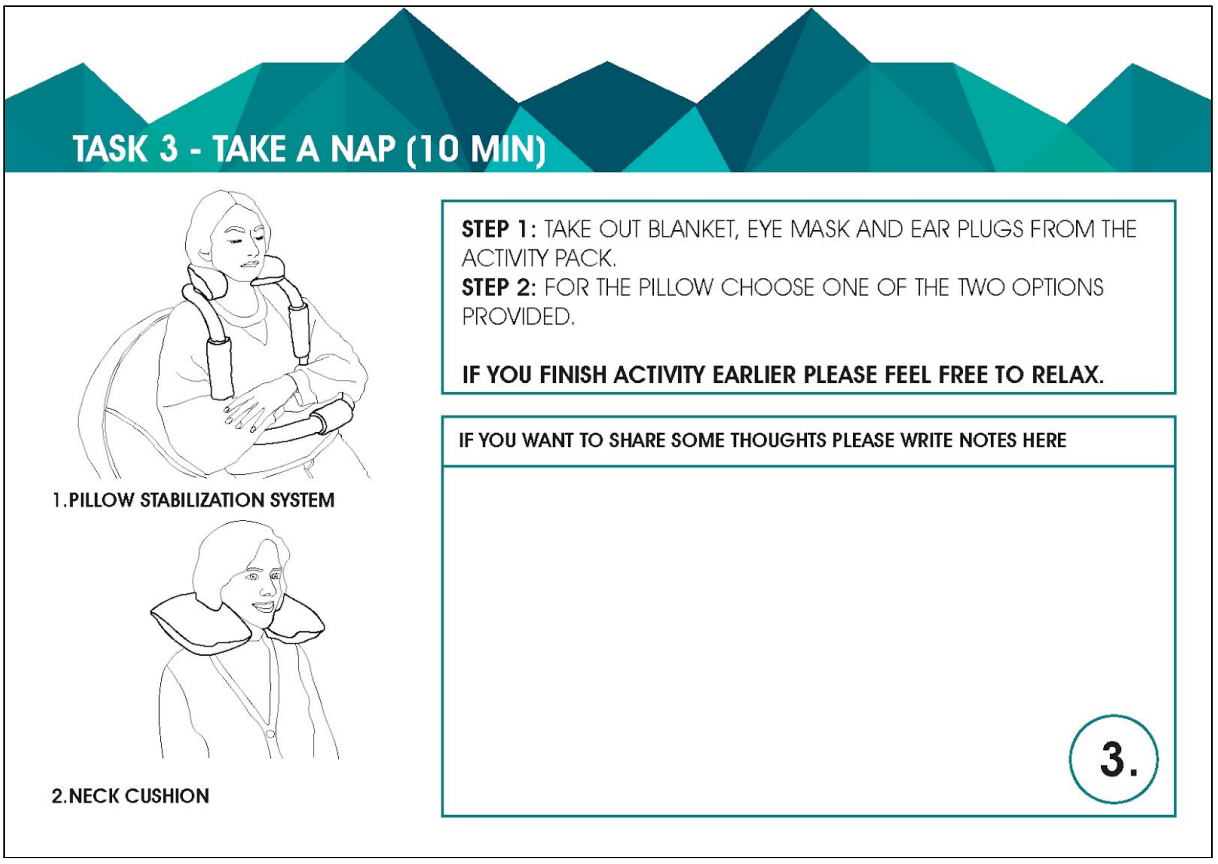

Figure 5: Commute Task 3 - Take a nap

Going shopping

The shopping experience included ‘making a shopping list’, ‘wrapping a present’, and using a piece of massage equipment to relax at the end of the journey. The scenarios and props are shown below:

Pen & Paper

“In order to make your shopping experience as smooth as possible create a shopping list and decide which shops you will go to.”

Figure 6: Shopping Task 1 - Make a shopping list

Wrapping paper & box

“Now imagine you bought a present for your friend who is having a birthday tonight. Wrap it up and write a card.”

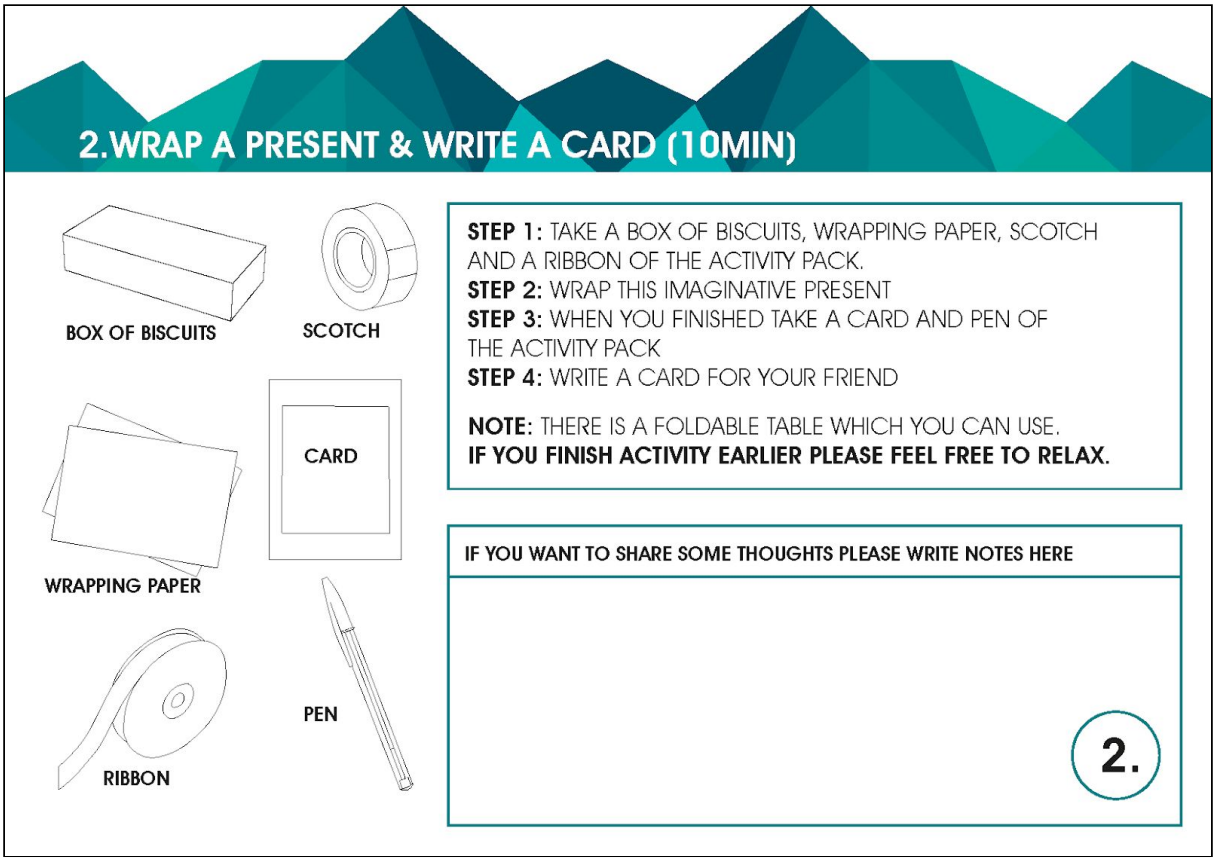

Figure 7: Shopping Task 2 - Wrap a present

“Now you have finished preparing the present, experience a post-shopping relaxing activity”

Figure 8: Shopping Task 3 - Have a massage

Going to a party

The ‘going to a party’ experience included playing a game, having a drink and snacks, and dressing up ready for the party. The scenarios and props are shown below:

Game

“Start your journey to a party by playing a short game with other passengers”

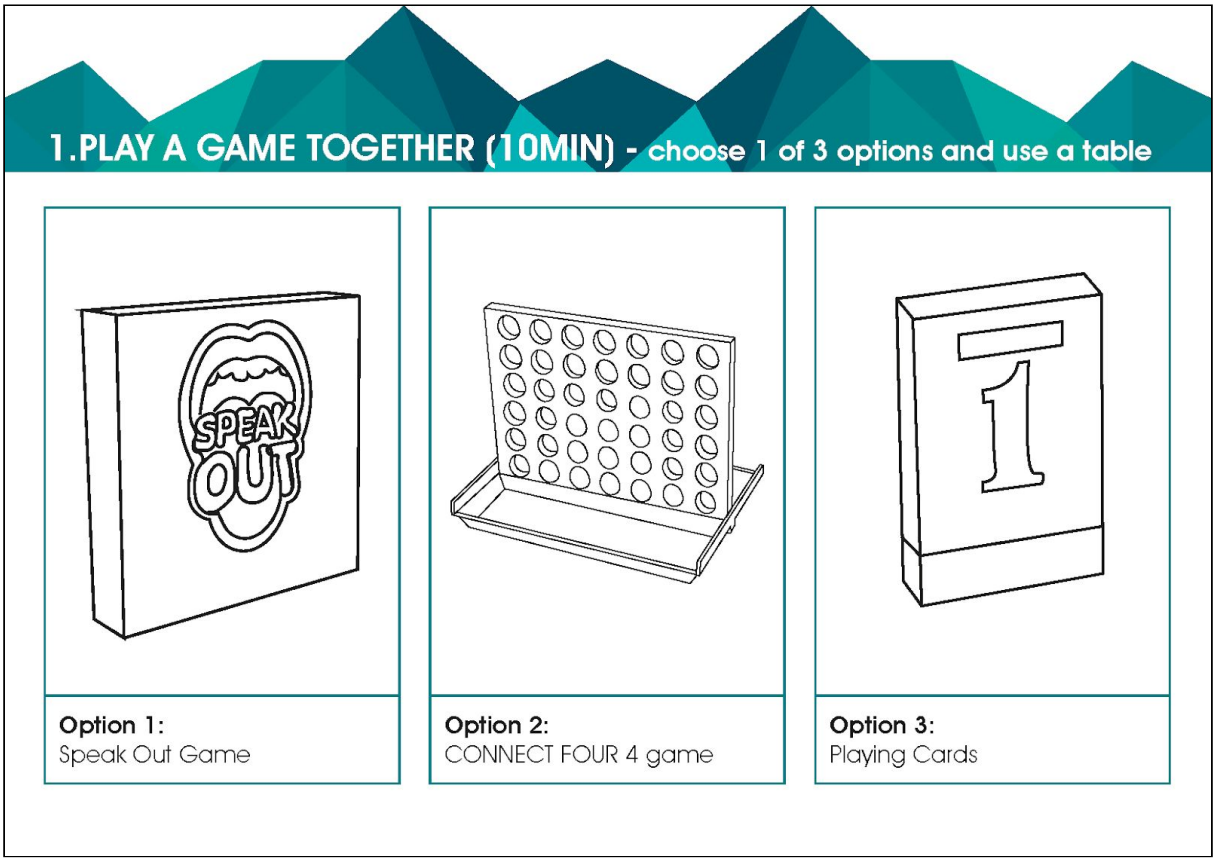

Figure 9: Party Task 1 - Play a game

“Now try to eat & drink some snacks on your way to the party”

Figure 10: Party Task 2 - Have a snack and drinks

Tie, make-up, comb, mirror

“We’re getting close to the end of your journey so now it’s time to get dressed and ready for the party”

Figure 11: Party Task 3 - Get ready for a party

3.3 Reflection and Improvement

The third stage of the research comprised a one hour post-trial workshop, where participants were asked to reflect on and improve the driverless experience. This was divided into two parts, firstly describing their feelings towards the journey and activities and then designing a future journey and vehicle.

Journey experience

Participants were asked to describe what they liked and didn't like about the experience from a practical, social and emotional/physical perspective.

- Reflections on the practical experience including function, environment and setting.
- Reflections on the social experience including ownership, territory and interactions.
- Reflections on the emotional & physical experience including feelings, reactions, health & wellbeing

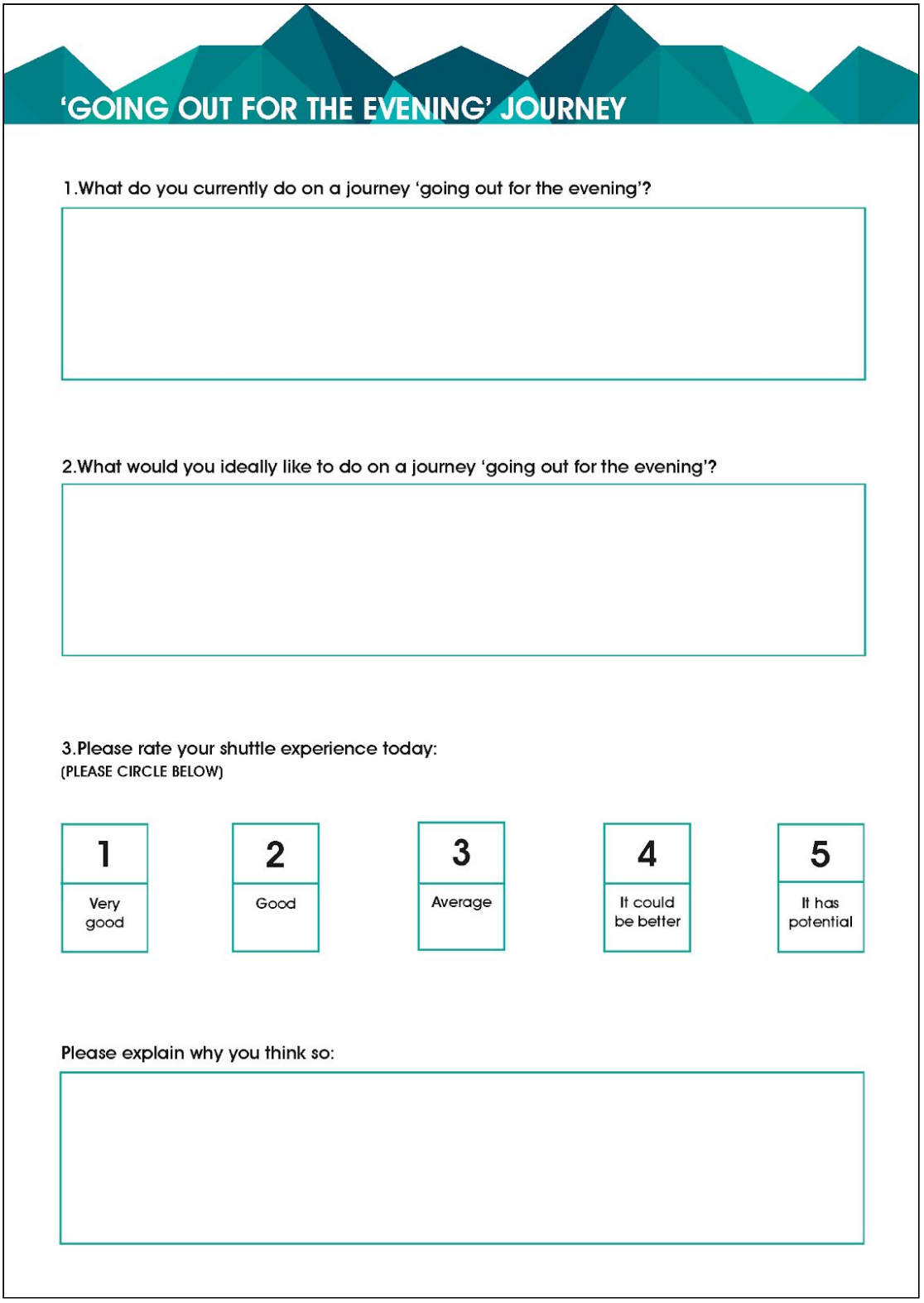

Figure 12: Journey experience 1

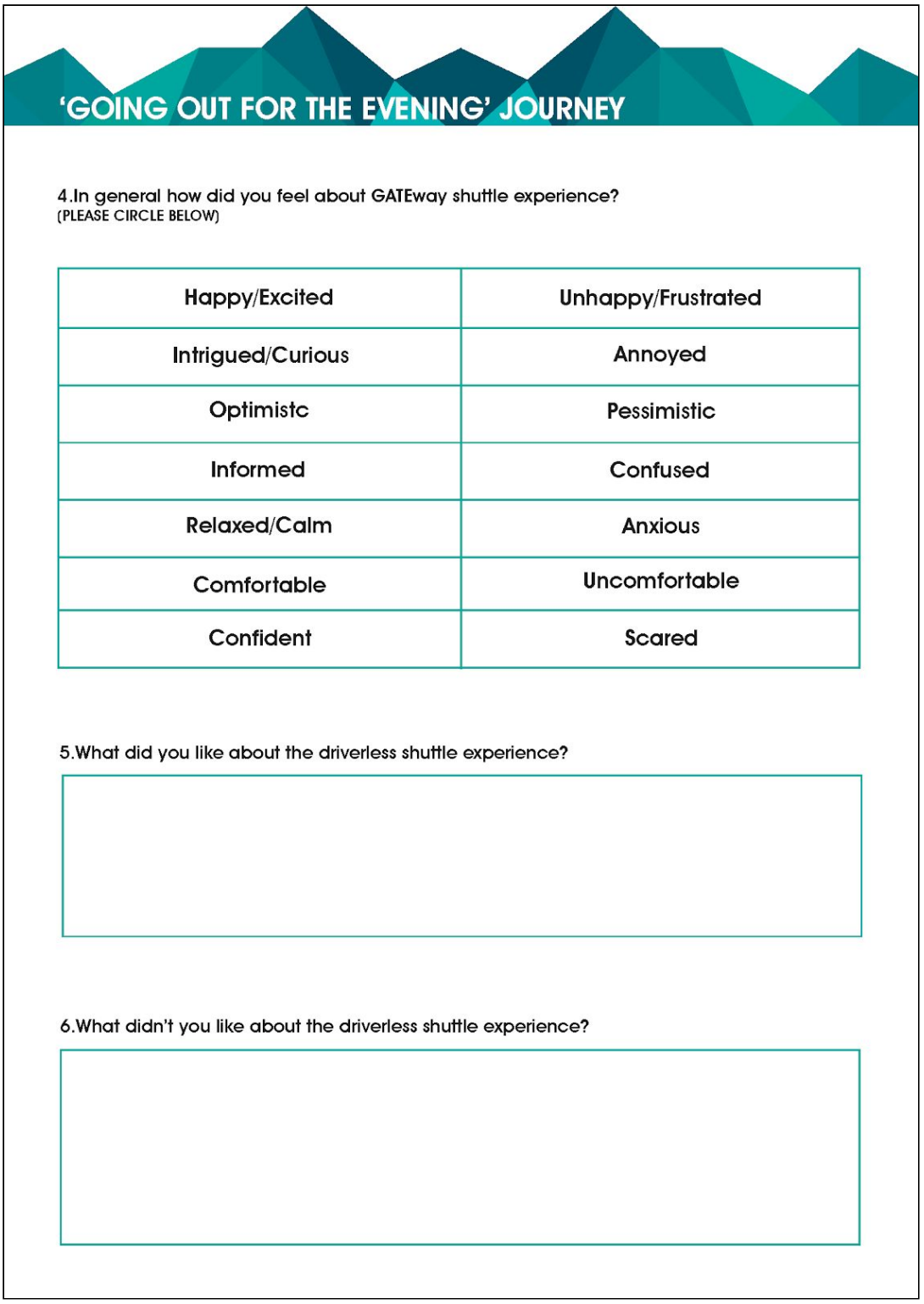

Figure 13: Journey experience 2

Figure 14: Journey experience 3

Future Driverless Experience

Participants were then asked to design a future autonomous vehicle experience including the creation of a mood board. During this part of the workshop participants were asked to speculate on future AVs including type of journey; cost, quality and ownership; functionality; environmental requirements; service requirements; materials and finishes and a moodboard describing how they would like to feel and what the ‘perfect’ experience might include.

