VISIONS FOR FUTURE PUBLIC BUSES

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a **Final Bachelor Project**

in the **Adaptive Mobility** squad

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Introduction

You are now reading the final report on the Final Bachelor Project of Thijs Baselmans. I am a third-year Industrial Design student with a focus on user experience, communication and storytelling.

In my Final Bachelor Project, I have sought to learn more about user involvement and participatory design practices. My aim was to be able to engage and stimulate people creatively and to capture and analyse this creativity by means of illustration and narration.

I have done so in the context of the public bus, because I was interested on how autonomous driving could impact this sector, and because I see big potential in the public bus as a mode of transportation.

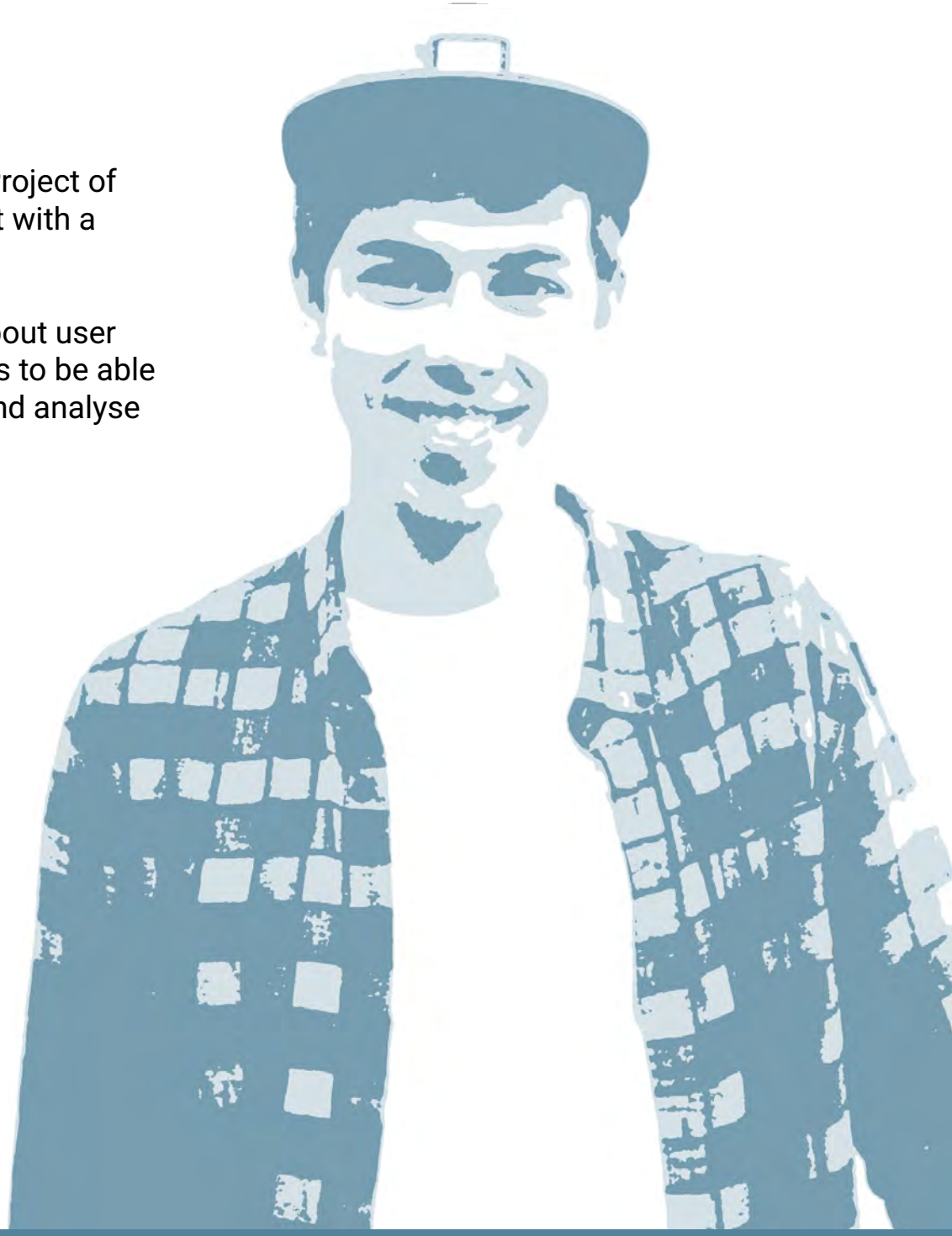


Photo: SOEPS creative collective

Finding a direction

During introductory meetings with the Adaptive Mobility squad I was inspired most by public buses. I have a lot of first-hand experience riding the bus to high school.

I researched buses and found big potential in the efficiency of the bus. Several developments in the field of self-driving buses were also found, which was much in line with the activities in the squad (appendix A).

My first iteration focused on this last area: I raised the question whether driver-less buses would be desirable and made plans to design a system that would replace the bus driver in all their tasks and duties by a computer interface (appendix B).

During a critique session about my first iteration, I received feedback that made me rethink my initial assumption that making buses autonomous would automatically lead to them becoming driver-less. In trying to replace drivers I had identified a lot of valuable tasks they fulfil. Instead of trying to replace a bus driver by a machine, I decided to design for drivers of autonomous buses with level 3 or higher driving automation. I sought to design to support them in all tasks not related to driving but vital to their role as a bus driver.

The weeks that followed were spent researching participatory design and preparing to involve bus drivers in the design process (appendix C; appendix D) for I wanted to gauge their take on how their job might change in face of developments in automated buses.

Next, the spread of COVID-19 created an environment which made it a lot more challenging for me to meet and engage with people. I was in contact with several public bus companies but inevitably all of them were too busy to be able to help me with my project.

Out of necessity my project focus thus shifted towards a broader audience. I was still able to apply much of the newly gained insights on participatory design in engaging with bus passengers. Together with them, I focussed on the experience of a bus-ride and their visions on how this experience might change in the future. In doing so I became involved in designing furniture solutions.

I found a new challenge in the diversity of opinions and visions. Everyone has different ideas about what the bus might be like in the future, so I tried to find a balance between capturing ideas that reflect popular opinion as well as some more singular, individual visions.