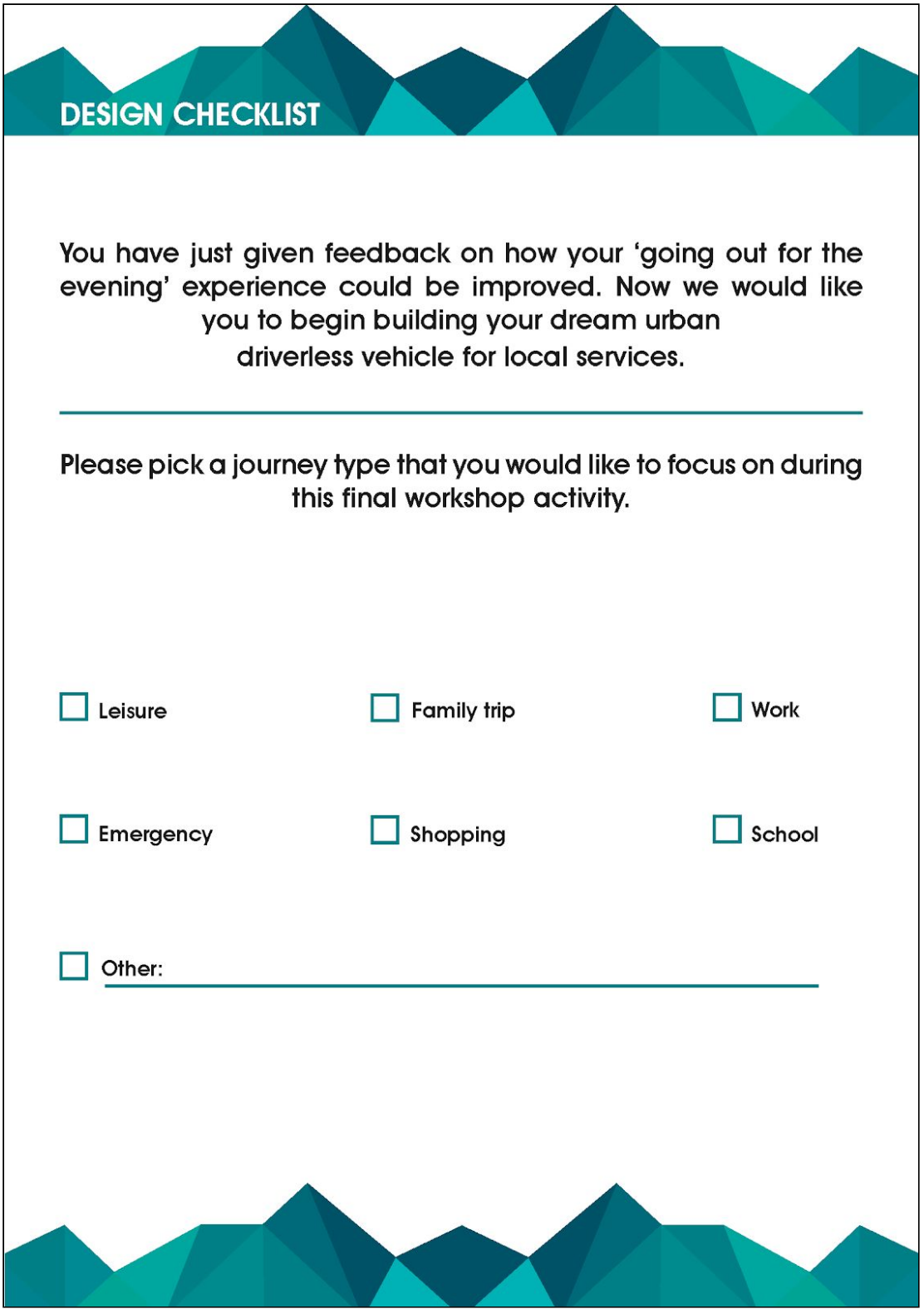

Figure 15: Design Checklist - Type of Journey

1. COST AND QUALITY REQUIREMENTS

1a. Please break down how you usually take this journey.
(Please find an example below)

1b. Roughly, how much do you spend on this journey?

a day

a week

1c. How do you imagine your future journeys?

- ☐ I own the vehicle and only I can use it
- ☐ I own the vehicle but lease it out when it's not in use
- ☐ I would pay a premium rate for a private service
- ☐ I want to pay a mininium amount for shared public service

Any other comments:

Figure 16: Design Checklist - Cost and Quality

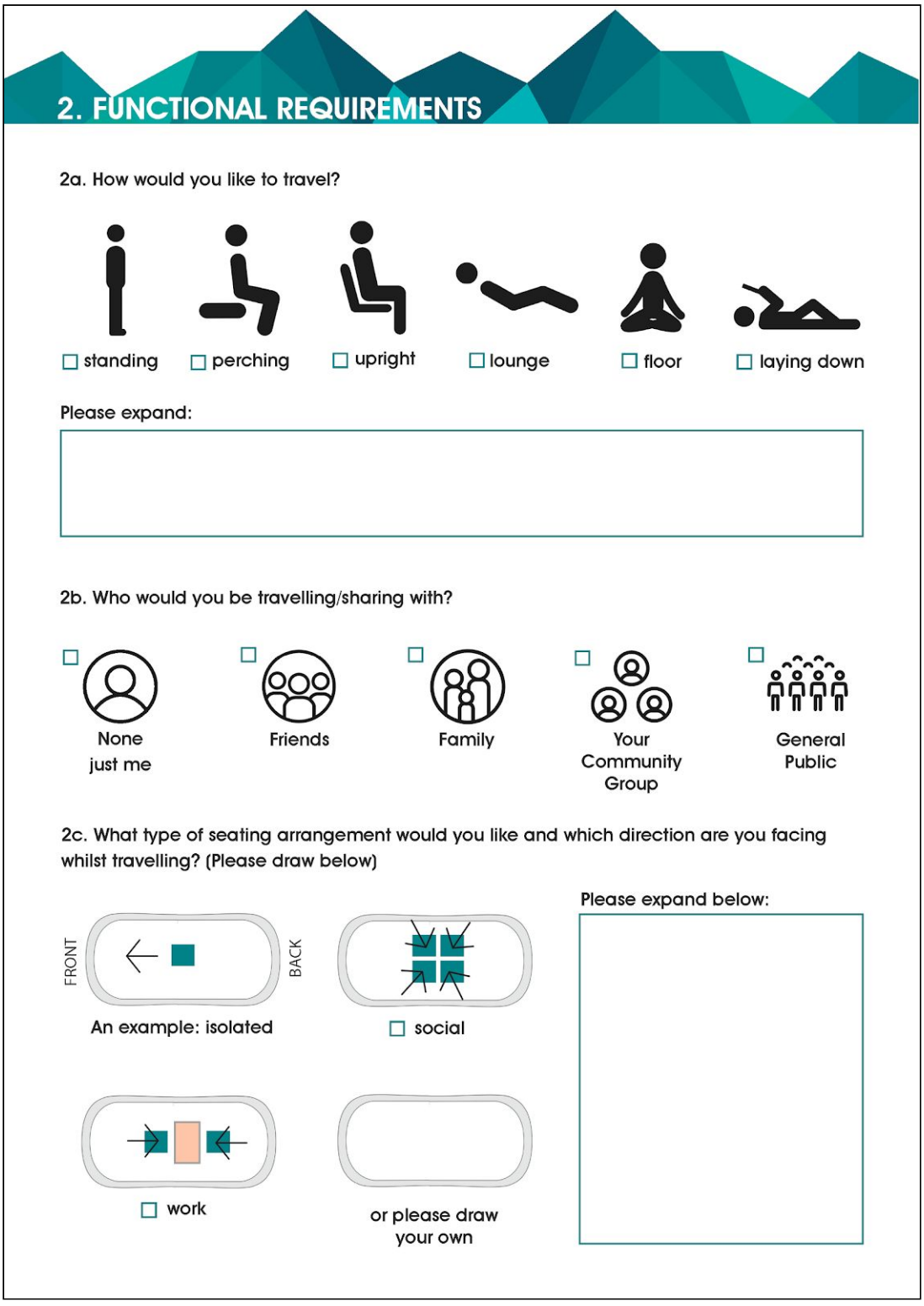

Figure 17: Design Checklist - Functional Requirements 1

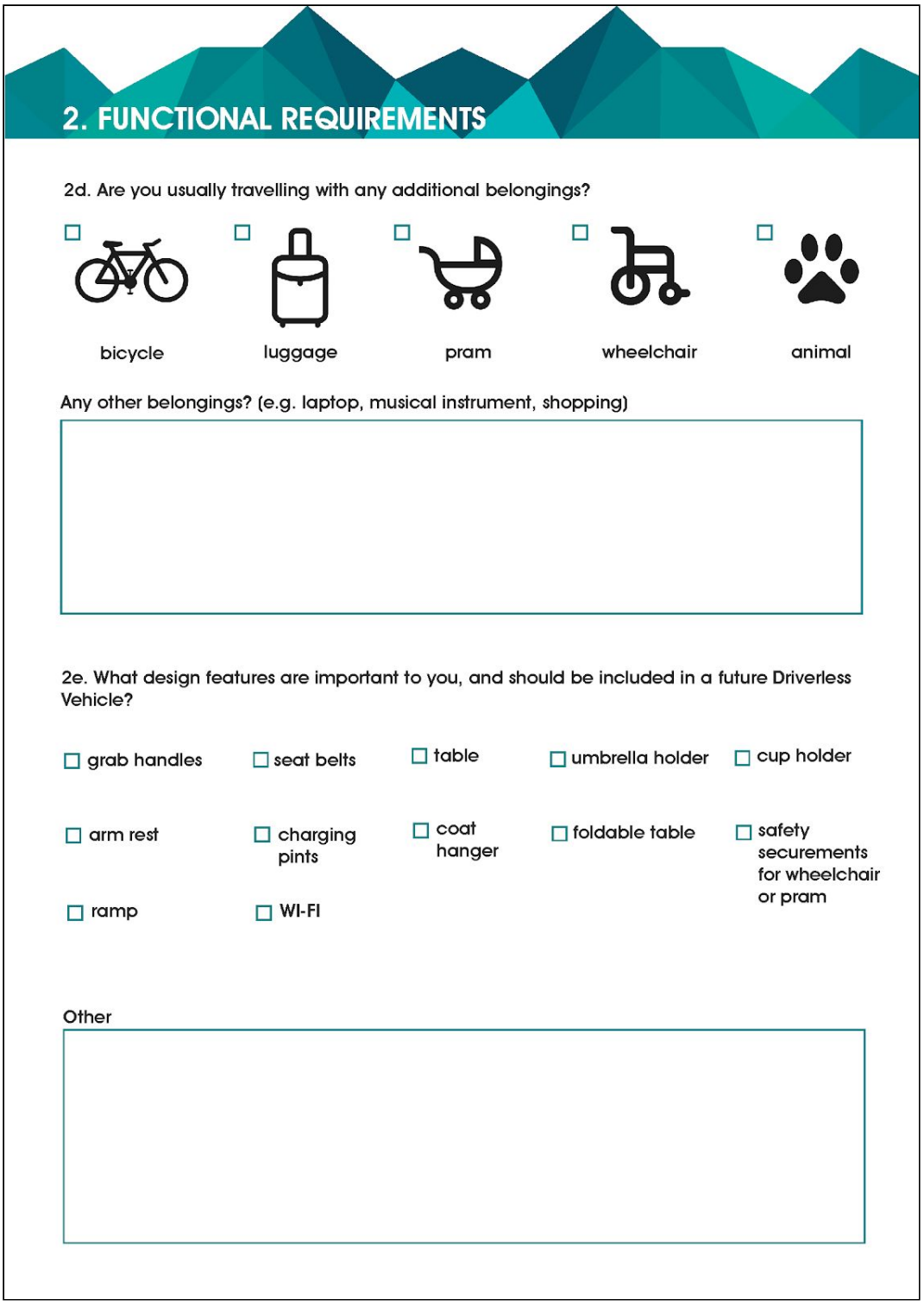

Figure 18: Design Checklist - Functional Requirements 2

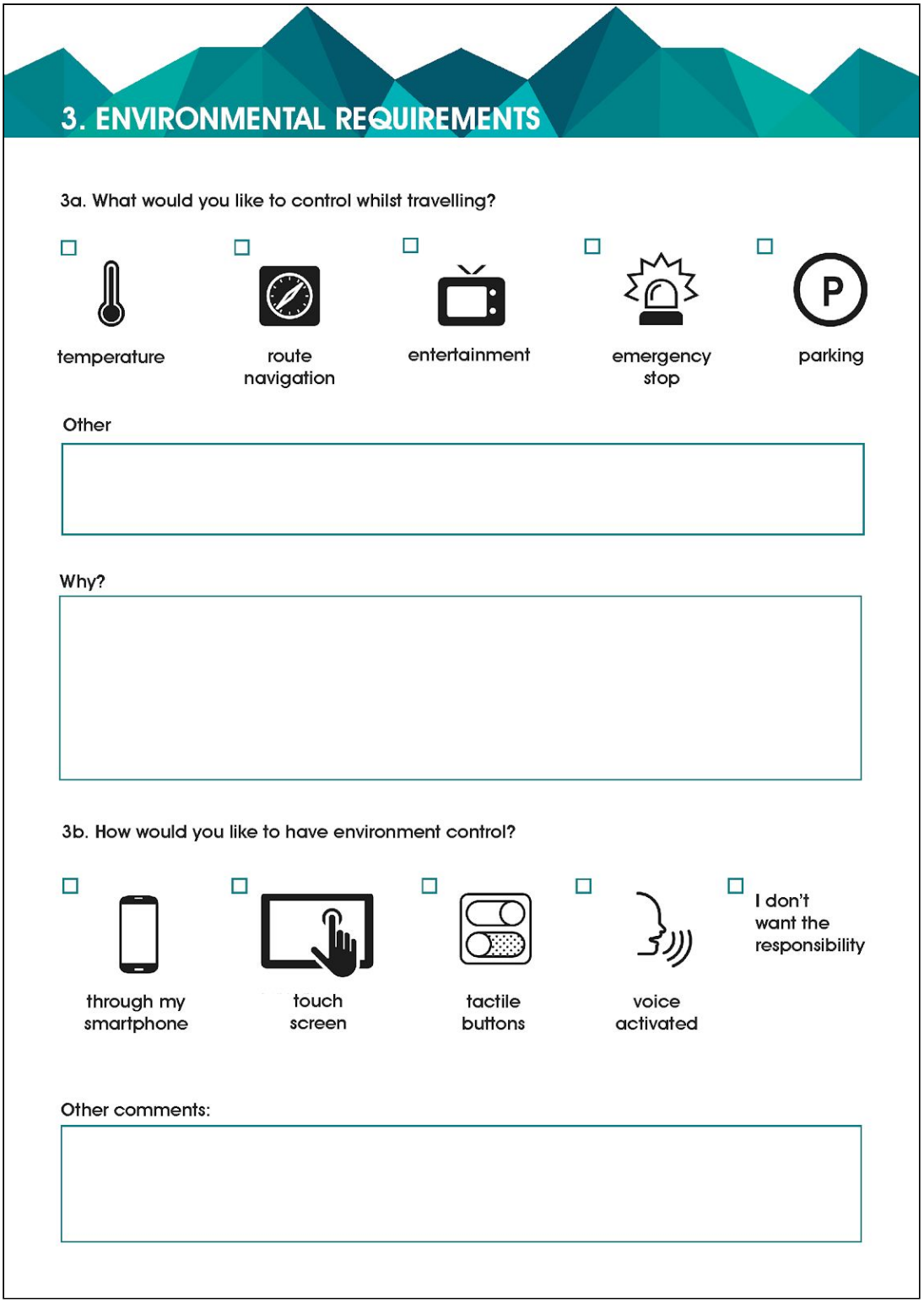

Figure 19: Design Checklist - Environmental Requirements

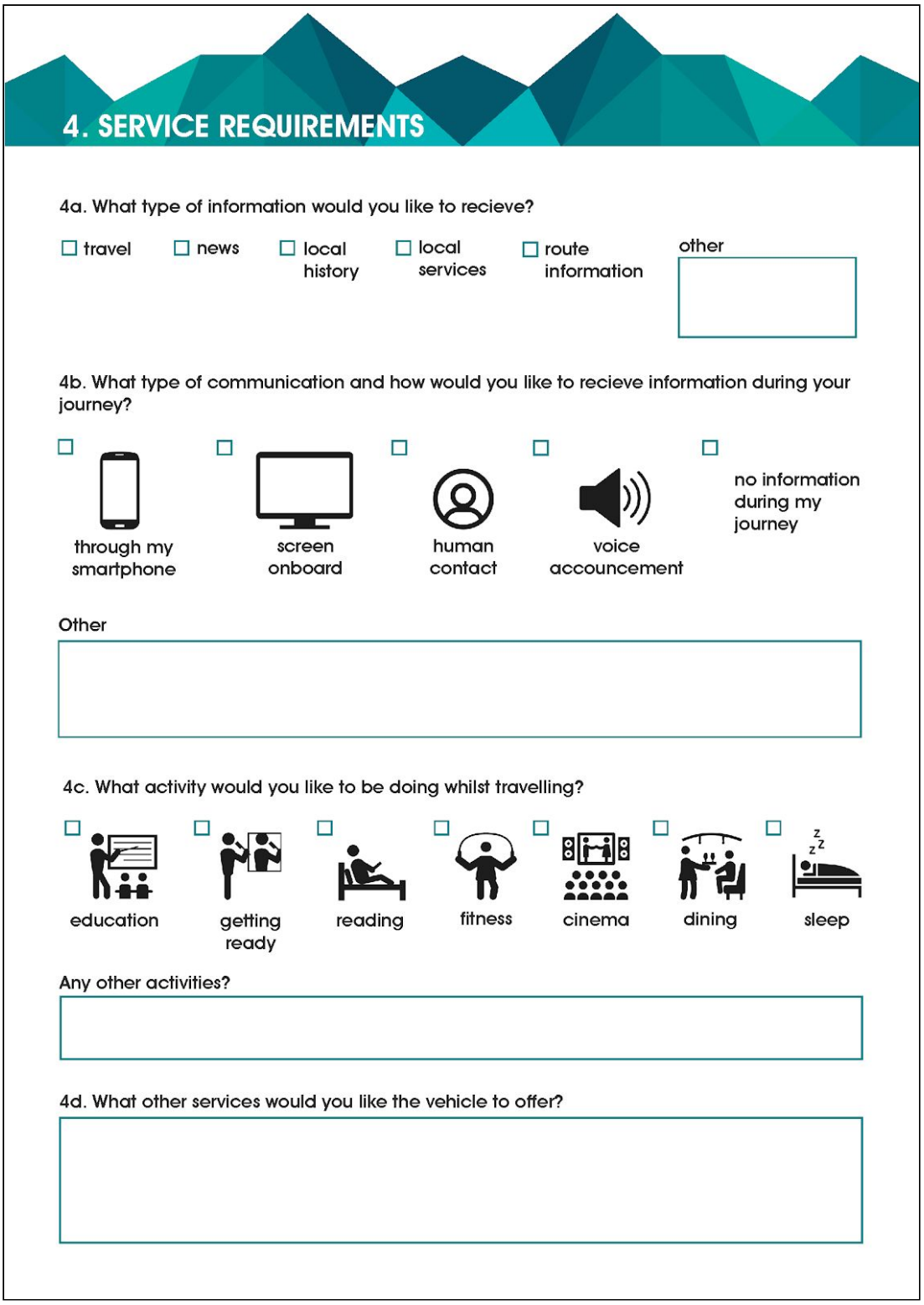

Figure 20: Design Checklist - Service Requirements

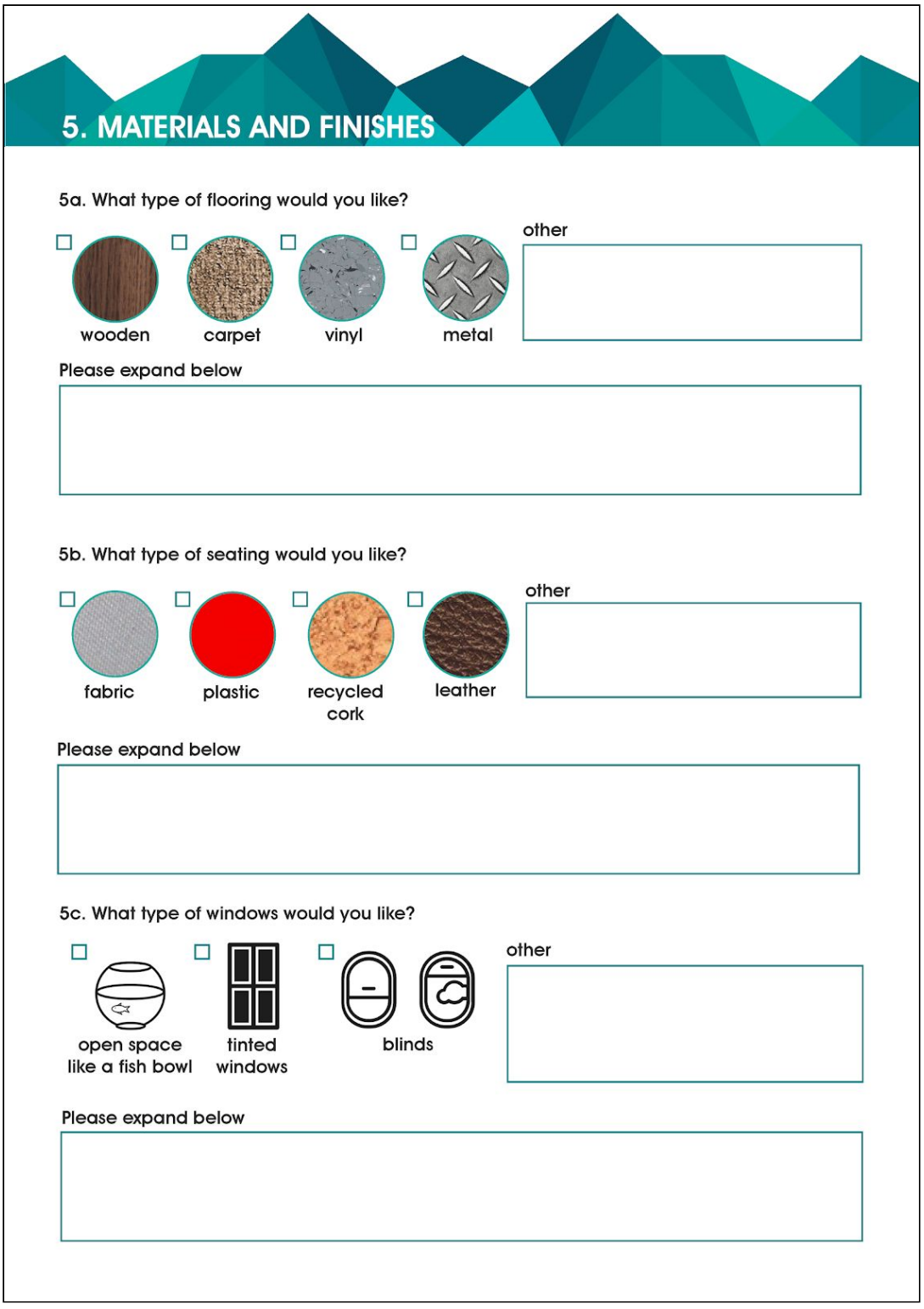

Figure 21: Design Checklist - Materials and Finishes

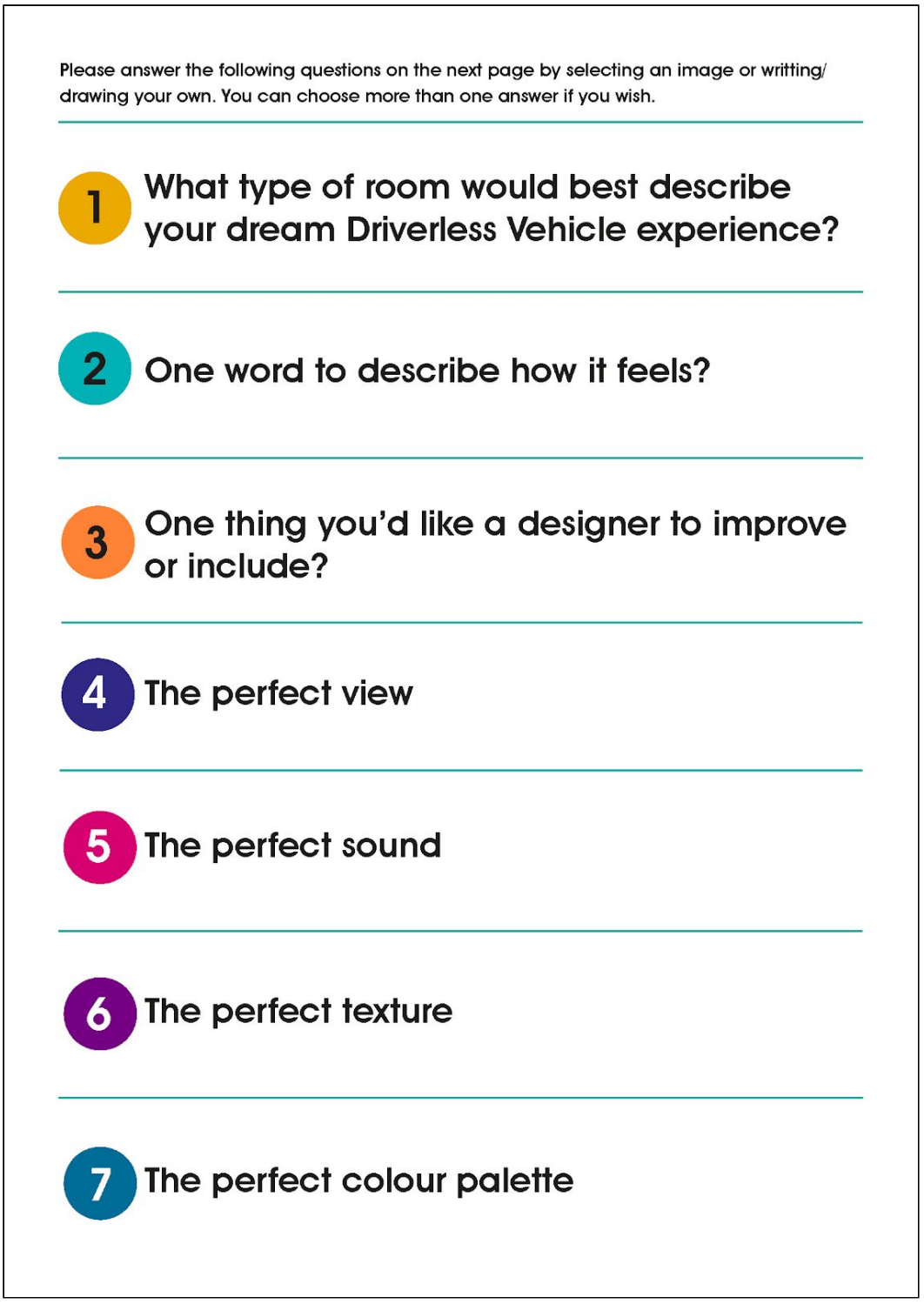

Figure 22: Design Checklist - Moodboard headings

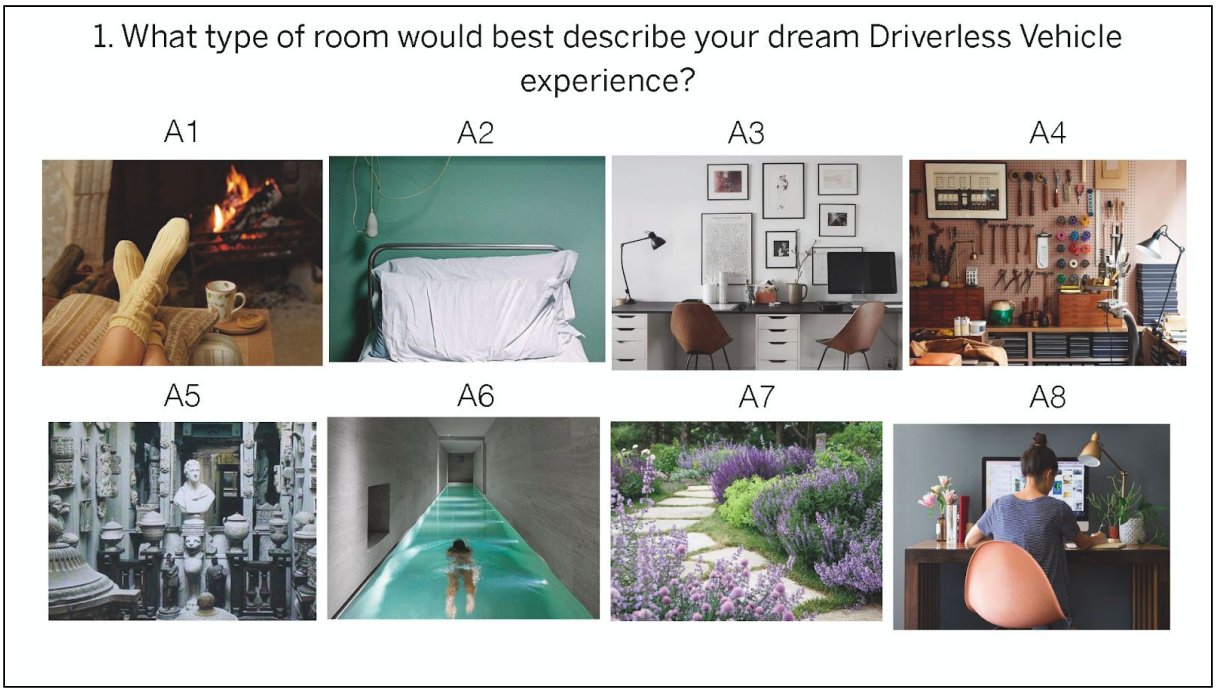

Figure 23: Design Checklist - Moodboard room 1

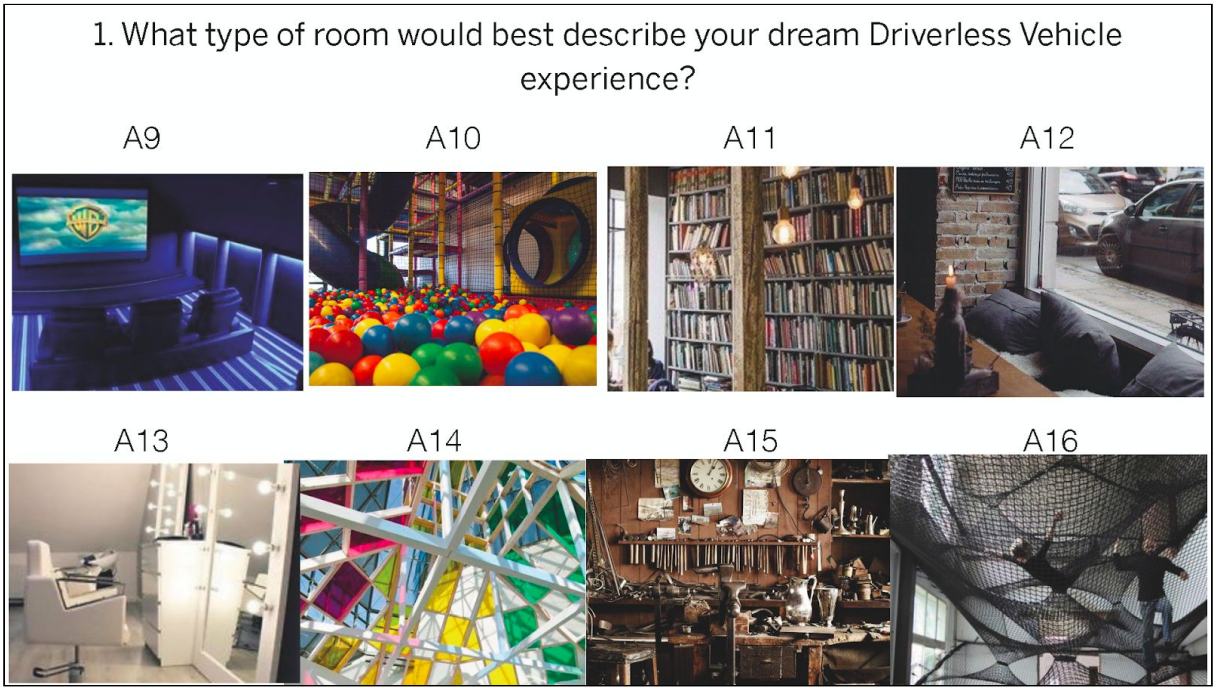

Figure 24: Design Checklist - Moodboard room 2

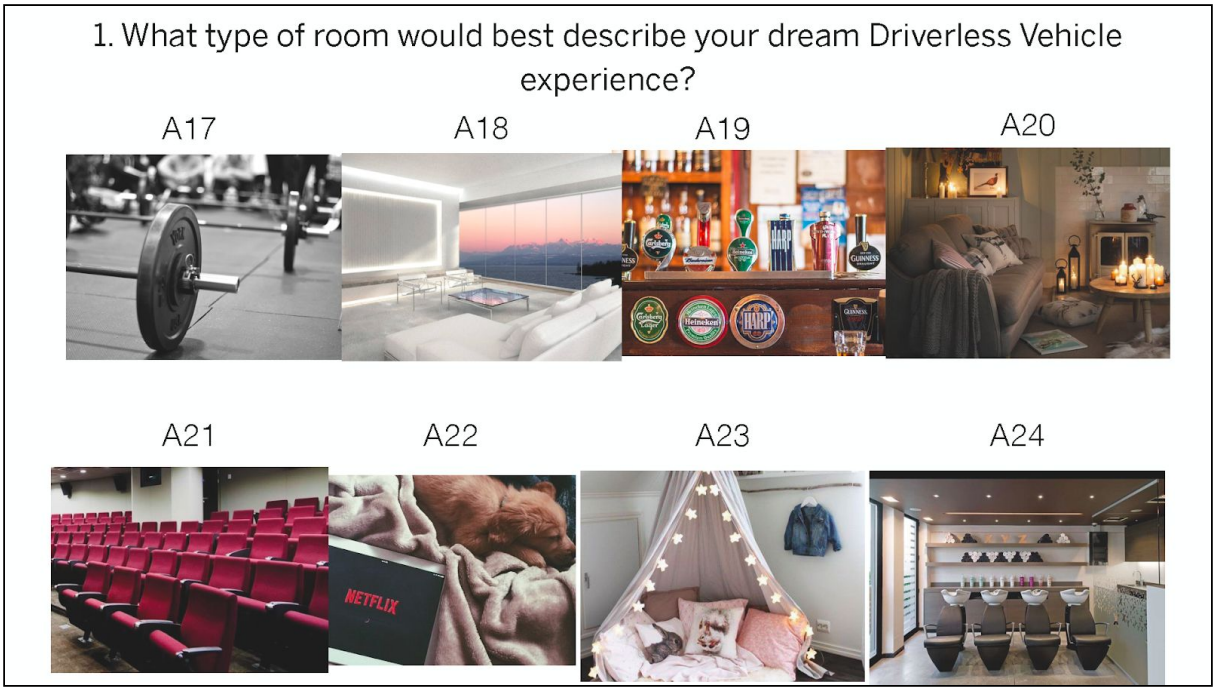

Figure 25: Design Checklist - Moodboard room 3

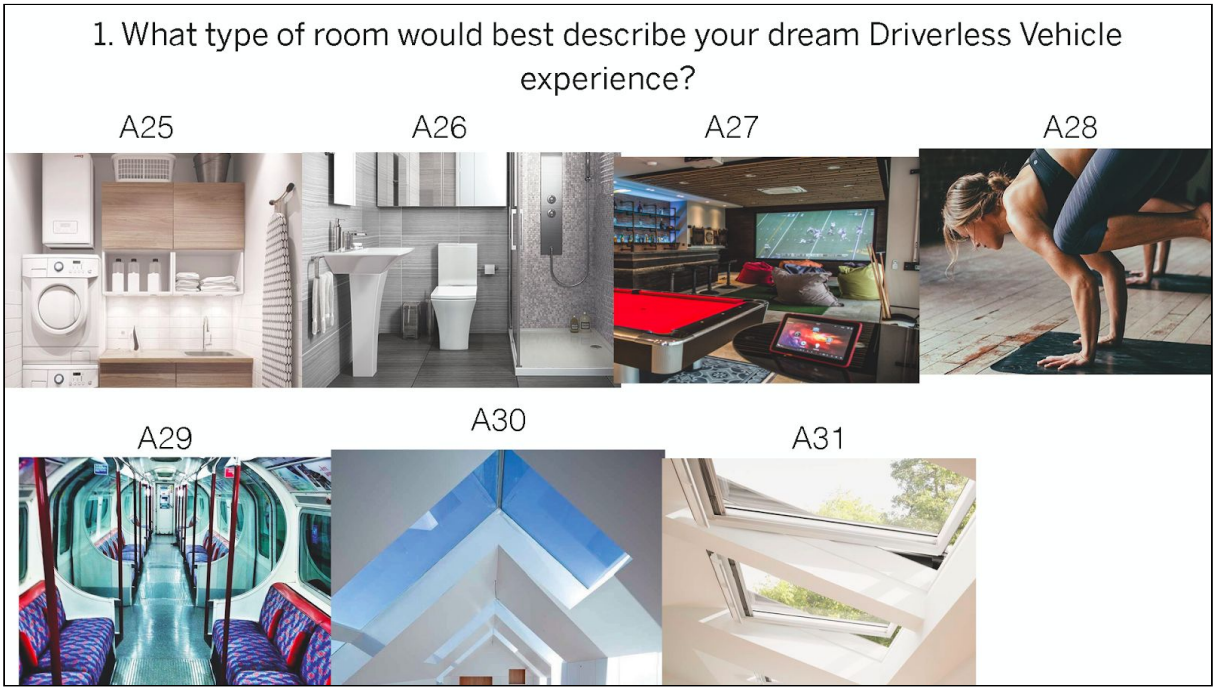

Figure 26: Design Checklist - Moodboard room 4

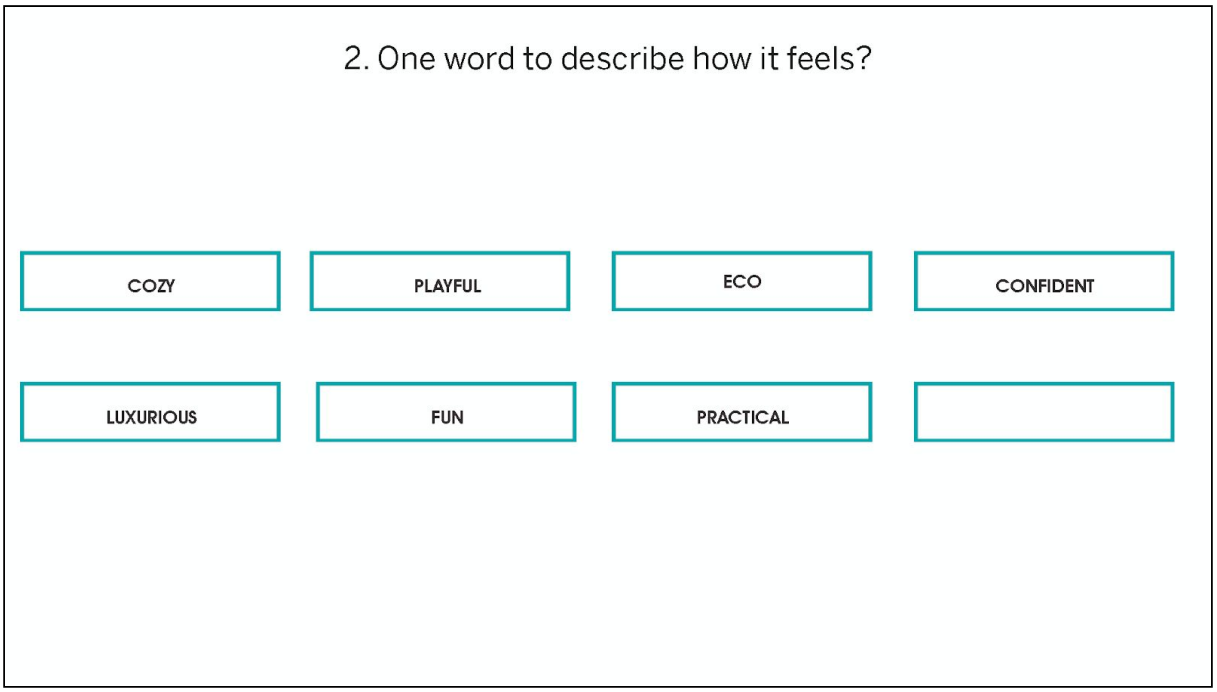

Figure 27: Design Checklist - Vehicle Feeling

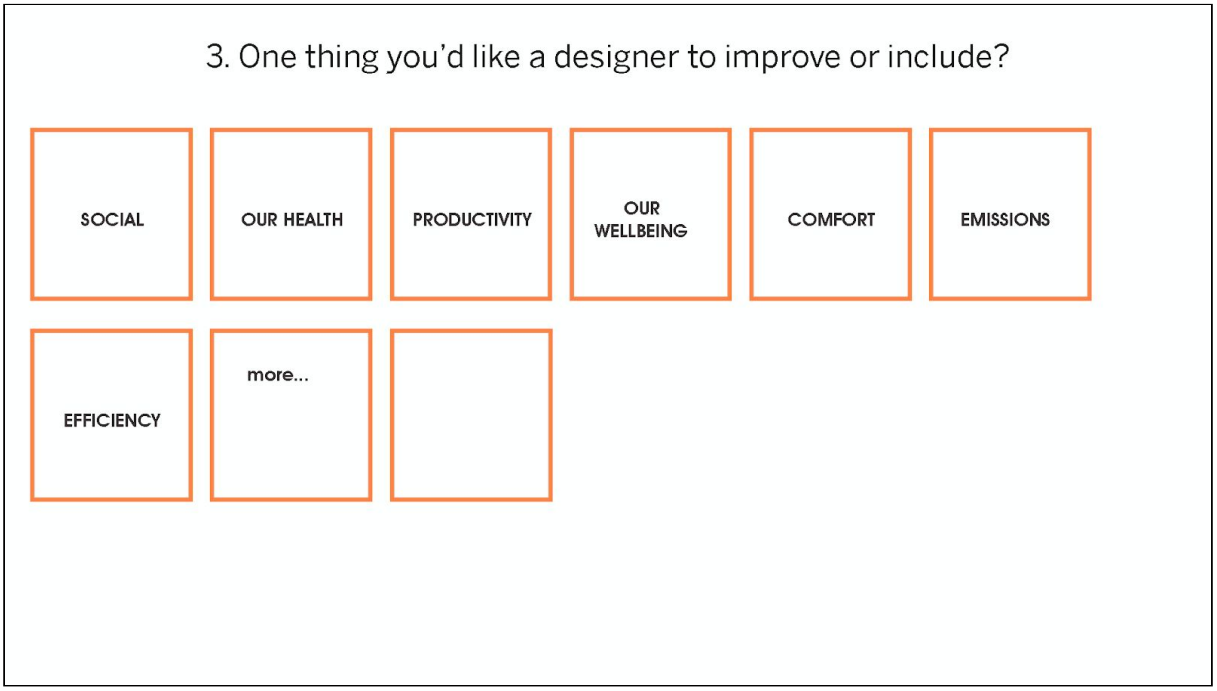

Figure 28: Design Checklist - Design challenge

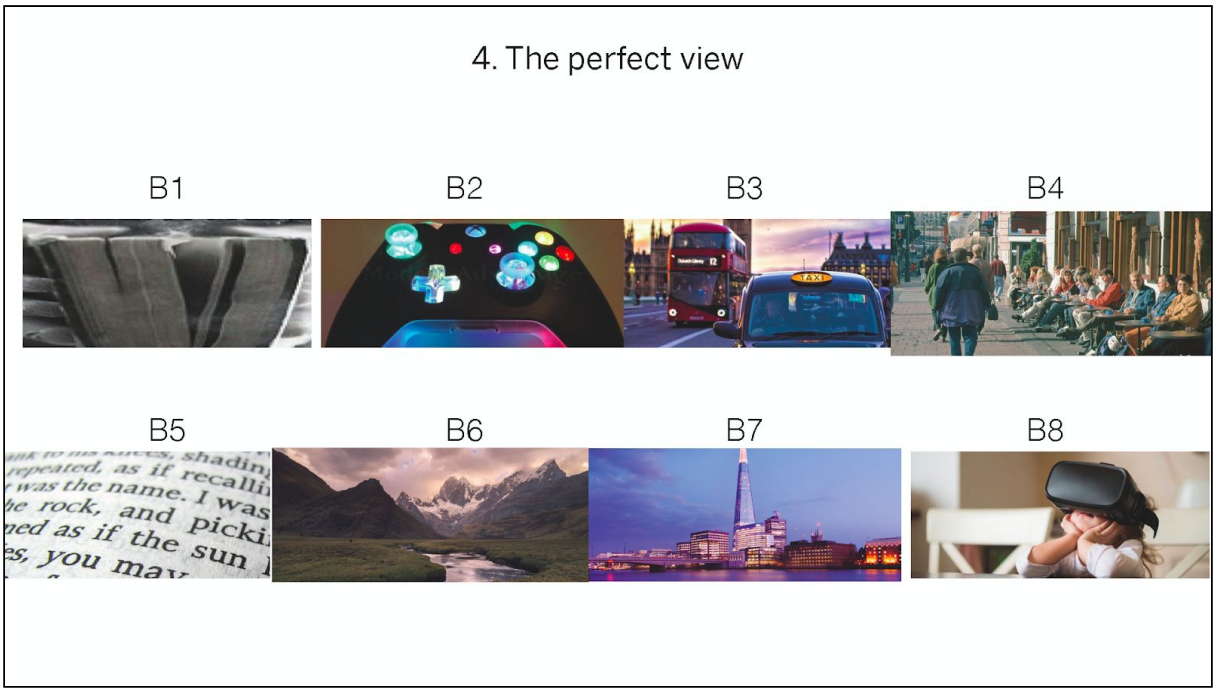

Figure 29: Design Checklist - Perfect View 1

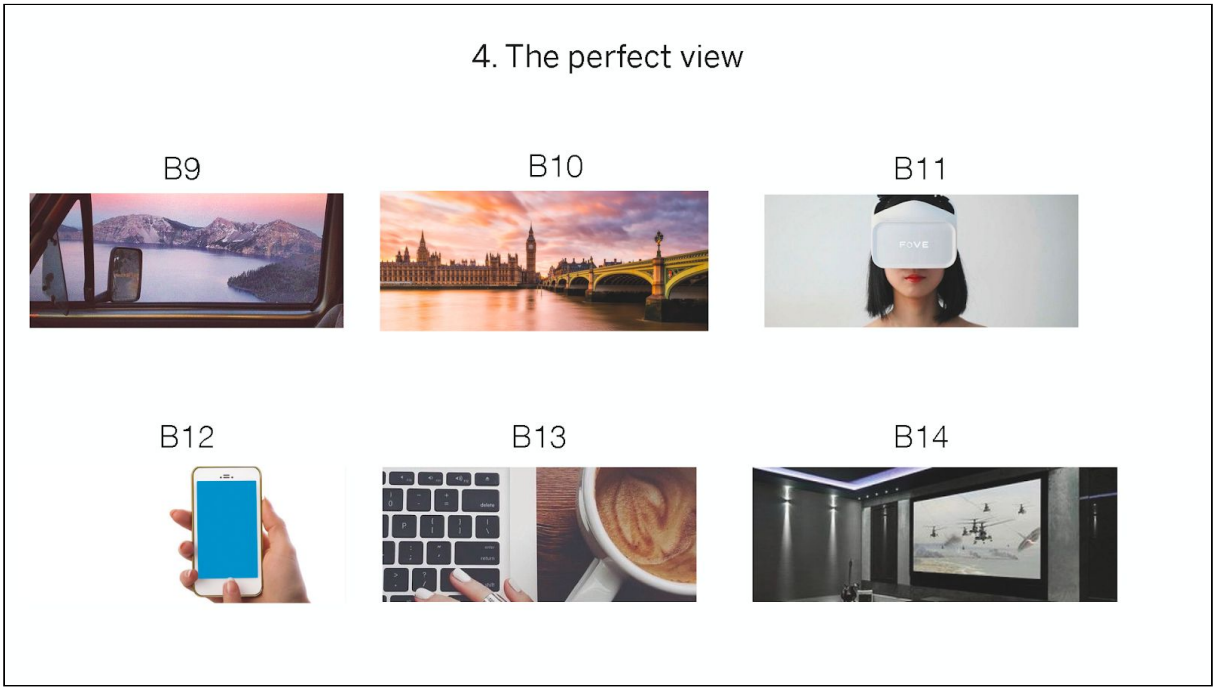

Figure 30: Design Checklist - Perfect View 2

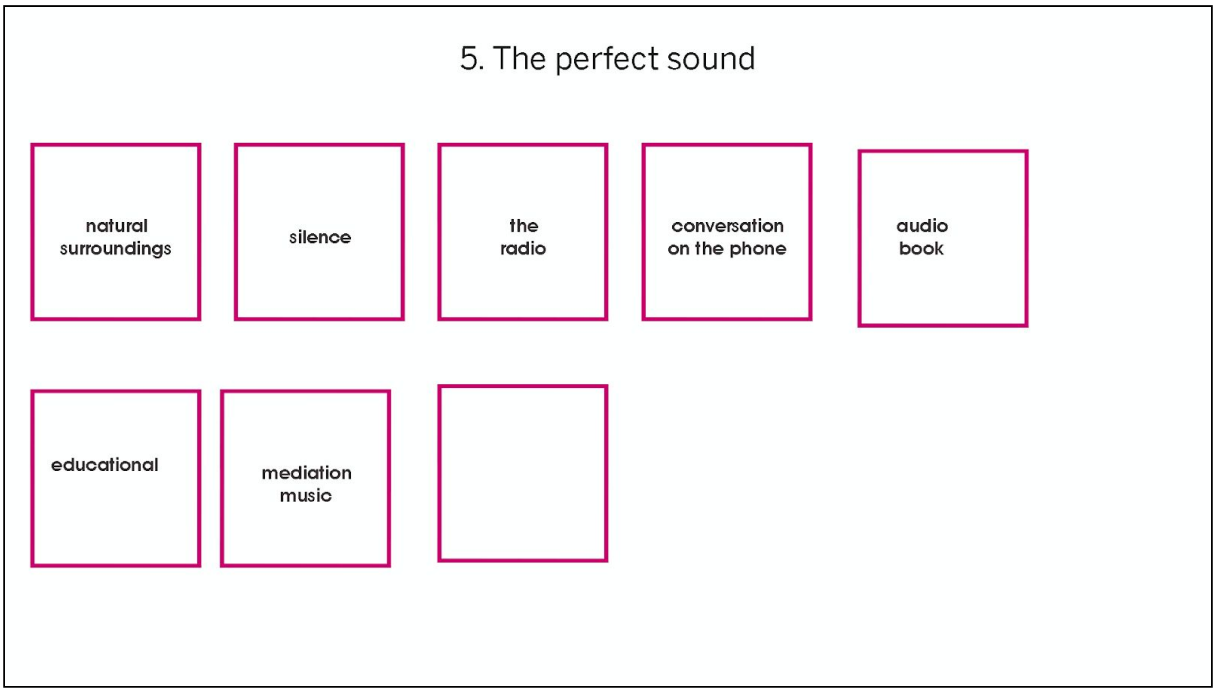

Figure 31: Design Checklist - Perfect Sound

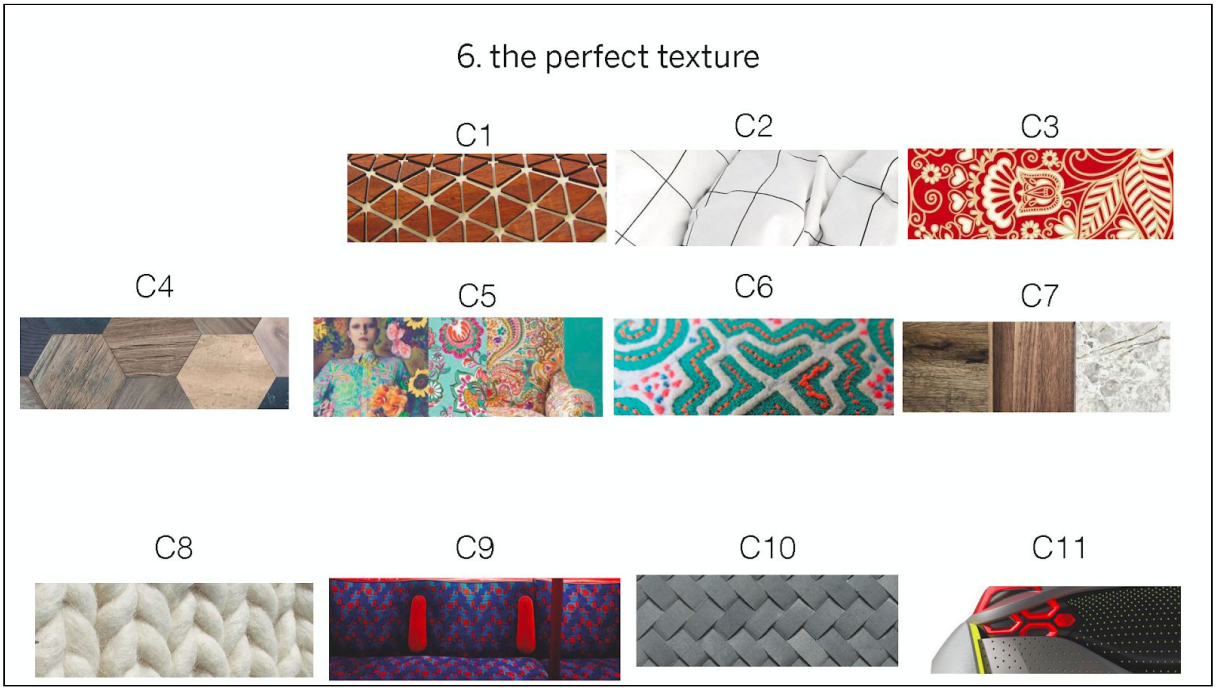

Figure 32: Design Checklist - Perfect Texture 1

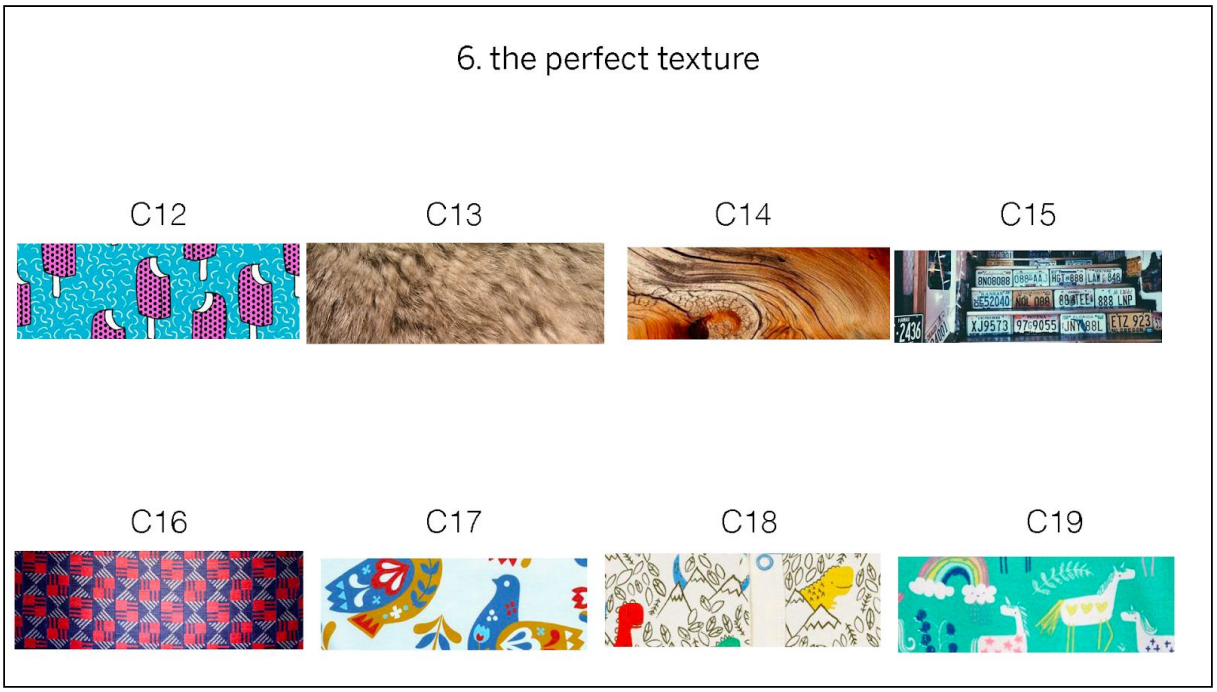

Figure 33: Design Checklist - Perfect Texture 2

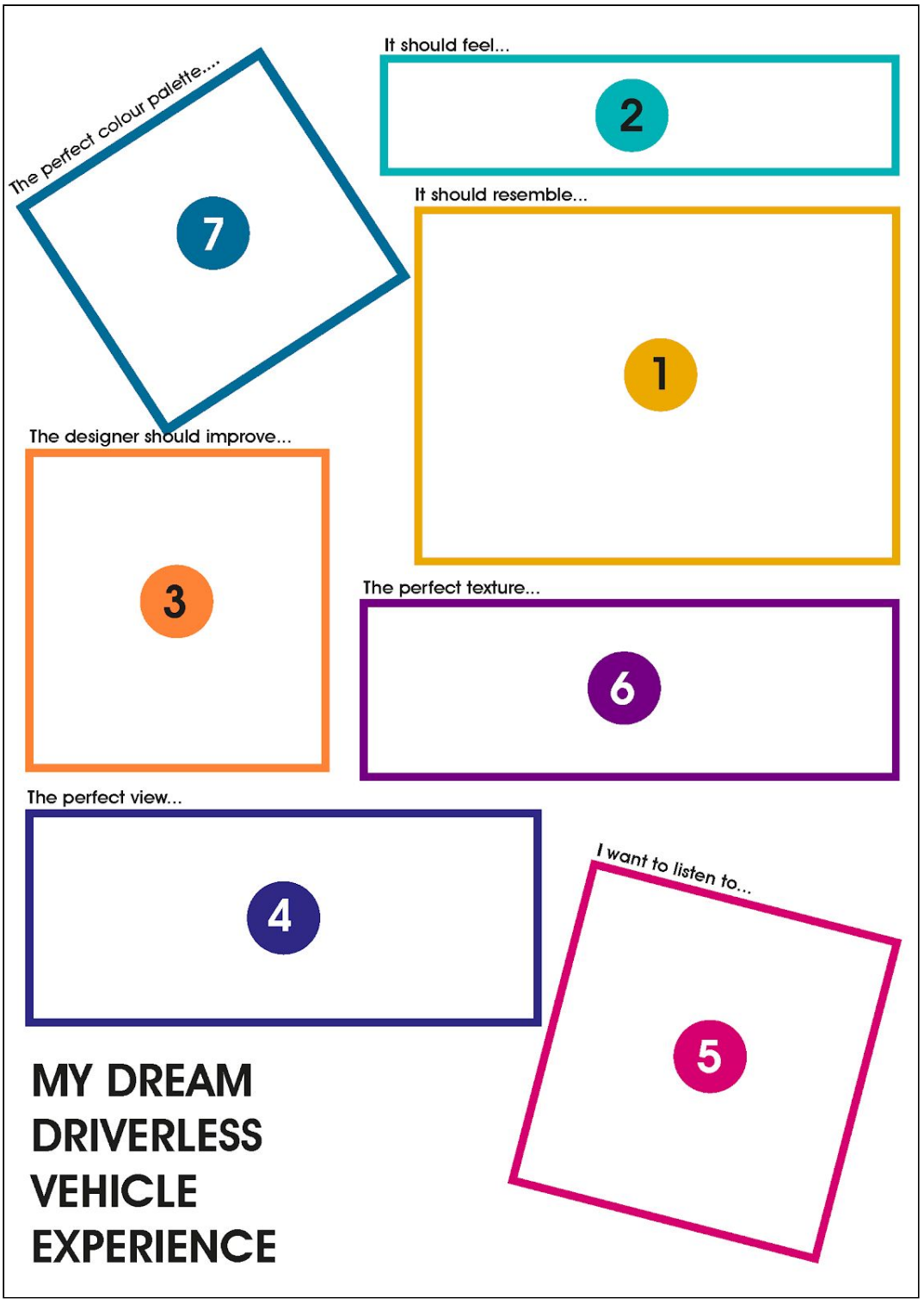

Figure 34: Design Checklist - Moodboard summary

At the end of the workshop participants gave feedback and were asked to reflect on new learnings and how they now feel about driverless vehicles:

Figure 35: Feedback including feelings towards driverless cars after workshop

4. What we learnt

The research findings have been divided into a number of sections based on the activities that participants took part in. This includes an overview of the trial experience, what people thought about the in-vehicle activities, design checklists for future journeys and moodboards associated with different demographic groups.

4.1. Trial Experience

About the participants

48 people completed the workshop activities including 16 women and 32 men. Half held a current driving license, six people had additional needs, eight were technology enthusiasts and six were classed as professional stakeholders. Their age distribution is shown below:

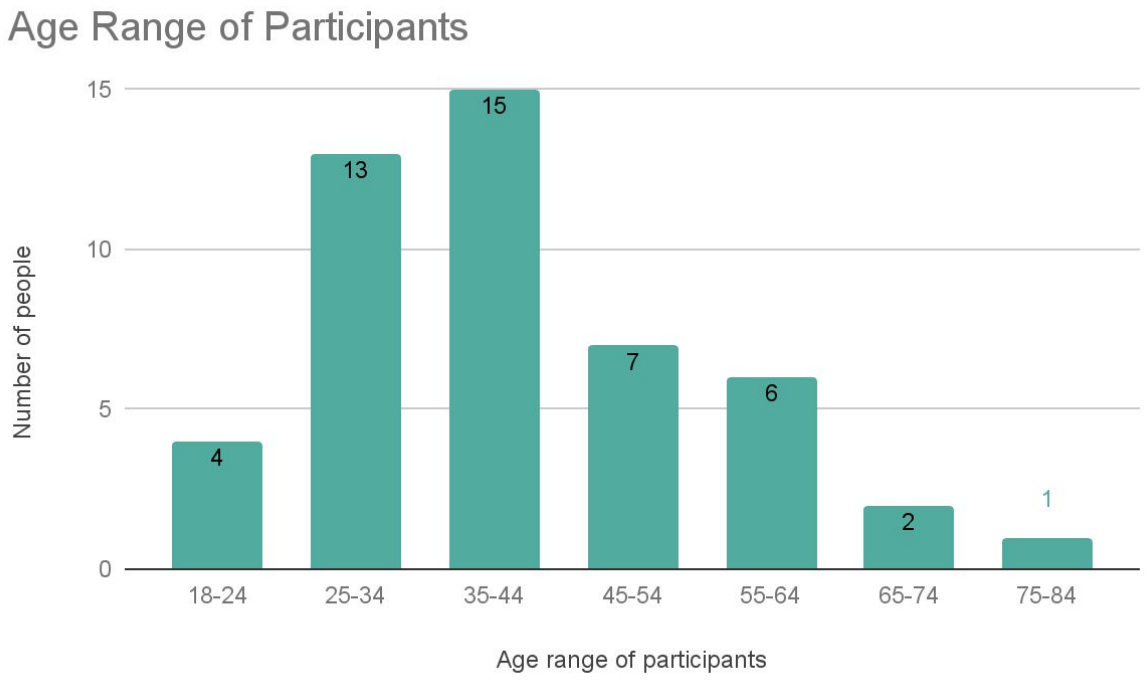

Figure 36: Age range of participants

20% thought the experience was very good, 55% thought it was good, 6.5% thought it was average, 15% thought it could be better and 4.5% thought it had potential.

Figure 37: AV experience rating

Those who enjoyed the experience did so on the basis that it was a prototype and they were excited by the future:

"I thoroughly enjoyed the shuttle ride, however there were quite a few technical issues during the journey. Very interesting to see the prototype in action"

"I think the concept is GREAT! But I gave a 4 because at least half the journey today was NOT autonomous. The rest of the journey was fine, if a little slow"

"The vehicle was a good size for the journey - there was space to comfortably do some pedal exercises and sleep if necessary. The ride could have been smoother - and faster - but it definitely has potential"

"It was fun and interesting. Experience was nice (comfortable etc.). It was a bit bumpy, stopped a few times, children staring in. But quite relaxing speed and music. Would need to go faster in real life."

"Loads of travel benefits; felt secure, social environment, effortless, relaxing, easy, comfortable and spacious, I got free pistachios"

“It was smooth, spacious and comfortable. I was surprised at how consistently it travelled despite coming across other cars/road users. Really enjoyed the views!”

“The shuttle experience in general was great. It's early days and there needs to be improvements, like more windows - so it's better clarity, more comfortable seating, better suspension & bigger tires”

Those who did not enjoy the experience focussed on the technological failures of the prototype and expressed a lack of confidence in its performance.

“The vehicle malfunctioned and so the driver had to take manual control. I was not very confident in the vehicle’s performance”

“The DLR is a more comfortable journey (in the front seat, which we always have). The DLR also goes quieter and avoids traffic. I really struggle to see why we should have autonomous vehicles over rail transport for anything other than the last mile.”

“Too many reasons - firstly the vehicle broke down due to a software fault which they couldn't rectify and secondly I don't think they received enough feedback when initially prototyping the vehicle - from a usage and maintenance perspective it's appalling”

“Slow cramped, poor view. Bumpy - made me feel travel sick, didn't drive around obstacles by itself”

“1. suspension on the vehicle was poor. This made writing, resting, and even sitting uncomfortable 2. Temperature control - didn't appear to work in the heat 3. Abrupt stopping when no obstruction present. Too many false alarms”

Ownership versus sharing

When people thought about future ownership models for driverless journeys there was a significant reduction in demand for privately owned vehicles.

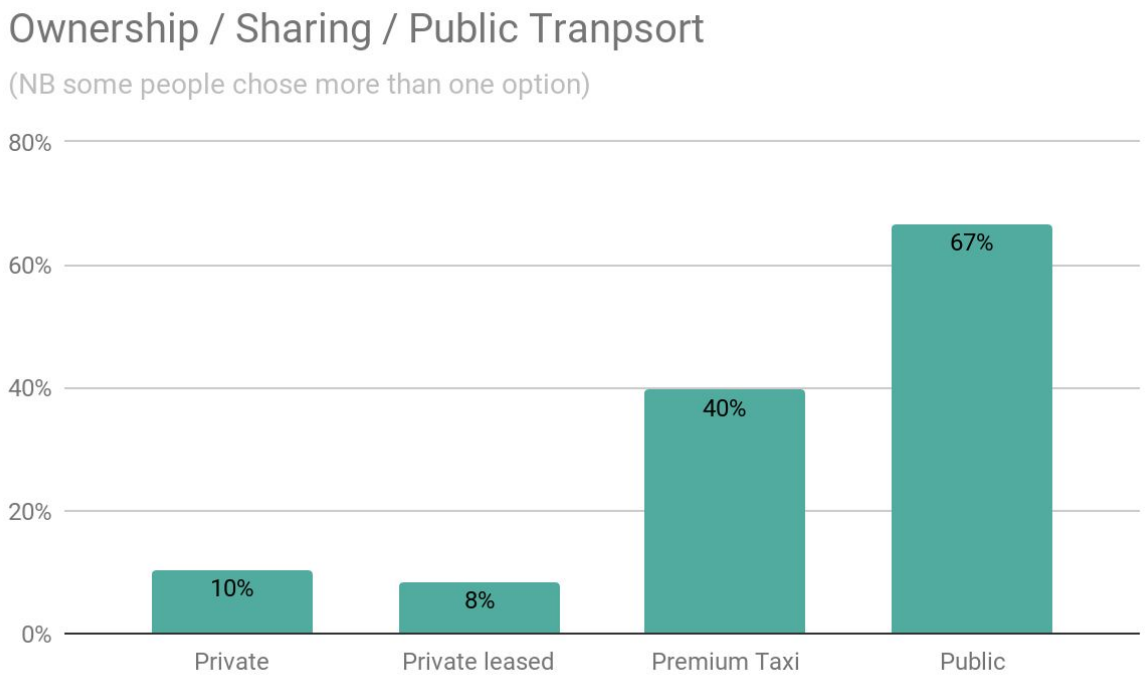

Figure 38: Future ownership versus sharing

Only three out of fifty participants wanted to use private vehicles for all of their journeys, with another five using a private car that they might lease out when they don't need it. 20% wanted to use a premium taxi-type vehicle with another 20% using a premium service occasionally. 48% wanted to use public transport for the majority of journeys with a further 16% who would use public transport for some. This points to a reduction in car ownership, an increase in the use of car clubs, an increasing demand for premium taxi services and the continued popularity of London's public transport. This compares with research by LSE that showed the largest share of Londoners—nearly half— would prefer to travel by car over any other form of transportation, with 37% preferring public transport and just 6% preferring to cycle.[1]

[1] Rode, Philipp, et al. "Towards new urban mobility: the case of London and Berlin." (2015).

Feelings towards the driverless experience

When asked their feelings about the experience most had positive things to say as seen in this word cloud of responses:

Figure 39: Word cloud of feelings after AV experience

People liked the novelty of the experience but once it had worn off many found the ride relaxing, safe and effortless.

"I liked the novelty aspect of being driven in the shuttle although this didn't last long! I enjoyed seeing some of the technology behind it too"
"It was smooth and quiet and at a relaxing pace"
"It felt relaxing - the fact that none was driving made it a calmer experience. I liked the large windows and the layout of the vehicle - it was easier and nicer to talk to other passengers as seats were facing each other"
"Private shuttle, sheltered from the weather (but too hot) comfortable seat, innovative"
"No need to pay attention: the entire travelling part was entirely effortless. Allowed me to do other things or relax"
"There were no moments of anxiety or any problems due to bad navigation etc. The