Chair bodystorming exercise

My first exercise in participatory design was one in bodystorming (Gray, Brown & Macanufo, 2010, pp. 59). I chose this because it is a very hands-on, physical exercise. During the curriculum at TU/e I have often noticed the importance of prototyping and experiential qualities, so I wanted to bring this into the hands of participants as well and see whether they would also react well to it.

I invited two sets of two people into the setup shown here, reminiscent of the layout currently active in many of the public buses in the Eindhoven area.

First, I asked participants to enter the fictional bus and sit down as they would on a normal bus, aiming to familiarize them with the use of the chairs as props for role-play.

Next, participants were asked to re-arrange chairs into different layouts. I encouraged experimentation, and the trying of as many different ideas they might have as possible. When at a loss, I was able to help their thought process by posing questions like “what would your ideal bus look like?”, “you mentioned you like looking out the window while travelling on the bus, what would a bus look like in a world where all passengers wanted to do this?” or “maybe we could try the opposite to this?”.

After building each layout of chairs I asked for a moment of reflection on how the chairs had been arranged. In doing so we acted out personas of different types of passengers we had come across when travelling by bus; wanting to socialize, daydream, work, sleep, meet people etc.

Interestingly, there were some overlapping themes between the two sessions. Both sets of participants mentioned at some point that they valued being able to look out of the window and having a sense of personal space.

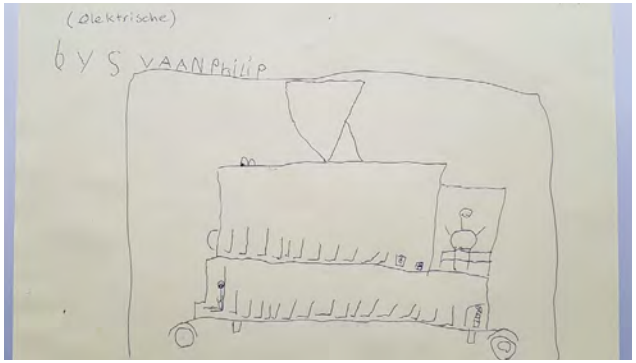
During this exercise I learnt a lot of things I might not have otherwise. For example: one participant told me they would love more personal space, and to sit by themselves. We proceeded by arranging all chairs into single-file lines. After trying this out, we all agreed it didn’t feel at all right. Similarly, the second set of participants initially identified with values such as spaciousness, privacy and calm, but when reflecting on the exercise indicated to much prefer the denser, more social-oriented layouts. These findings solidified for me the notion that what people say they want is not always in line with what they actually want (Ketterman, n.d.).

More detailed documentation on this exercise can be found in appendix E.

Arts and crafts exercise

When researching participatory design I came across the “Marshmallow problem”, a design thinking exercise coined at IDEO (TED, 2010; Skillman, 2019). Although this design exercise was run with many different groups of people, one group was found consistently performing better than most others: recent graduates of kindergarten.
Inspired by this, I wanted to run a design exercise with some recent kindergarten graduates myself. I challenged the children from my local beaver scout troop (aged 5-8) to dream up their bus of the future.

This exercise returned beautiful and interesting results. Many kids identified the roof of the bus as a space with potential. The kids often expressed environmental concerns, by using the roof to harness electricity, wind or solar energy. I received one bus designed to run under water, which could be a solution for a world where rising sea levels have forced us to adapt to a more aquatic lifestyle. Two kids show curtains in their buses, which could provide passengers with more privacy or calm.



"The year is 2051, and the beaver scouts would love to camp at a log cabin far away. Draw or build the bus of the future with which the beaver scouts can go on a trip.

What does the bus look like, and what can it do?
Who is driving the bus, or is there no driver at all?
Where are the beaver scouts, and what are they doing?"

Conversational exercise

In order to collect insights from a bigger body of people, I reached out to via social media and managed to contract five participants for some semi-structured interviews.

This exercise is in some ways a continuation of preparations I had made for a focus group with public bus drivers.
For this focus group I had carefully considered the specificity of what I was asking. This meant a fine balancing act between open and closed questioning: giving people a steady foundation —something they can build off of— without guiding them so much they are not thinking for themselves anymore. To do this, I came up with some preliminary concepts to offer a starting point for discussion. Some were easy to imagine, others more futuristic, in order to gradually let the mind wander further from the status quo.

When the COVID-19 pandemic made running the focus group near impossible on multiple accounts, I chose to convert the plan for the focus group (appendix D) to a plan for a semi-structured interview (appendix F).

I did this because I still wanted to apply the knowledge gained about focus groups in some way, because I wanted feedback on the preliminary designs I had made and because I wanted to collect the design visions of more people than just those I had contacted in my other two exercises.
A semi-structured interview has many of the elements of conversation and discussion that make a focus group valuable, albeit with me rather than other participants.

Having conducted six interviews, the thing that stands out most is the diversity. This was expected and anticipated, but warrants highlighting since it is part of what made running this exercise so interesting and inspiring.

The way one uses the bus defines the things they find important.
When using the bus in the city centre rides are often so short that people don't mind standing while for longer trips, comfortable seating is important. Tourist use requires a bus to have seating with good views and have information available.
As in the chair exercise, I came across a dichotomy between riding with a group vs riding alone. Since many users indicated they do both from time to time, flexibility is required here.

I found that many participants' main concerns were with the logistics of the public bus rather than the design. Frustrations about the punctuality of the bus was common and the fact that some buses only run every 30 or 60 minutes, makes the experience less streamlined and makes missing the bus a major disruption.
One participant used the example of trams and metro's being a lot more convenient because it runs so fast and frequent, while another pointed to the prospect of bus lanes allowing buses to be on time more often.
These notions pose a challenge of rethinking public transport on a more fundamental level, something outside of the scope of this particular project.

On the topic of self-driving buses, participants were mostly indifferent, saying things like: "the benefit to me of travelling by bus is that I don't need to drive myself. Being driven by a human or a robot driver doesn't make a big difference to me". Another participant envisioned buses could become smaller and on-demand (much like a taxi service) when driverless because the running cost of a bus would go down.
Regarding the alternate activities a bus driver could undertake participants told me that they would like a bus driver present on the bus as someone to talk to, someone to ask questions and to take responsibility over what goes on in the bus.
The information concept and was likened to the information desks on some trams (GVB, 2018). It is most in line with what is expected from bus drivers.
The food concept was met with the most enthusiasm. It looks cozy, warm and social and is a service that would come in handy in multiple situations.
Participants liked the surveillance concept (appendix G) the least because it does not add value for passengers and it makes the driver more intimidating and less accessible.

Generating design visions

The data I had gathered was diverse in its form as well as in its content. In translating the views and insights gathered from my participants into coherent visions I mostly looked at themes that seemed to resonate with the majority of the people I talked to.

I picked roles for the bus driver from the preliminary concepts that gained most support among participants as well as a nice vision that one of the people I talked to came up with.

Although I started my project centred around bus drivers, the fact I didn't manage to contact them for input made the focus shift to the passengers whom I did manage to engage.

Multiple people came up with ideas for chairs that move into different layouts to allow people to sit alone or in a group depending on their need. To accommodate for this, I prototyped using cardboard until I found an elegant way to do this.

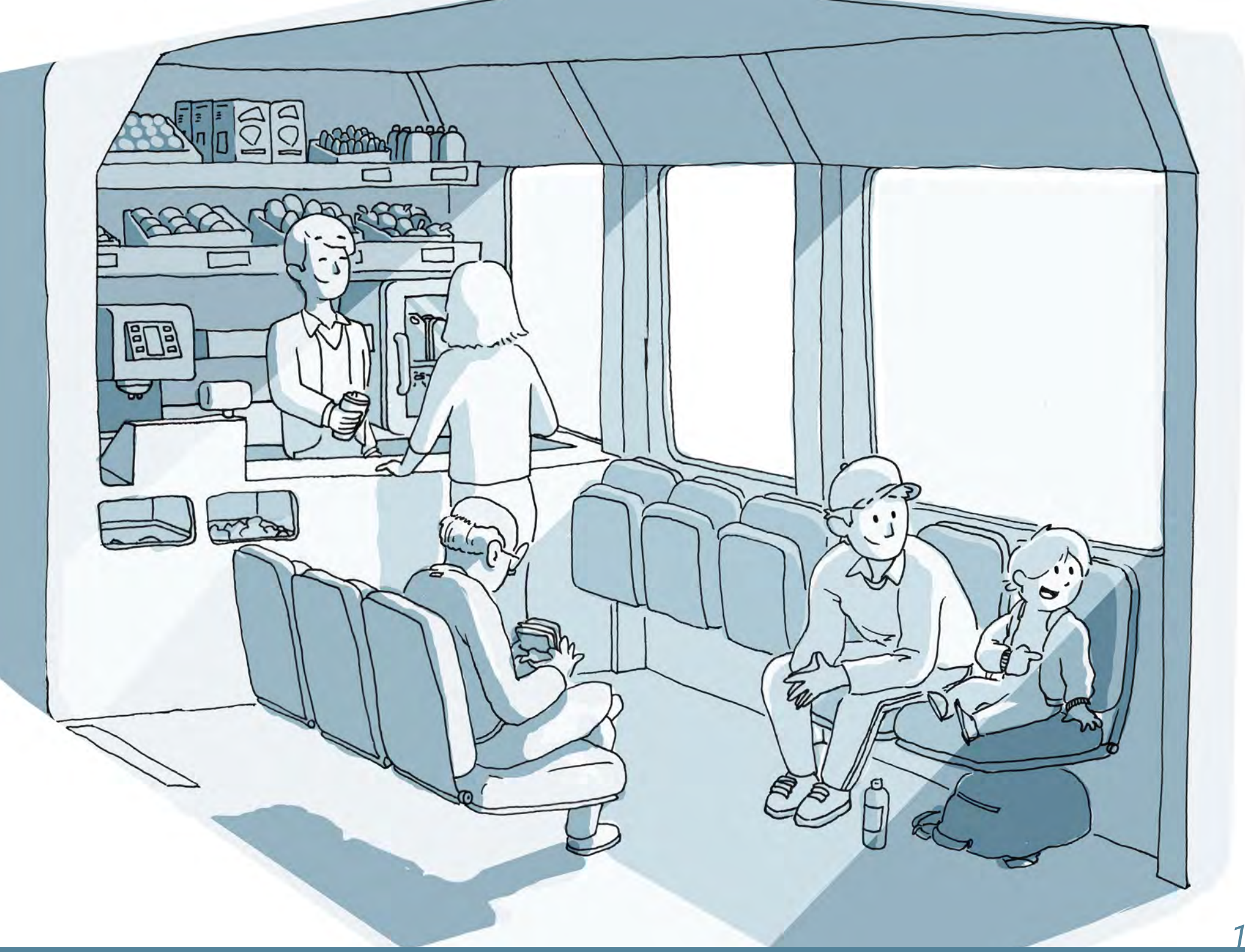
The final design was chosen because it was the most space-efficient and had minimal places where users' hands could get stuck. For safety reasons, it will lock into place upon sudden moves (similar to a seatbelt).

Various people also advocated to have a desk to be able to do work more comfortably while travelling. I saw potential in this idea too, but on the condition that it would not take up the amount of space of a normal desk, especially when not in use, which is why I came up with a stowing mechanism. As you can see I had to tweak the support structure to allow greater accessibility.

I chose to communicate the design visions I formulated using illustrations that show the space, all it's facilities, and the way different people might interact with them, inspired by the visualizations for NS's Vision Interior Train designed by Mecanoo and Gispen.
I used Autodesk Fusion 360 to 3D-model the interior to make sure the sizes and proportions were correct. I then sketched people and details using an image of the model as an underlay. Next, I used the sketch as an underlay when tying together the whole image with simple, clean lines. The line-art I brought into Photoshop to do a final pass with colour to define the space with a better sense of depth and to bring focus to particular elements.
The results can be seen in the pages that follow.

Having lunch on your way to your next meeting? Buying a snack to bring to your friend's place? Your driver is happy to serve you a coffee, soda, sandwich or another refreshment from his stall in the back of the bus.