experience was quite novel. The views are good and it was possible to see and enjoy them. It is nice to experience an emerging technology. I quite liked the more upright seating- also compared to a conventional car"
"I liked being able to spot landmarks and see clearly out the windows, being able to socialise with others and traveling at a constant speed"
"The ease of it. Easy to trust, easy to relax or not concentrate on what was happening outside and easy to see myself using a car like this in the future"
"The ability for us all to be sociable and able to interact and engage with each other; the tasks were great. Young mother of 2 children, sharing the journey with a blind and an elderly person and it felt amazing to know this solution could really benefit and enrich our lives."
"The fact that it's early 2017 and I rode in a driverless prototype! In 5 years these things will be everywhere, in 10 years the global transport system will be transformed - safer, faster, cleaner, cheaper- we are on our way!"

People's dislikes included both the technical failures and the design of the environment and support systems

"I didn't like when it would stop abruptly without explanation and I could not understand why it did this."
"Vibrations, view blocked, speed, suddenness of stopping"
"Mixed feelings about the speed, it was relaxing, but in reality I would probably want to go faster. Good if had handrails and more seat room"
"To have a fold down /stow away table would be nice, that was the only part that was a bit tricky."
"No big front window. No ability to change route, navigation and need for manual intervention needs work. No sensors monitoring road condition to try to provide comfort. No ability to drive in different direction. Limited room in vehicle."
"Not able to open windows, table too low, no bin to put food in, not being able to fully see out the front and back. Too busy doing tasks to appreciate the experience"

4.2. What people thought about the in-vehicle activities

Over the course of the trials, nine different activities were tested that might take place in future driverless vehicles. This section gives an overview of what people thought about the activities and whether they might do them in a future driverless vehicle.

Future Commuters

Figure 40: Commuting participants

Future commuters thought they would *rest, relax or be productive* (if they were being paid).

"I'd either sleep or ideally do some work, if my employer counted the time in my working hours"
"Probably listen to something, work or check social media"
"Read, watch TV, have wifi connectivity at all times so allow me to be productive with my
"Also being able to look outside, while having a nice clear view

During the 'commute' participants were asked to use a tablet or mobile phone to send email, do some exercise or have a nap.

Send an email

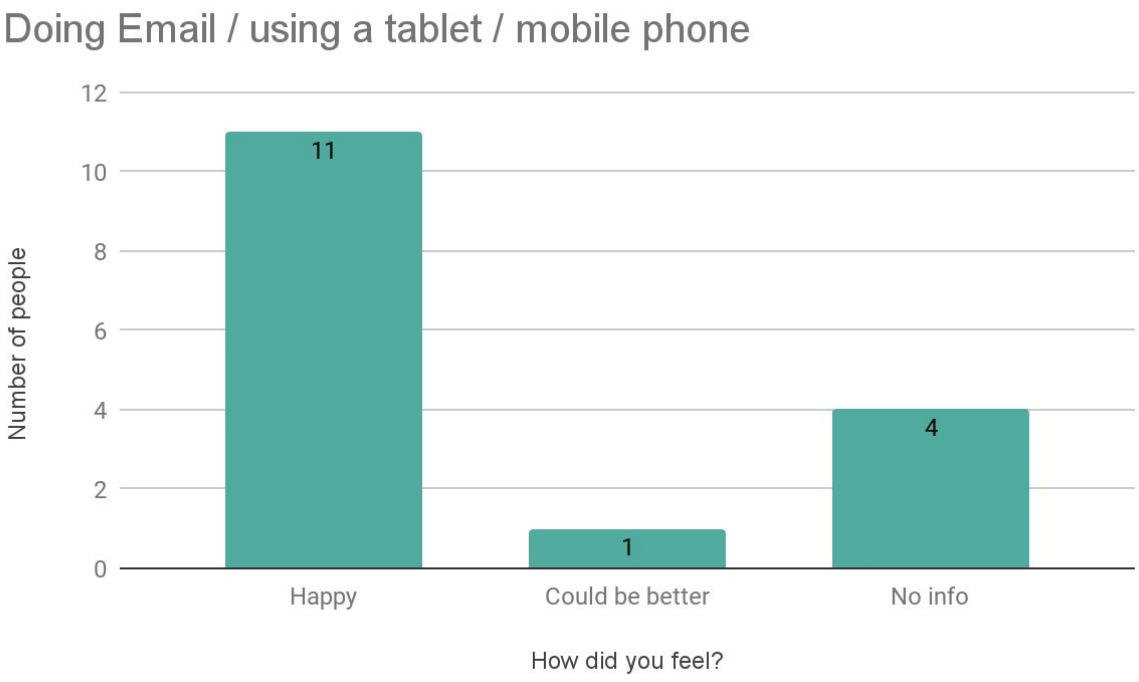

Figure 41: Feelings towards doing email on journey

Most people were happy with this task and thought it was a comfortable, easy and natural activity that many people already do whilst travelling to work.

Improvements to enhance the experience included better suspension, free wifi, charging points, fold out tables, a reading light, sunshade, an armrest and voice recognition.

"If the table was hardwired into the chair (like an airline table) it would be much easier to write the emails. It's an easy and great place to work though. Really comfortable and feels authentic and realistic"

"A little difficult to write, so a smoother journey would help"

Exercise / Meditation

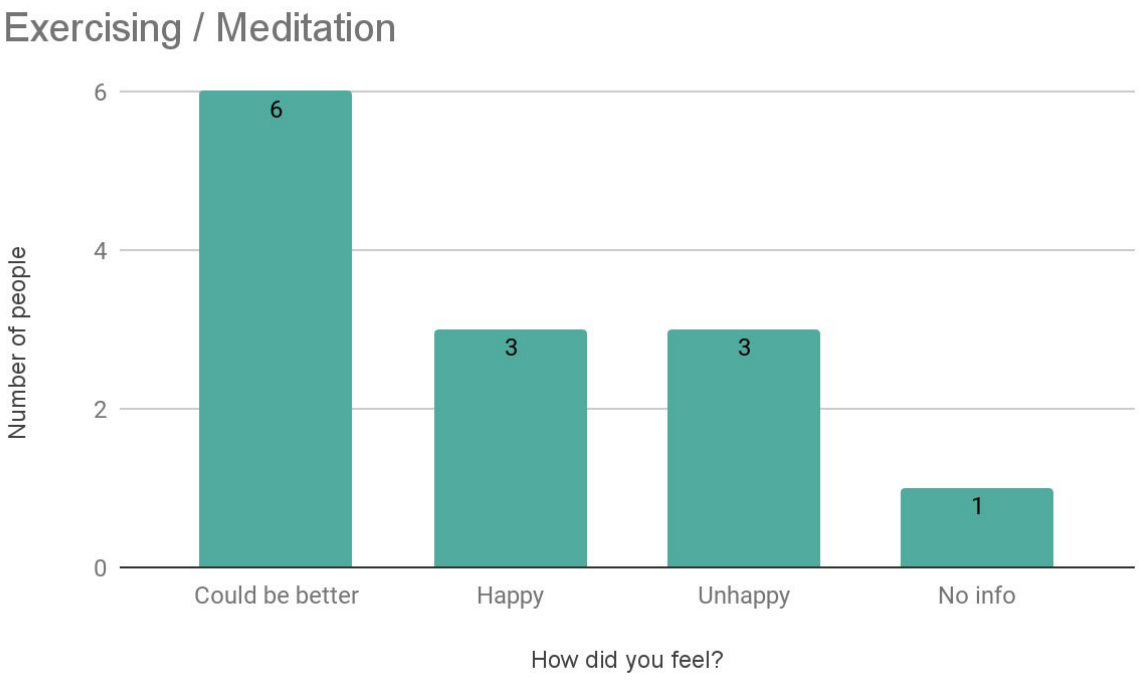

Figure 42: Feelings towards doing exercising / meditating on journey

Participants were given the option of doing some physical exercise using a pedal exercise machine or a pilates ring or try to meditate.