The seats fold down from the sides, making storage room more accessible under the chairs. At busy times, this means more people can stand.



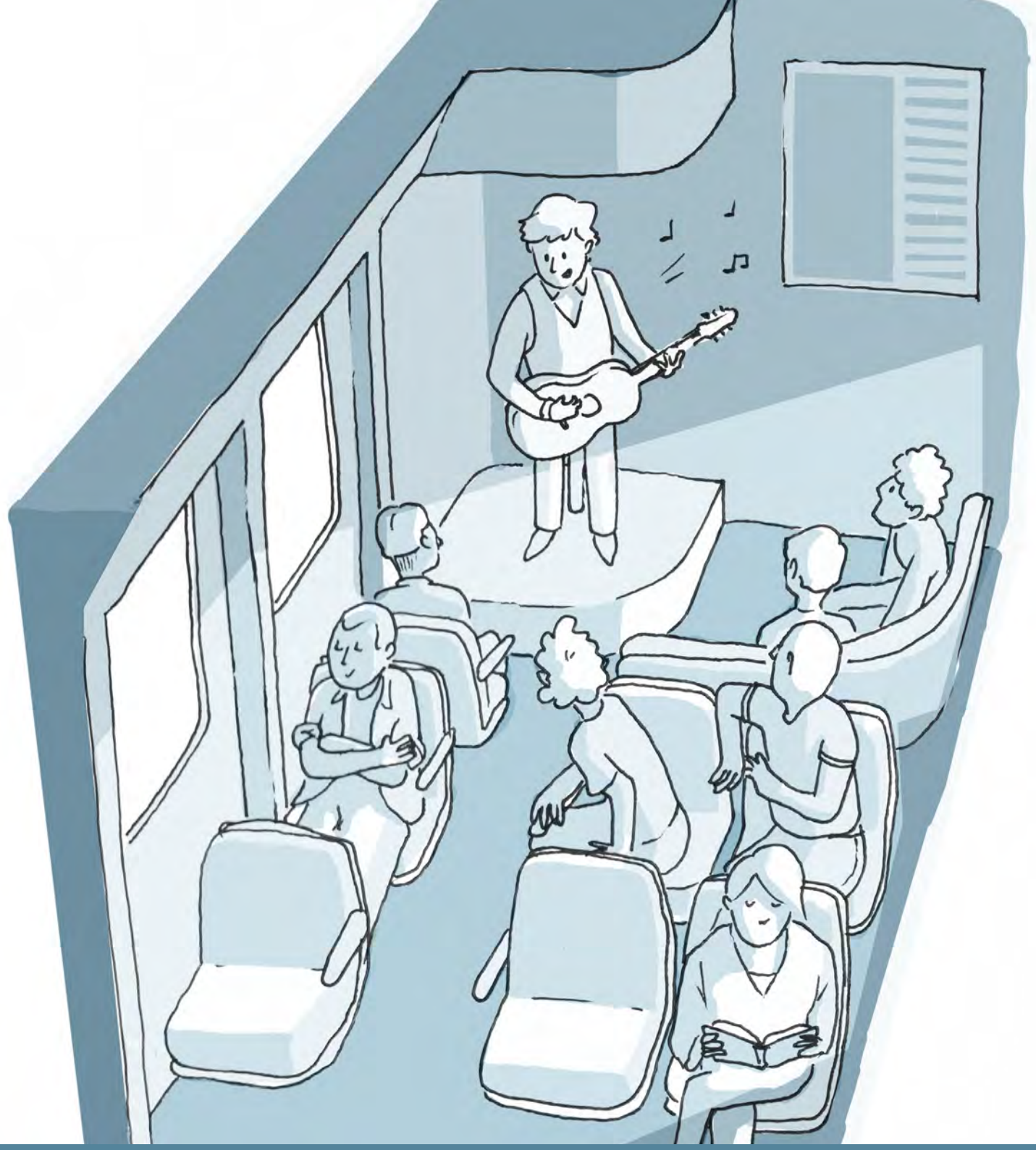
Get updated on the latest news from a central screen to which you can tune into using a dedicated Bluetooth channel or from a newspaper provided to you at the front of the bus.

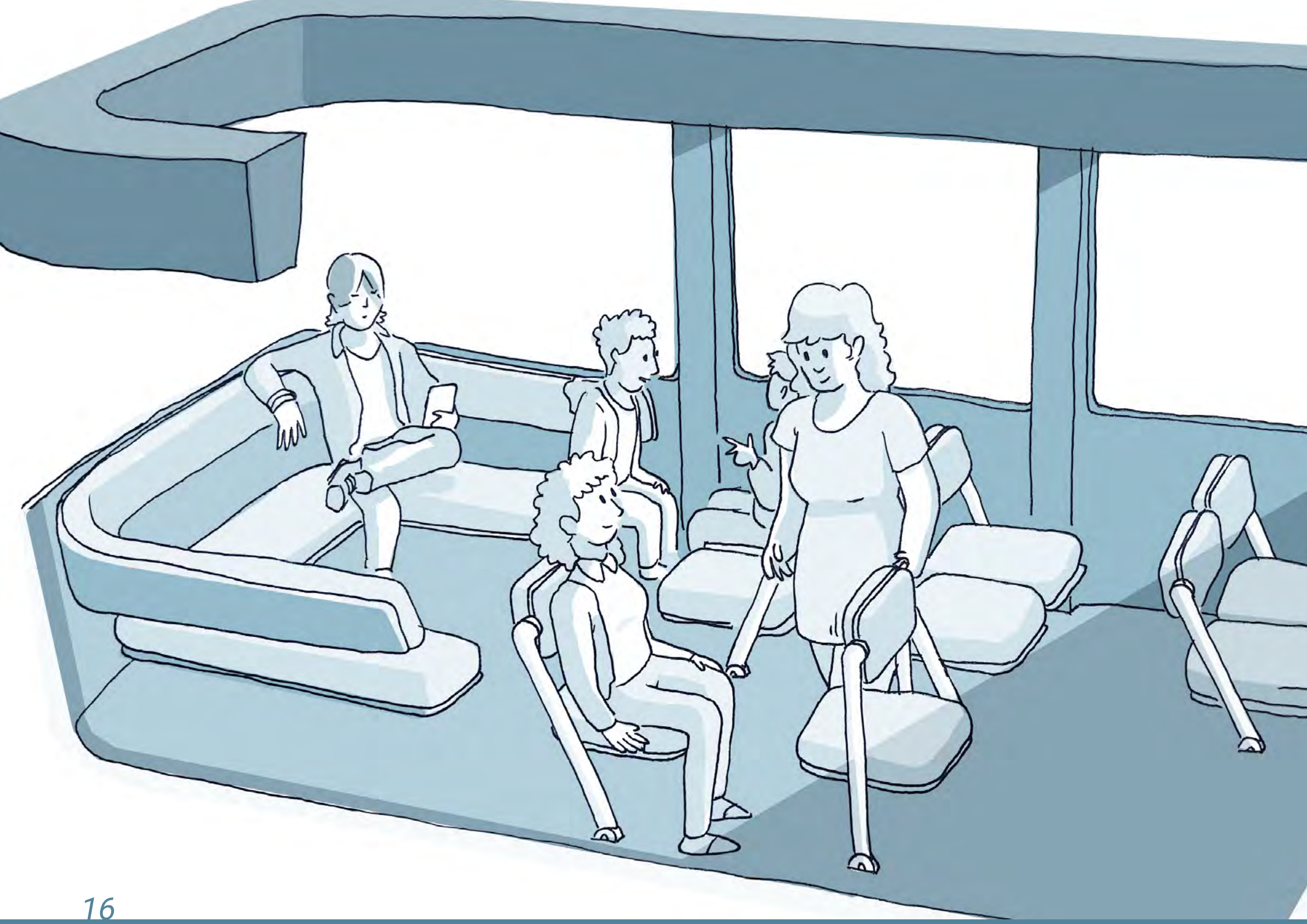
The driver can supply you with more information on the bus routes as well as relevant sights and events in your city.

Based on many people's morning routine of checking up on the news, this vision provides passengers and tourists with info on what is going on in the world and in their city.

Imagine walking into the bus and being welcomed by the sound of a live performance by your bus driver. Everyone listening to the same performance makes riding on the bus a lot more enjoyable.

Bringing arts and culture into public transport makes passengers feel more connected to the driver and each other on their journey.
There could be a magic show, stand up-comedy routine or open mic.



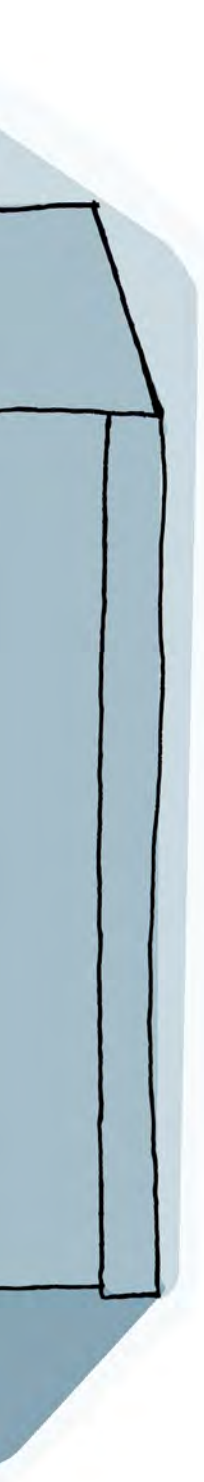


Travelling on the bus, you are sometimes by yourself, while at other times you might be with friends, your partner, or others. Seats that can be used to face either way on the bus open up more options to you as a passenger.

A continuous sofa in the back offers a place to sit for large groups travelling together.

Having a desk on the bus is useful if you need to finish some work for school or your job on your way there. The desks face the window, meaning they also make a great place to read a book or watch out the window.

The desk and the seats being as narrow as possible ensures enough room for everyone on the bus.



A worldwide pandemic is challenging in a lot of ways. One way designers can take into account these strange conditions is by designing to minimize the need to touch surfaces that might be contaminated with your hands.

Using foot-pedals rather than buttons is a great example of this. Seats that can be leaned against discourage people from grabbing the chair before they sit. Small armrests, too small to grab onto, offer extra support.

Reflection

Looking back on the body of work I have generated, I am happy to say I feel quite proud. I feel proud because I think I learnt some new skills (using 3d modelling in the illustration pipeline, engaging others creatively) while also displaying what I learnt earlier in the bachelor (graphic design, literature research, analysing the problem space, ideation, communicating and presenting ideas).

That being said I also had times where I definitely struggled with this project. I had a hard time adjusting to study setup at home and staying focussed. I felt uncertain of how the circumstances would impact my progression. I think I've lost valuable time around the middle of my project in figuring out what to do and how to adjust. This is something I have experienced in some earlier projects as well. Undertaking physical activities with users, starting small and reaching out to others helped me retrieve my footing and made me more pro-actively engaged in my project again.

In hindsight it would have been to explore more extravagant visions for bigger problems. The reason I came to focus more on smaller, more everyday problems I think is twofold. Firstly it could be due to the people having a harder time to think far outside of what they are currently familiar with. More importantly, in designing exercises like the body-storming using chairs I set the scope of the task to be quite narrow and focussed. The initial setup of the space already assumed a traditional bus and it took participants time to get away from that and think of different shapes and factors outside of the physical bus.
I wonder whether I took enough control or was led by my process too much. One could argue the presented visions came about in line with what my participants expressed. It is a matter of valuing user input versus expert visions, conflicting strategies dating back to Ford versus General Motors (Vlaskovits, 2014). I see merit in both methodologies and would like to be able to apply both in my work.

Finally, although the visions are not so visionary that they don't fully tackle issues like the last mile problem or transition to autonomous buses I think they do show what my participants deem important and even came up with some novel ideas that might be very applicable and useful in buses in the near future.

Conclusion

Public transport is a field within mobility that has enormous potential to make travel more pleasant, more accessible and less polluting. At the same time, it is a challenging undertaking to design for public transport because there are many different stakeholders involved and many different perspectives to take. In my project I tried to take the perspective of the bus driver and gathered lots of input from users to get the perspective of the passengers.