Overall, this was one of the least favourite activities to perform in the shuttle. People felt uncomfortable performing exercises in front of strangers and the environment was not conducive to exercising or meditating. Even though it wasn't popular some people thought they might meditate or do exercise in a more private environment.

Key improvements included doing this in a privately owned vehicle, integrating exercise equipment or activities into the vehicle, providing more space, improving the environment with air-conditioning and providing privacy blinds.

"Felt very odd to be pedalling. I would prefer to face the direction of travel"
"It was fun and easy to exercise using the equipment. Perhaps better quality equipment, adapted for personal use"
"It was fun to do but can't see myself doing it in a shared pod. Built in equipment would improve experience"
"The layout of the car doesn't really lend itself to exercising. Meditation yes absolutely."

Have a nap

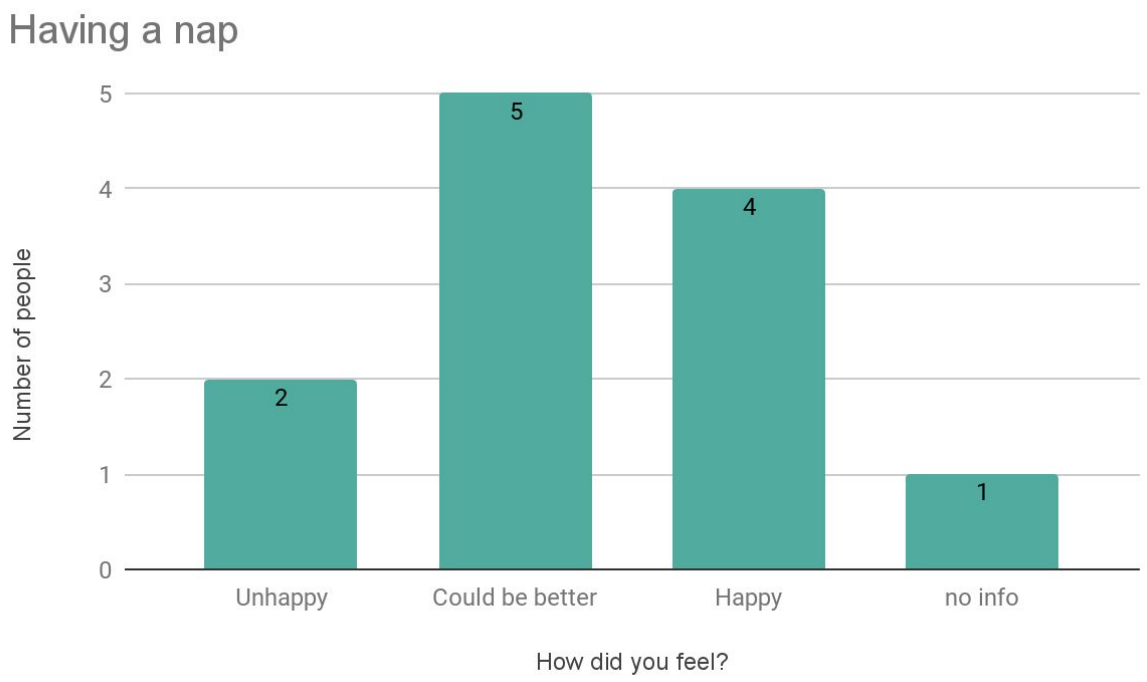

Figure 43: Feelings towards having a nap on journey

Activity three allowed people to use a blanket, neck cushion and eye-mask to have a nap.

Most people could imagine doing this in a driverless vehicle but the shuttle was not the ideal environment to test it because the ride was uncomfortable. The experience could be improved by ensuring the ride was smooth and quiet, providing reclining chairs, lumbar cushions and winged seats to provide improved support. Some mentioned privacy screens, blinds and even a flatbed for a longer journey.

“Totally comfortable. Could see myself taking a nap on a long journey”
“Sleeping is one of the things I am brilliant at - eating is the other”
“Impossible as the ride was so bumpy and neck support was not full inflated”
“I don't think i'd ever want to nap on the way to or from work. I've never done it before so I don't see why I would”

Future Shoppers

Future shoppers could easily imagine using a shuttle for future shopping trips where they could do other things whilst the vehicle kept them safe.

"The ability of Harry (the name of our prototype AV) to safely shop should circumstances require. Size of vehicle. Potential to keep aging population mobile"
"Although it seemed rather small from the outside, the internal space was simple for 4 of us, each with a bag. I had full confidence in the shuttle to drive safely, probably helped by the slower speeds we were travelling at."

Creating a shopping list

Figure 44: Feelings towards writing a shopping list on journey

Activity one allowed participants to prepare for a shopping experience and write a shopping list using a notepad and pen. Overall, people mentioned that this was an easy, time efficient activity and they could see themselves doing it in the future. A few people found the ride too bumpy to write, or that looking down for a prolonged time made them feel sick.

Key improvements included providing voice recognition to dictate the list and to suggest shops to visit based on the route.

"Good use of time. Able to complete fairly easily."
"Cannot write in that environment. Would have already done it anyway. Time pressure - it took me 10 minutes"

Wrapping a gift

Figure 44: Feelings towards wrapping a gift on journey

Most people could imagine doing this on a future trip and some already find themselves wrapping presents in their car if they are running late. Key improvements included a smoother journey and a foldable fixed table, so both hands could be used.

"You need to imagine this as a train experience not bus."
"Previously I have wrapped a present in a car. This is more time efficient"
"I really wouldn't wrap a present in a moving vehicle"
"A bit all over the place. I kept dropping things + the table wobbled. It was easier than in a normal car though"

Having a massage / relax

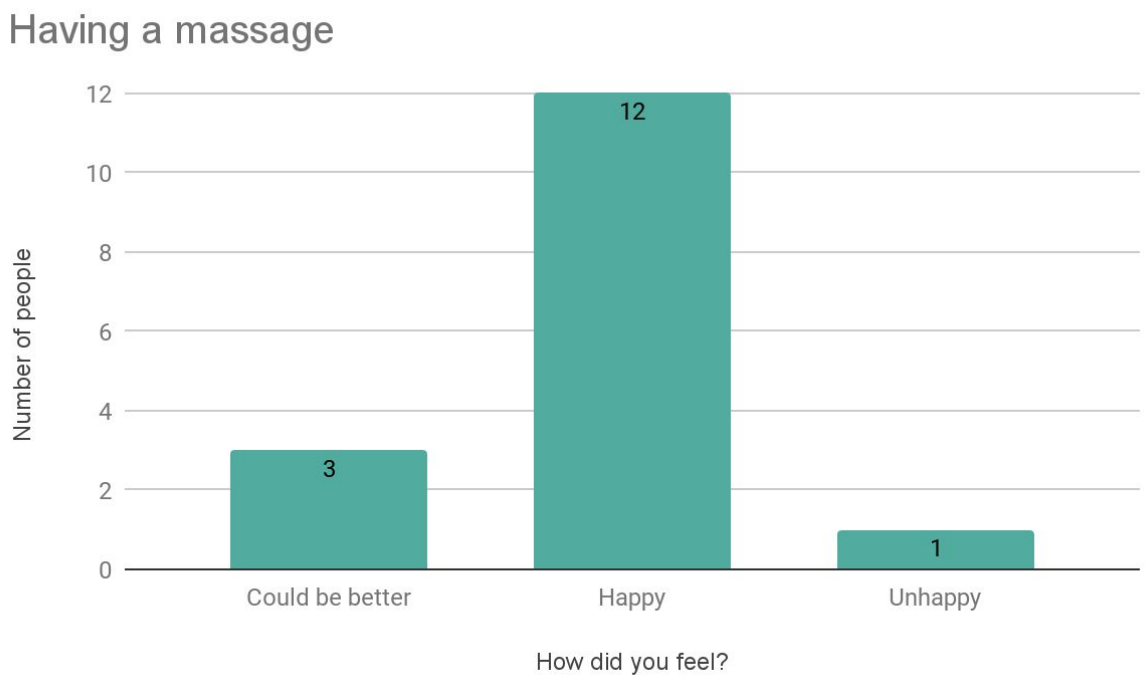

Figure 45: Feelings towards having a massage on journey

People could imagine having a massage on future trips, particularly on longer journeys where you can stretch your legs out and take your shoes off. Those who did not enjoy the experience, felt like it was an odd thing to do in front of strangers and would prefer full privacy in a private vehicle.

Key improvements, included air conditioning, the massage equipment being built into the vehicle seating and also if the seating could recline.

"while stuck in a traffic jam this felt fairly relaxing"
"It was a completely uneventful time. The massage was pleasant and it was like riding in a private tube carriage."
"It was nice, especially being able to take my shoes off"

Future Leisure trip

Future leisure trippers enjoyed the experience of going to a party and could imagine doing this in a future vehicle provided they were with friends and family rather than being on public transport.

“A very smooth journey, great to socialise and have enough space for the game. The car is comfy and spacious and has enough windows to make it feel safe.”
“During game play you forget you are riding in a car. It's bumpy on the cobblestones but you aren't focussed on the driving - it is incidental to the activity inside and the interaction with the other riders.”
“The vehicle will need a better suspension system before people will be able to apply eye-make-up! Other than that, it was easy and straightforward to change into party gear - a great timesaver to be able to get dressed on the way.”

Playing a game together

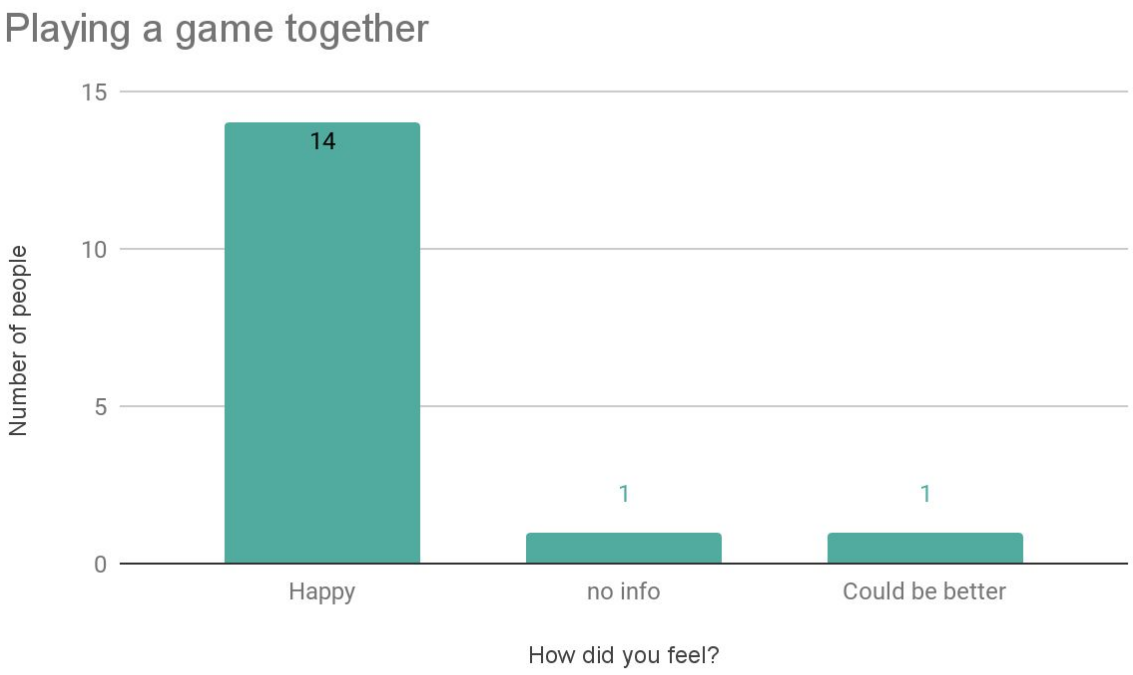

Figure 45: Feelings towards playing a game on journey

It was easy for participants to set up and play the game whilst travelling, creating a great ice breaker for social interaction with fellow passengers and taking their mind off the fact they were in a vehicle. Those who did not enjoy playing found it impractical and made them 'feel a tad car sick"

Improvements included building the playing surface into the vehicle, providing a place to store games, using a computer instead of a board game and having a higher surface so people didn't need to bend down.

"I can imagine a car full of happy children, and friends and family etc."
"I felt like I was at home and was excited that I could actually play a game while travelling."
"It was fun to socialise during the journey"
"A larger interior with an automated gaming table system - press a button and up pops the card table or chess or billiards…"

Having a drink and a snack

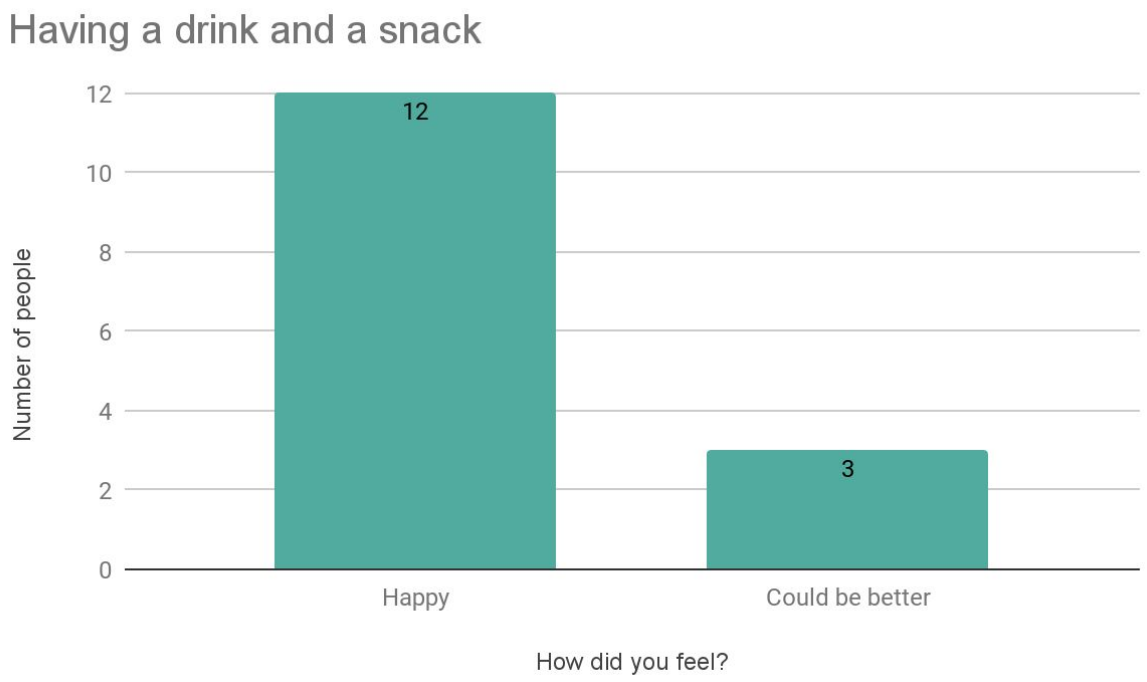

Figure 46: Feelings towards having a drink and a snack on journey

Everyone enjoyed eating and drinking on the move despite the jerky ride and the occasional emergency stop.

"Nice to relax with food and share conversation about local landmarks"
"We used the table in the middle and ate together. I love socialising and I love meeting new people. I would not mind sharing the vehicle but it depends on the people - if someone is drunk that would be strange."
"Ok but awkward unpacking the bag due to lack of space and I experienced some motion sickness"

Apart from better quality food and drink, key improvements included somewhere to store snacks (potentially including other kitchen equipment to keep things cool or warming them up), tables and cup-holders integrated into seating and a place to dispose of rubbish.

Getting ready for a party

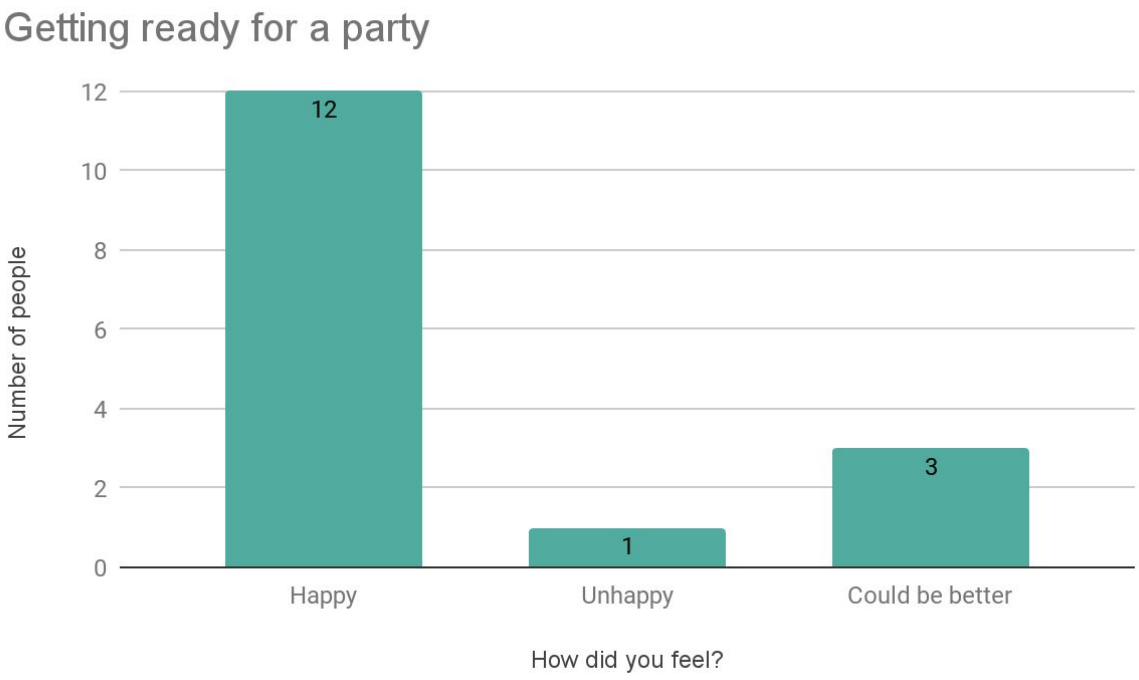

Figure 47: Feelings towards getting ready for a party on journey

Most people enjoyed dressing up despite the lack of space and the bumpy ride.