I think there is great value in generating design visions together with users. One notices quickly that when posing people with a blank slate like I often did, everyone will come up with a singular vision, unique to them. It also puts me and my activities as a designer into perspective to see the diversity of ideas out there in the world. Capturing that potential is a challenge, but a rewarding one. A drawing can communicate and make concrete the possibilities and restrictions of a space. It brings quick, visual focus to a topic like no other medium.

Together with all participants who helped me out during the course of this project we made a case for the value of a bus driver as a central figure in the bus. A figure not to be forgotten in the rapids of technological advancement in autonomous driving.

At the same time, we think the design of bus furniture could be more flexible in the way it allows people to use the space. We propose just a few options that allow the passenger more ownership of how and where they are deciding to sit on the bus, making the ride just a bit more stimulating and engaging.

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Appendix A: on self-driving buses

Photo: Marcel van den Bergh (de Waard, 2014)

I started by looking at Phileas. Phileas was an idea, started in 1998, to develop a vehicle for larger cities that could not afford a tram network. It was a longer, faster bus that would not need guidance rails. It would steer itself and therefore the driver would only have to intervene in case of emergency. While still in development the bus started driving in the Eindhoven area in 2004. Due to various reasons, the subdivision of VDL that developed Phileas (APTS) went bankrupt in 2014, and Phileas ceased to exist (de Waard, 2014). Many people argue that having started in 1998, the Phileas concept was too far ahead of its time.

Photo: Jonathan Bloom (KGO-TV, 2018)

And may very well be true. In more recent years we've seen other developments in the area of self-driving buses; like in 2018, when the EasyMile shuttle hit the streets of San Ramon, California (KGO-TV, 2018). This 45km/h autonomous shuttle with no gas pedal or steering wheel seats 6 people (having space for an additional 6 standing passengers) and is a proposed solution for the last-mile problem. This is the problem of getting from a transit hub to the final destinations that a lot of people using public transport face. It is often quoted as one of the hurdles that needs to be overcome in order to get more people to travel on public transport.

Photo: BestMile (GCR staff, 2018)

In more news from the same year (GCR staff, 2018), similar self-driving shuttle pods are outlined by local transport providers from Australia, China, Japan, Sweden and Switzerland. Often these projects run at lower speeds in low-risk areas outside of the city, but they are being tested under real-world conditions and among regular traffic. These buses feature tons of sensors, like laser radar, wave radar, ultrasonic radar, GPS antenna and camera system to help monitor the whole driving environment (Tao, 2017). Some still need a driver to monitor the vehicle, while others are fully autonomous.

Even more recently, it has been becoming increasingly clear that buses are even expected to be one of the biggest growth areas in the self-driving vehicle sector. According to Allied Market Research, the global self-driving bus sector is expected to rise from $6.81 billion in 2019 to $74.52 billion in 2026 (Allied Market Research, 2020). This rise is driven by the promise of more user-friendly and accessible public transport, attracting more people and reducing traffic congestion. To reach this, the main hurdles are improving safety, high manufacturing costs and challenges regarding data management.

Vehicle manufacturers mentioned in the report who will help drive the self-driving bus sector include AV Volvo, Volkswagen AG, Tesla, Continental AG, Scania AB, Hyundai Motor Company, Proterra, Hino Motors Ltd., and Navya.

What is also interesting to point out is that currently, North America holds two-fifths of the global market, but according to the same report, Europe will experience the steepest growth at a CAGR of 44.8% in the period between 2020 and 2026.

And all this is for good reason. Buses have huge potential. As Steven Higashide mentioned during a podcast on the topic (FitzGerald, 2020): "…the typical lane of general-purpose traffic in the city – a typical car lane – can carry perhaps 1000 to 2000 people an hour. If you have a bus-only lane that jumps up to 4000 to 8000 people per hour. […] And if you are giving over more of the street to transit and creating a transitway, now we're talking 10000 to 25000 people per hour.". In some larger cities where transit is well-implemented, the bus is often the fastest way to get around. Higashide proposes that we need to improve buses and bus services in order to get more people to ride the bus. This means:

• making buses run more frequently
• making them run faster (e.g. freeing them from traffic using bus lanes or transitways,
making people board more efficiently)
• make getting to and from the bus easier
• making passengers feel safer on buses.
(Higashide, 2019)

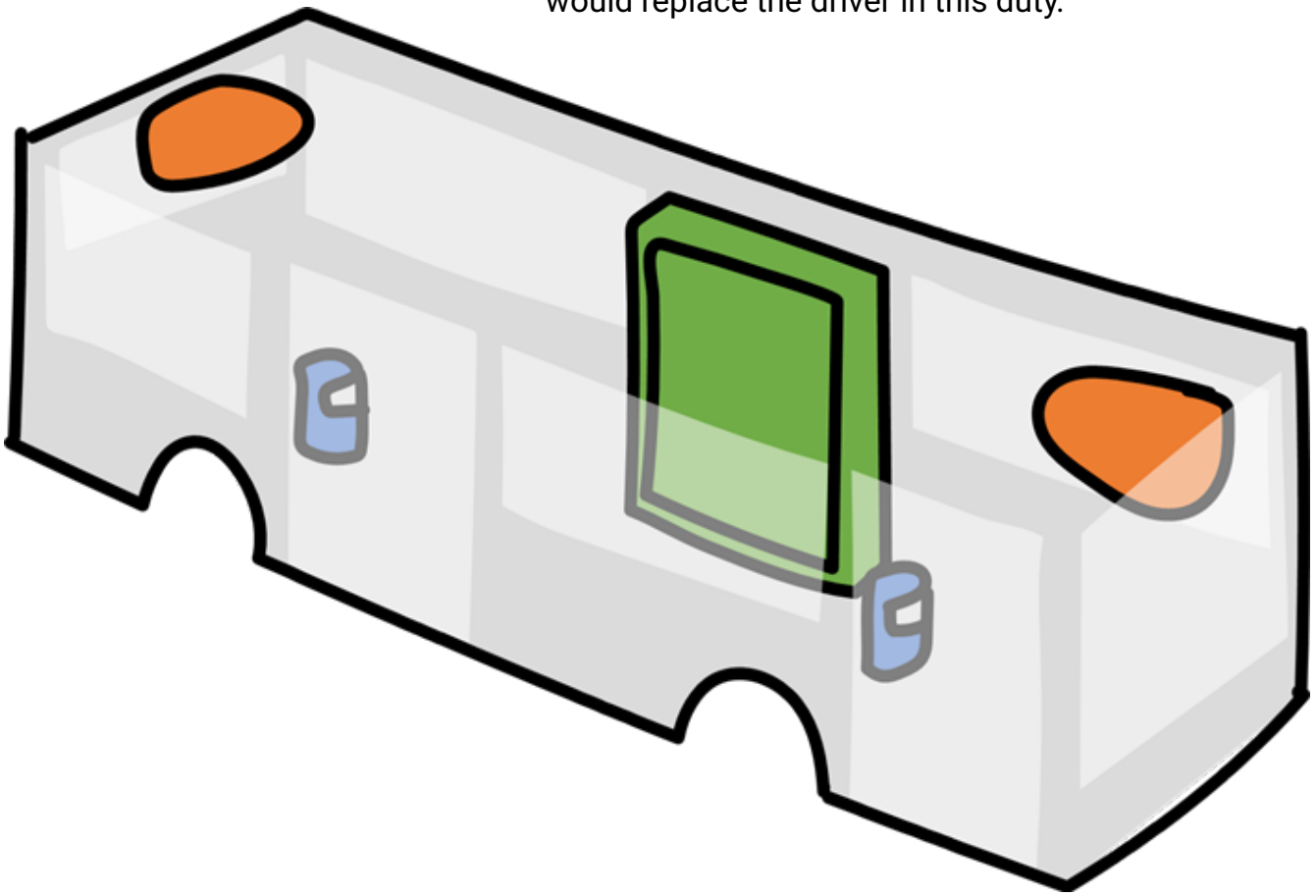
He also has interesting notions about the impact of having or not having good transit systems. Besides lowering traffic congestion levels and greenhouse gas emissions, improving bus services improves equality among citizens. In cities that are hard to navigate by transit, car owners might be able to reach 80 to 90% of jobs in the city within a half hour. But if a household can afford only one or no car at all, the amount of jobs available to you within a half hour by walking and taking transit decline greatly.

The bottom line is that a lot has happened in recent years surrounding self-driving buses, and a lot more is expecting to happen in the near future. And it's for the right reasons too. Buses and public transport are an often-overlooked part of city infrastructure that has enormous potential to improve the lives of so many people.

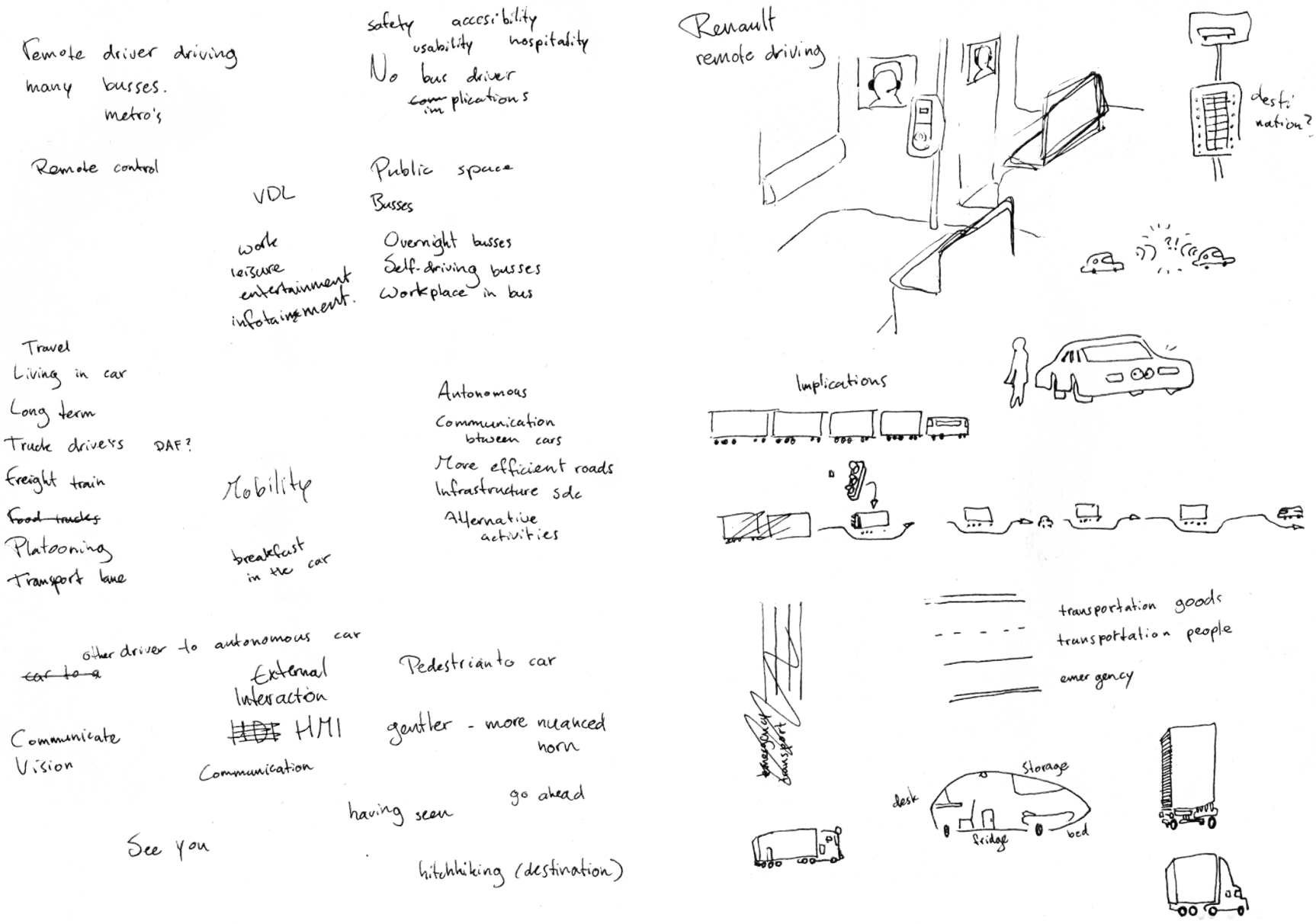
Appendix B: Iteration One

This sketch features card readers for purchasing a ride similar to the ones currently installed in most Dutch buses (blue), a multimedia panel in a central location of the bus (green), and a self-driving system with camera's, sensors and computing unit (orange). Note that there were also some activities require a human driver.