"It felt like i'd stop being late for things as my journeys would no longer be 'dead' time"
"I loved getting ready for a party and do so frequently on the move. This felt very stable"
"The blue wig didn't suit me"

Some people would not do this in a vehicle due to lack of space and the possibility of getting makeup all over their face.

Improvements included a mirror, more room, a place to store clothes and make-up safely, a small wash basin to clean up and even disco lights to create a party atmosphere.

4.3. Future Design checklist

Participants were asked to design a future driverless vehicle experience including the creation of a mood board. They chose journey types; cost and quality criteria; functional, environmental and service requirements; together with materials and finishes. They then described their dream driverless experience through a series of pictorial and emotional responses.

Types of Journeys

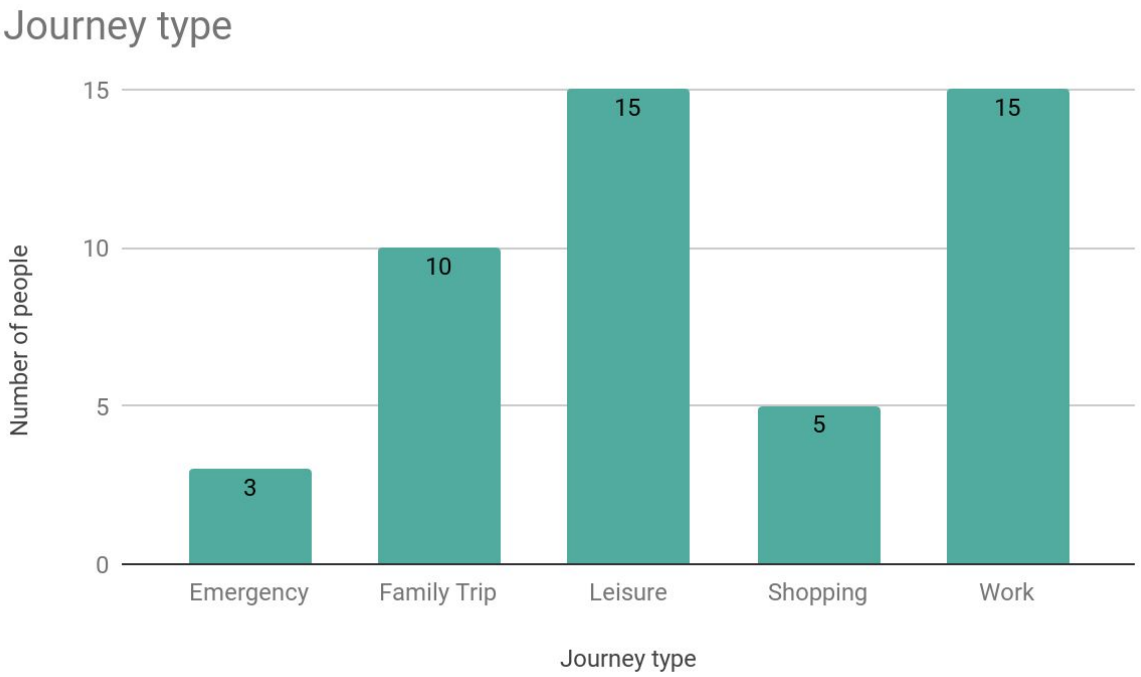

Figure 48: Future journey types

When designing for future AV experiences, our participants chose five types of journey including (in descending order) leisure, work, family trip, shopping and emergencies. Their responses to the three most common journey types are described in the following sections.

Future Leisure journeys

A third chose to redesign a leisure journey.

Type of vehicle

Most people (13) wanted to use public transport and 3 preferred a taxi. They wanted to save time, keep costs down and favoured shared use over ownership. One participant imagined a future public leisure vehicle would change depending on their need or mood.

“I want an autonomous vehicle that takes the place of static spaces in my current life. I want a ‘kitchen’ car and a ‘bedroom’ car and a ‘bathroom’ car and a combination of those, and one for taking 10 people and one for 2. They shall be flexible, configurable and adaptable.”

Seating, grouping and orientation

Most chose an upright seating position although a few chose a range of positions depending on the length of the journey and mood.

“Ability to recline and snooze on longer trips would be great”
“A normal seat is the best. I just want to get A-B quickly and affordably”
“Ability to either sit upright or lounge depending on mood, much like an airline business class pod”
“I would like variety, especially to be able to stretch”
“I think of a leisure trip with friends therefore I would like to sit and socialise with them”

Some wanted to travel alone, some with family and friends and some also mentioned travelling with the general public or their community. For those travelling alone they wanted to seat facing forwards, while those travelling with friends wanted a social seating arrangement. Some wanted configurable seating depending on mood or if they suffer from motion sickness.

“Prefer forward facing as I like to see where we are going”
“Prefer to look out of window ahead - not sideways. Would like choice of front or rear view.”
“I would like social but of the 'quiet coach' type”
“If I'm traveling with people I know, the 'social' layout would work best. Perhaps if travelling with general public, I'd like separate compartments.”

Functional requirements

People want room for luggage, backpack, laptops, coats and shopping and one mentioned the need to bring their bicycle and some food for the journey.

Common design features included seat belts (if travelling fast), charging points, WI-FI, umbrella/crutch holders, foldable table, cup-holders and a big screen to sync their phones or onboard computer. Some wanted an audio / visual console with information about the journey, a ramp for easy embarkation, a space to secure prams, wheelchairs and bikes, while others wanted a space for securing speakers, a neck and arm rest, grab handles and live travel status updates. Interesting additions included smoke detectors and CCTV for personal safety, seat position memory (even in a private taxi) and even mood lighting.

“grab handles, armrest, ramp, seat belts, charging points, wifi, coat hanger, umbrella holder, foldable table, cup holder, safety fastener for bike”
“I think ramps and wheelchair/pram elements are important to include, even if I do not personally need them”
“A future driverless vehicle needs to be a space for living. It's not door handles and wifi, it's taking any current living room and making it mobile. I don't want a car - I want a place where I can work, play, sleep, eat, make love, go to the toilet, etc. that will also transport me wherever I wish to go.”
“mirror (make-up/shaving), lights, net/secure points for balls, adjustable seat heights, memory for seat position, seat heaters.”

Environmental controls

Most people wanted to control temperature, entertainment and have some choice over route navigation while half wanted an emergency stop feature. Only a few wanted to choose where the vehicle would park. They recognised the need for default settings but would like to be able to adjust (and remember) settings for personal comfort. They wanted to control the environment using a range of services including smartphone, touch screens and tactile buttons. And those who had additional needs wanted controls that worked for them.

“I would like to be able to input route specifications if I know there is an accident or a better route. Being able to control my own entertainment is also important, even if this is just plugging a media device in”
“I want to ‘control’ everything about the journey, but maybe the way I do this is by giving the vehicle full ability to override a machine- made choice. If I'm hot I want to turn on the A/C. If I want to take a scenic route, listen/watch a favourite piece of media etc. I should have that option just like now.”
“Emergency stop - should only be needed until the technology is fully developed.”

Services

People wanted to receive travel, news and route information including estimated time of arrival. For some, being able to turn these off was also important. They would communicate using smartphones, receive information via voice announcements and, if in a taxi, might want to sync their device with an onboard screen.

“Through my smartphone, onboard screen and voice announcements. Definitely would not want human interaction as this would feel intrusive in small vehicle.”
“Smartphone, screen on board, human contact, voice announcement. Give me all the options”

While on the journey most people chose to read or learn something and on longer journeys sleep or be entertained. Interesting options included an on-board coffee machine, the opportunity to order / pick up food or get ready for wherever they might be going. Some thought they might exercise (potentially in the same way people exercise on a flight) while others suggested connecting with other vehicles that might be carrying friends along the same route.

“Education, reading, cinema, dining, sleep.. An onboard coffee machine, or a drive by. Pick up point for food, drinks, and even Amazon”
“Education, getting ready, reading… singing music, system/radio, contactless payment.
“Settings/profiles. Quiet/autism friendly”

Materials and finishes

Most people wanted easily cleaned and maintenance free materials. Fabric seating and vinyl floors were popular in public vehicles while premium users wanted leather seats and carpets. Half wanted tintable windows while the rest wanted a more open space (like a fish bowl) with blinds for privacy and glare control.

Future work journeys

Participants based future work journeys on current experiences which included walking, cycle, bus, train, tube and electric chair. Journeys ranged from 20 to 90 minutes. These journeys ranged from free to £12 a day.

Type of vehicle

Most commuters still imagined using public transport for some or all of their commutes but some imagined using premium taxi type services or using a private car that they might lease out when they weren't using it.

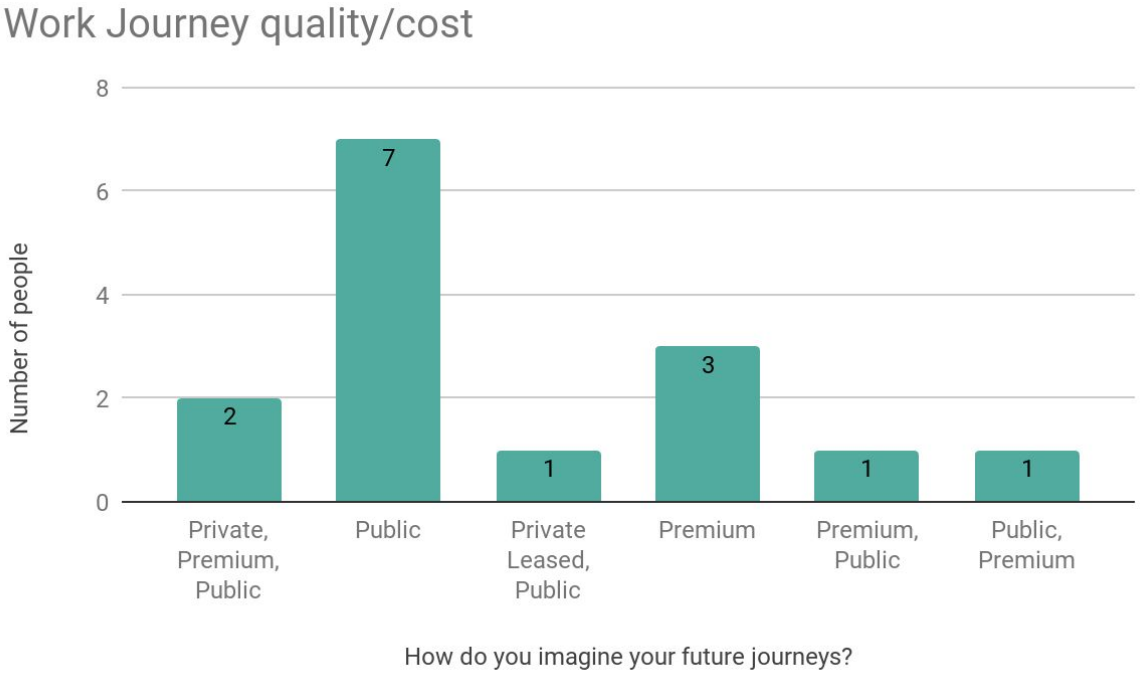

Figure 49: Type of vehicle on a future work journey

"Would use the bus currently but with the pram and wheelchair space debate, I'll rather get their myself. Have to use the battery on the chair, this is not ideal."
"Convenience and value of time is important as a business traveller"
"If it was a shared public services it needs to be well maintained and clean, reliable and there are enough to meet demand"
"Quite flexible on ownership - key thing is availability and journey time"
"I would feel sad if driverless cars took passengers away from public transport. They should reduce individual car ownership instead"

Seating, grouping and orientation

Most people chose an upright seating position so they could relax / read or work. A few wanted the option to lounge, perch or stand:

“I like trying new seating depends who your travelling with/going to work would want to be upright”
“I prefer seated travel. In the future I imagine more standing space & less seating”
“upright - productivity. lounge - rest/relaxation”
“On this journey (typically business attire) it would be challenging to use any other position (but on leisure journeys it would definitely be an option)”
“able to relax/read /work whilst on the move”
“Sitting is fine, but option to stand is good as sometimes get backache + need to move”
“I sit down most of the time at work. Prefer to stand/lean against something when off work sitting is the devil. I do it far to much. Being able to move about and not just sit is the best”
“Can't imagine lying down now, but not ruling it out”
“i'd like the choice - on my current journey, I sit, perch and stand. Lounging is a nice to have. unless it's an overnight journey, I just want a comfy seat”

Most imagined their work trip would be alone or with the public. Some wanted an isolated seat suitable for working while others were happy with social arrangements that allowed them to chat to fellow travellers. Many liked the idea of a table (personal or shared) so they can work/read on the move.

“I haven’t experienced a car-pool but it sounds positive. Flexibility is important. If with people I know would like a table and seating close together. If on my own want to sit on my own.”
“Would be great if seating arrangement was completely adaptive and could be changed quickly”
“Today's layout was good - comfortable if sharing and good for one too”
“Ideally isolated, but would also share as good to have table or other surface for work”
“Either on my own or with the general public, but facing away so we can look out the windows on my own. Should come with desk for working”
“If paying for a premium i'd choose to travel alone. Movable seats would give maximum flexibility like the revolving seats on japanese bullet trains”

Functional requirements

People want room for a rucksack, a laptop, shopping and gym bags. Disabled participants needed space for their electric chair (or guide dog)

Grab handles, seat belts and securing devices for wheelchairs and prams were important safety features while a table, charging and wifi /data helped people work on the move. Most wanted cup holders for drinks and a bin to dispose of rubbish. Disabled users needed a ramp to get on and off as well as instructions so that someone could help to set it up for them.

Environmental controls

Commuters would like to control temperature and route with a few expressing the desire for additional entertainment options and an emergency stop if they felt the need to stop quickly.

“temperature, route navigation, entertainment, emergency stop, how much noise I can hear from outside”
“temperature, route navigation, entertainment, open the window, lighting (for makeup), volume of sound”

Most were happy to control these through touch screens or smartphone but some expressed the desire for tactile buttons and voice activation.

“Smartphone, voice activated if on own. No more touchscreens/buttons other ux clutter please”
“Through my smartphone. More sanitary, less to be broken/vandalised”

Services

People wanted travel, news and route information with onboard screen and voice announcements. Some would like it to sync with a smartphone app and some wanted to get additional information like local history.

“travel, news, local history, route information, screen onboard, not voice, as want the choice of whether to look/listen each time”
“I would prefer a minimum number of voice announcements”

While commuting, people would like to educate themselves, read, listen to the news, be entertained, sleep or communicate with others. Some mentioned eating and drinking and one suggested they might also rate fellow passengers.

“get ready, sleep, watch Mr Bean, catch up on social media, entertainment on the phone, news channel”
“education, getting ready, reading, fitness, cinema, dining, sleep, most likely to read but have options to choose”
“food, coffee, wifi, stops at useful places - for food, picking up dry-cleaning etc.

“Quiet pods on request. Ability to 'rate' any fellow passengers”

Materials and finishes

People who were using public transport recognised the need for easy clean surfaces and finishes such as vinyl and fabric seating but also wanted the materials to be comfortable and adjustable. Those using premium or personal vehicles were also happy with fabric finishes and could imagine carpet or wood flooring, with some wanting leather seats and a couple suggesting recycled cork as a good ecological alternative.

“carpet, a quiet zone where one can focus on work, leather or fabric in premium vehicles, tinted windows with ability to electronically adjust level of tint”
“fabric, recycled cork, leather, no plastic seats, they are awful in all times of the year”
“Vinyl, easy to clean. Cheap & lightweight & easily replaceable, fabric, allows some breathability and comfort, tinted window”

Future family journeys

Type of vehicle

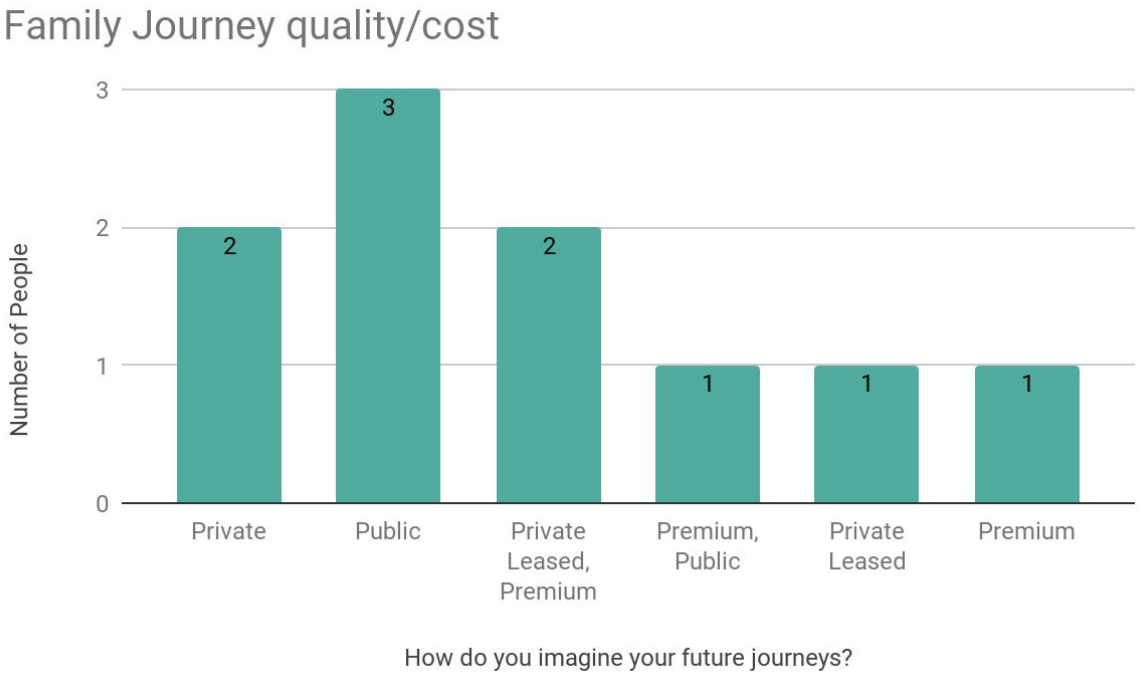

Figure 50: Type of vehicle on a future family journey

People divided future family trips between private, premium and public modes with 3 people imagining they would also lease out their car if they didn't need it. Only 3 out of 10 wanted to own their own vehicle and keep it for personal use only.

"I want a model which allows me to use differing vehicles for different trips e.g. small single use for commute, lounge experience for longer or important trips (less frequent)"
"I would prefer to have my own or access to a private service but I would also be happy to use this as a publically shared service"
"One of the major burdens of these trips is having to bring stuff around, hence the individual vehicle"
"door to door and bookable. Compete with uber"
"it might depend on the type of journey, I would probably own a vehicle just to make it available when it's needed"

Seating, grouping and orientation

Most chose an upright seating position but some liked the option of a lounge arrangement or even lying down

“The journey is an expansion of "family time". This is often best in a more relaxed but communal atmosphere”
“standing, perching, upright, lounge, floor, laying down. I get aches in my joints if sat for too long so I like moving around on long journey and tend to fall asleep in morning”

When travelling with family many imagined a flexible seating arrangement that allowed the group to socialise, to look out or be alone in company.

“Table and 4 swivel seats. Retractable table, swivel seating so we can face each other or turn to outside windows with space/shelf for devices, book etc.”
“I would want to be able to swing the chairs to be able to look out the window or talk to the person next to me or the group of people and a media centre per chair”
“some seats facing in some open space for pram or toddler to move around in”
“The more flexible the seating positions the more comfortable we all are but all facing in we can be sociable too”
“To enable exchange of views although in reality everyone would just look at their phones”

Functional requirements

Families want to carry luggage, bedding, food and prams together with clothes, entertainment and laptops. A few wanted to carry bicycles so they can cycle when they reach the destination and one wanted to bring a pet or a guide dog.

Interesting additional features beyond seat belts, tables and cup holders included the ability to ‘night’ the cabin to aid sleep, a bin with lid for rubbish, a ball pool or climbing frame for the kids, and plants to make it more approachable and homely.

“a flip out table would be great! seat belts if we were travelling faster would feel safe, cup holder for drinks especially when kids are around, plants to make it more approachable and homey, washing facilities”

Environmental controls

Families want to control their vehicle as if it was a family room.

“temperature, entertainment, visibility of route, navigation to add way points but not where it goes, lighting, vehicle should do the driving, parking, stopping. I don't need that ability or need to be conscious enough to do it.”
“temperature, route navigation, entertainment, emergency stop, because these things make the journey more comfortable and give you trust that you have a little control”
“temperature, route navigation, entertainment, window shading, light level for different use, cases, napping vs seeing outside controlled through my smartphone, tactile buttons or voice activated”
“Temperature and entertainment are moment dependent. Route navigation, it should be able to change destination, but the actual route planning shouldn't be my concern. shouldn't think about parking or e-shops. Touch screen, voice activated. Just got google home and its voice feature set is perfect for a single room/space control of environment “
“Alexa style support for playing music and asking the vehicle to stop/reverse would be useful! Entertainment, emergency stop because I need to control my music and disco lights. Also in case something wrong with the shuttle I can stop it in case of emergency”

Services

Families wanted a whole range of additional service including travel, news, local services, local history, route information, together with education and entertainment. Interesting quotes included:

“I would like a map showing planned route”
“Careful balance - the right information without overload. No ads.”
“Cuddling my kids and husband, massage chair would be great!”
“Alexa to sort my life admin, to sell stuff on ebay and amazon, do my tax return”
“Children’s activities to keep them happy and no more "Are we there yet!"
“Car to drive back home on it's own”

Materials and finishes

Families with private vehicles wanted comfortable environments including carpet, leather, tinted windows and blinds. Interesting quotes included:

“might take shoes off - so best comfort”
“blinds like in dreamliner/A380 planes. Touch a button changes the tint level”
“a good view out but the ability to shut out the sun would be great (even on tinted windows)”
“almost anything but carpet as it severely limits in what state one can enter the vehicle”
“fabric & leather, soft & comfortable, open space as a fish bowl, tinted windows”
“It is essential to be able to see out but given how little control one has over route and traffic it would be best to not be too observable”
“wooden, vinyl, carpet, fake grass? I like carpet, but trust that vinyl/wood are easier to clean”

“fabric, recycled cork, leather, open space, like fish bowl, blinds, would be great if solar cells were included too, as well as a special polished glass which goes foggy when electricity passes through”

4.4. Mood boards and characters

During the analysis of the trials the research team categorised people into groups based on their ongoing relationship with participants and the personal information provided before the trials. People were grouped into the following segments and the research team used their mood boards to understand the different emotional and practical needs for future AVs:

- Older people - 65+ and uses a freedom pass
- People with additional needs; someone who uses crutches, a wheelchair or has a visual or auditory impairment.
- A family, a parent with younger children
- Young workers; 25-34 year old who has recently graduated or started out on a career
- A young person 18-24 year olds, unemployed and living on a tight budget.

Older people

Figure 51: Sample mood board vehicle for older people

The three older participants were interested in creating vehicles that were comfortable and supported their wellbeing. They wanted the vehicle to be practical and reliable, connect them with the outside world, have the sonic feel of nature and be ‘green, yellow or grey’. Ideally the vehicle would be open clean and comfortable with the texture of a friendly wallpaper or soft sheepskin.

“I’d like to look out and read”
“I would like variety, especially to be able to stretch”

All older participants wanted grab handles and charging points and most wanted armrests, Wi-fi, safety features for a wheelchair or pram, accessible ramps, cup holders, tables, seat belts, toilets, and space for shopping. On short journeys they would like to read, while on longer journeys they might sleep, watch a film, eat something or get ready.

“I would like maximum flexibility to do what I want including socialise”

People with additional needs

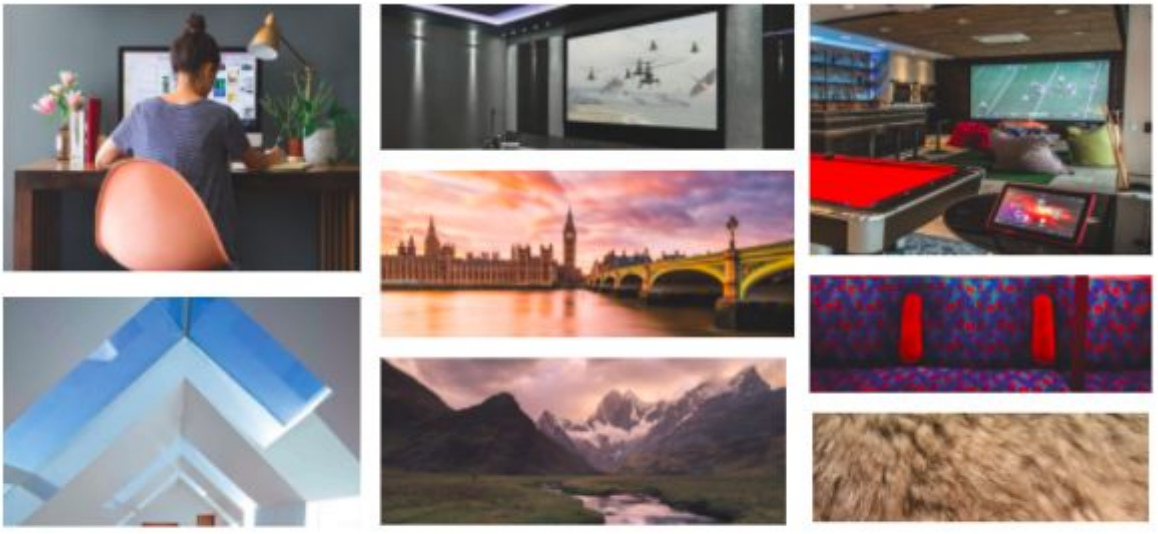

Figure 52: Sample mood board vehicle for people with additional needs

All five people with additional needs wanted to use public transport for some of their journeys but half would like to have a vehicle they can lease out or make use of a premium taxi service.

On a commute, one participant wanted a ‘living room/office’ that was comfy and accessible , with a chair that feels like my own, big windows and lots of colour ‘like the stagecoach brand with orange grab-bars and red floor’

An male participant imagined a future family trip that was luxurious, cozy and playful with an entertainment pack, cinema and music built in, with hip hop and RnB tracks like in a nightclub, in pinks and browns’

Family

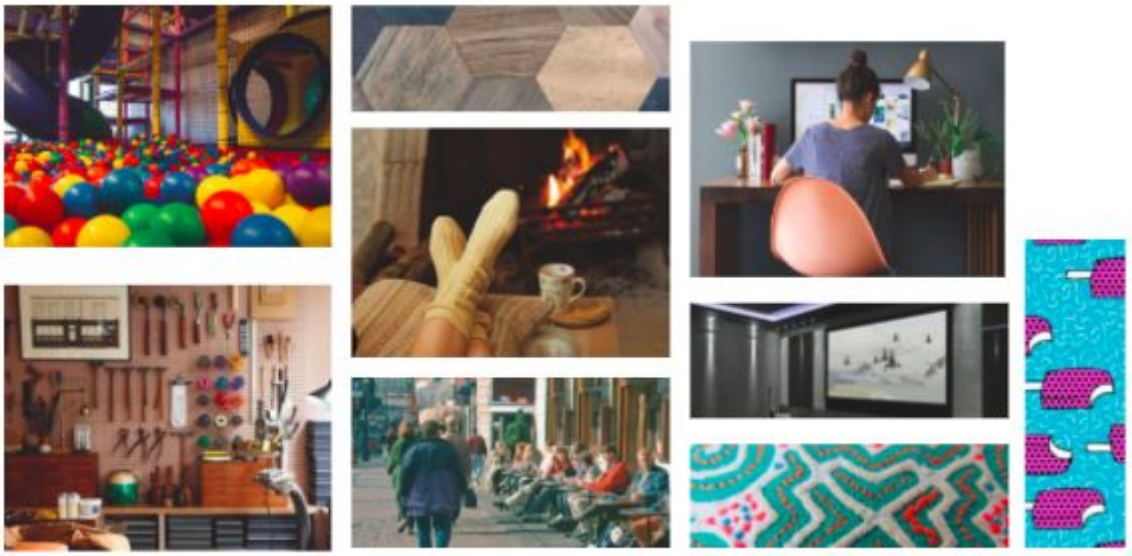

Figure 53: Sample mood board vehicle for parent

For this group a personally owned vehicle was the prefered choice (followed by public transport). This was due to the need for immediate access, living in an area where public transport is not accessible, or the challenges of carrying kids and stuff around.

There was no single type of vehicle with some preferring practical and efficient while others wanting a more playful environment that would keep the kids happy. Designers should improve the efficiency of the vehicle together with its comfort and versatility, “remove the stress of travelling and make it feel like downtime”.

“Tool garage / everything in its place / practical / reduce emissions / cinema interior / silence / grey, yellows, blue”
“Soft play space / practical / versatile / a distracted or entertained child, easy clean vinyl”
“A range of environments from practical to comfortable, effortless efficiency”

Younger worker

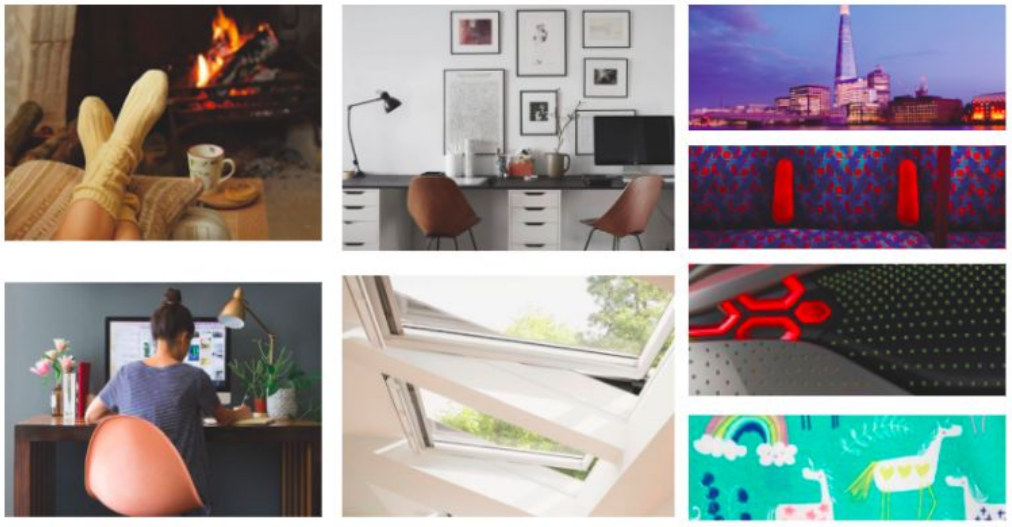

Figure 54: Sample mood board vehicle for younger worker

Most young workers wanted to use public transport but 15% imagined using premium taxis on future journeys.

"If I was making a routine journey. I would prefer a shared public service, however if it was a one off, I would pay extra for a premium"

Young workers wanted a cozy, practical and reliable environment with designers focussing on emissions, wellbeing and comfort. They mainly wanted to watch the world go by and enjoyed the urban environment. While travelling a few mentioned listening to meditative music, the natural environment or whatever they had on their phone.

"meditation music; my conversation on the phone (not anyone else's!) or whatever is on my phone but played through good speakers"

They generally wanted a clean and modern environment and the most popular colours were greys, greens and blues.

"natural, futuristic, modernist, monochromatic greys, one feature colour"

Young adults

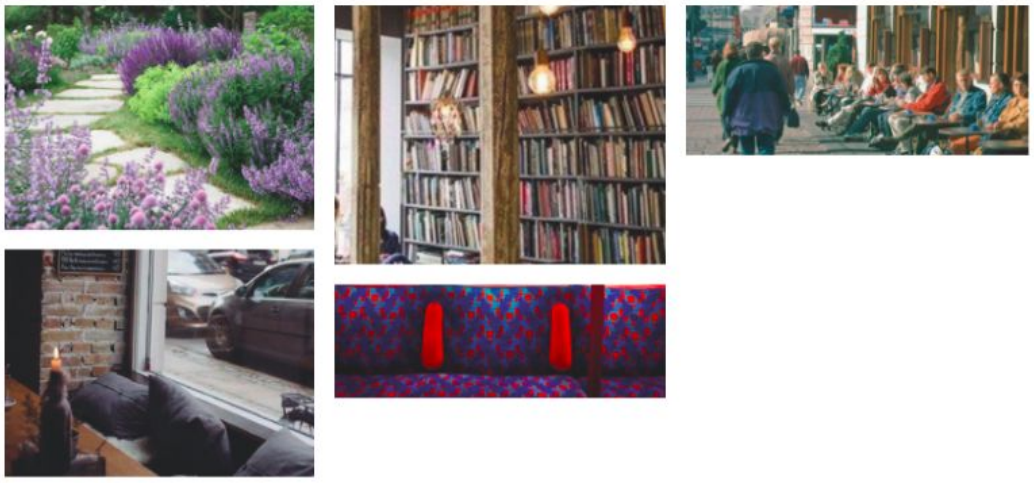

Figure 55: Sample mood board vehicle for young adults

The younger participants wanted to travel in public transport but imagined it could be a more social environment. They wanted a relaxed, personal and comfortable environment that was adaptable and had space rather than being cramped.

“a cafe with comfortable sofas, tables, a relaxing atmosphere and the smell of coffee”
“Make it more Rolls Royce than local bus, the ability for it to be multi-purpose”

They wanted to look at the passing city, listen to the outside world, have conversations with others or to their personal music and entertainment, with a, “reassuring voice explaining what is going on”, and they imagined the material would be, “smooth, so easy to clean between uses” in beige, blues, neutral, natural colours or with variety, “Blue car, yellow car”

“Designers should improve, just the internal space as it was just a bit too small. I think it should feel more spacious. That's the main thing I felt, both in terms of height and width. I know there's obviously constraints around that, but I don't know, making it feel more spacious somehow.”

5. Conclusions and next steps

5.1. Feedback

At the end of the workshop we asked participants to tell us what they learnt and what their feelings were towards driverless vehicles. All participants felt positive about driverless vehicles with nobody expressing a neutral or negative feeling about the future of autonomous vehicles.

Some participants felt the vehicles had a long way to go before they would be feasible while others expressed surprise that the technology was more advanced and more 'responsible' than they imagined.

"New automobile technology that will change the future of our travel"
"The technology is coming along but has lots of room for improvements in reliability"
"The effectiveness of sensors and how they affect the vehicle's speed/caution"

Participants would like to see greater manoeuvrability, the opportunity for open road experiences, to select ad-hoc routes, and move at faster speeds. They valued the ability to be involved in the activity and the workshops, to give feedback on the technology in a fun and interactive environment. They also enjoyed the range of activities and the human-centred thinking focusing on 'how people might use it' rather than 'creating another product'

"the experience - being part of something at the beginning that is going to be a huge part of the future"
"getting to ride in the driverless car! Can't wait for the tech to develop"
"The people and value in user engagement, all inclusive, equality and diversity the of tasks/dress up!"

5.2. Insights

Key insights from this research include the following:

1. All groups are positive about the potential of driverless vehicles even if the technology today is restricted and unfinished.
2. The prototype driverless shuttle meets the needs of last mile journeys but requires significant technical, environmental and informational improvements.
3. People want to see driverless technology in public, premium shared and private vehicles.
4. Most people would like to get around in driverless public transport followed by premium shared taxi type services with less than 20% mentioning privately owned vehicles.
5. People with additional needs, including the elderly, wanted inclusive features in driverless vehicles whether they were public or privately owned, although the majority expected to use public transport.
6. Most younger people would use public transport for journeys around town but hope that the environment is more comfortable while still being affordable.
7. Professionals without families want a range of options but are ‘quite flexible on ownership’. The key thing is ‘availability and journey time’.
8. The majority of families preferred to own a vehicle but some were happy to use public transport, premium or leased cars.
9. Almost half of those who wanted to own a vehicle also wanted to be able to share it with others.
10. People imagined a range of vehicles depending on who they were travelling with and what price they were willing to pay; from single person pods, shared taxis or private vehicles for family or friends to larger shared public vehicles.
11. Most people wanted to be able to see the world outside, with a significant number interested in ‘fishbowl type’ glazing, but they also wanted to control views to reduce glare and overheating.
12. Interiors should be designed to support social arrangements when travelling with friends and family, be flexible to support a variety of arrangements or allow people to face forward in comfort on public transport or if travelling alone.
13. During the journey people wanted to sleep, read or educate themselves, watch a movie or listen to music, drink or eat, or get ready on the go, with some wanting to socialise, play with the family, communicate via phone, work or de-stress.
14. Seating should generally be upright and supportive but on shorter journeys some preferred to stand or perch, and on longer journeys some liked the idea of lounging.

15. Inclusive features were important including grab handles, upright seating and security systems for wheelchairs and prams. Most people still imagined the need for seat belts if the vehicle was travelling at speed.
16. Apart from safety and inclusive features, people wanted space for luggage, tables and drink holders as well as support for electronic devices.
17. They wanted to control the vehicle's services through touchscreen, voice / mobile phone or with tactile buttons.
18. People expected vehicles to navigate without any intervention unless passengers wanted to add way points, stop en-route or change destination. They wanted the vehicle to do all the driving, parking and dropping off without any human intervention.
19. The only on-board navigation override needed was an emergency stop button that they could press in the event of danger or concern, but many wanted to see the route they were travelling, learn about the world outside and know the estimated time of arrival.
20. Practicality, comfort and reliability were the key qualities wanted in driverless vehicles. In material terms, this means people favour function over fashion, ergonomics over image and simplicity over complexity.
21. The key areas designers should focus on as these vehicles are developed are interior comfort, efficiency and emissions, and personal wellbeing. Other areas of opportunity include providing a sense of space, better entertainment systems and the ability to provide versatile environments depending on need.

5.3. Next steps

Next steps will be to take the learnings from the research, combining stakeholder research with feedback and insights from participants and the wider public at the driverless futures exhibition, to show how future Londoners might use driverless vehicles in their daily lives.

The research team will develop a series of characters, based on the characteristics of people that took part in the trials and explore how their lives might be supported by future driverless vehicles. The teams will also consider the wider social, technological, environmental and economic factors that might impact on urban living.

Based on these scenarios, the team will develop a range of vehicles designed to meet these diverse needs, show how they might be used and consider their impact on future service models as well as the wider environment.

The team will also build on people's attitudes to changing ownership to consider how London's streets might adapt to take into account these new patterns of use.

Finally, design patterns that emerge from the research will be developed, indicating the problems that exist today and in the future, and how designers and other disciplines might overcome these challenges through people-centred solutions and methods.

6. Appendix

6.1. 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 Managers
Dan Phillips
Gail Ramster

RCA Project Researchers
Sam Johnson
Gabriele Meldaikyte
Paul Piliste
Daniel Quinlan
Elizabeth Roberts

6.2. 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.

6.3. 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.