To the right one will find all the duties of a bus driver I could identify, colour-coded with the colour of the system that I could imagine would replace the driver in this duty.



- Sell tickets
- Give directions
- Inform about schedule
- Enforce rules
  - No eating
  - No vandalizing
  - No feet on chairs
  - Stand up for disabled or elderly passengers
  - Making sure passengers pay for their ticket
- Inform about detours
- Remind passengers it is their stop
- Climate control
- Drive bus
- Stop at bus stops
  - When button is pressed
  - When people are waiting at the stop
  - When people are running towards the stop
- Reach stops in time
- Unexpected situations
- Help with wheelchair/stroller
- Chat/socialize
- Fill bus up with gas
- Wake up sleeping passengers



Above: sketches and brainstorms from weeks one and two.

Appendix C: on participatory design

For this project, I have investigated the principles of participatory design.
I started by looking for articles online and immediately noticed there is a lot of material out there. A lot of the articles link through to more articles and resources.
In this chapter I will present some of the most salient sources and my findings from them.

A great place to start is an article by Ines Anić (Anić, 2015) I found early on. From this article I learnt that the way I have designed a lot before is called empathic design, where the designer moves into the world of the end-user.
In participatory design on the other hand, the end user is relocated into the world of the designer. Participatory design is about inviting users to enter the creative process, giving them the tools to create and design concepts of their “perfect world” scenario, while also asking them to explain why they built their concept in a particular way.

Takeaway tips Anić offers are to make sure to spend most of the session closely observing participants and encouraging them to think out loud.
Another article I found helpful was that by UX/UI designer Audrey Mothu (Mothu, 2017).
Muthu dives more directly into methods of participatory design and points to fun resources like Gamestorming (Gray, Brown & Macanufo, 2010), which offers a broad catalogue of exercises and activities for team-bonding and creativity stimulation.

I found the index a bit overwhelming and hard to navigate, but it was a good resource with quick descriptions of exercises one could use, like bodystorming (Gray, Brown & Macanufo, 2010, pp. 59), brainwriting (Gray, Brown & Macanufo, 2010, pp. 82) and Make a world (Gray, Brown & Macanufo, 2010, pp. 184).
Some were familiar to me, some new. All exercises can also be found on https://gamestorming.com/.

When I tried to broaden my search terms I used "co-design", a (much catchier) term that is in literature sometimes used interchangeably with participatory design. Using this as a search term I found “The A-Z of Co-design” (University of Edinburgh, 2016), through the website of the British design council, which encompasses a wide variety of guidelines including further reading in an A-Z style run-down. Co-design seems to be a term that is used for the process rather than the method, and often describes large scale operations involving hundreds if not thousands of people in the design process. Because of this the amount of useful sources I found using it were limited.

Next I looked into several sources on focus groups. I did this because a focus group incorporates many elements that are present in other participatory design methods. It is also a relatively easy way to capture a lot of opinions at the same time and enable participants to respond to each other. The Interaction Design Foundation recommends conducting focus groups with 5 to 10 participants in a circle arrangement (Interaction Design Foundation, 2020). They also recommend videotaping the proceedings to ease analysis afterwards. Other pointers include: being clear about the purpose and expectations of the group; carrying out an “ice breaker” exercise freeing people up to talk; progressing and facilitating discussion, not partaking in it and summarizing and checking for understanding afterwards.

Next, the discussion had during the focus group is analysed. It is important to look for how words are used, what contexts trigger particular responses, and how often and how intensely do themes come up.
Other sources generally agree with this approach (Krueger, 2002; Oxfam International, 2019; Citizens Advice, 2015). Professor Glenn Blank, ex-professor at Lehigh University adds some more details to think about: focus groups should generally last one or two hours, and that facilitators should think about the impact of the location and strive to get full answers and keep the discussion on track (Blank, n.a.).

A lot more in depth and comprehensive is the often-cited paper by Spinuzzi (Spinuzzi, 2005), in which the history, methods and limitations of participatory design are outlined.

Interestingly, multiple articles stress that the results of participatory design sessions are to be valuable source of information, but never an end decision. The designer should always be the expert making the final calls about what ideas to pursue and implement and which to abandon.
Another article outlines the dangers in wrongly interpreting user input without doing further research (Ketterman, n.a.). Ketterman offers a few ways to engage users in slower, more effortful thinking, by entering their world and finding out why (a technique also described in Gamestorming (Gray, Brown & Macanufo, 2010, pp. 141)).

Appendix D: Plan Focus Group

Inform participants:
This focus group will be exploring the job of the bus driver and how it will change if buses make a transition to being self-driving. I would like to get input from bus drivers and passengers on this subject, because they will be the stakeholders most affected by this. I would like to find out how bus drivers see themselves and their job, and what their thoughts are on a transition to self-driving vehicles.

The answers you give during this focus group will be documented and linked to a number. The researcher will know which number belongs to which participant but will not share this with anyone else. If at any point within the next two weeks you would like to withdraw the information you provided from this study, you can inform the researcher. If you choose not to, the data -which is thus anonymous- will be used at the faculty of Industrial Design at TU/e for my final bachelor project. I will use it to inspire a design process and might also use quotes and anecdotes captured today in the documentation of this final bachelor project.

Icebreaker:
What are your backgrounds? Tell us a little about yourselves.

Questions for discussion:
The topic is self-driving public transport. What do you already know about this topic, and what is your opinion on it?

What are your skills and knowledge, what are you good at? This can be professional or hobbies.

In the context of a self-driving bus, how could you practice these skills or apply this knowledge?

What are the activities of a bus driver, ranked from most important to least important? These can be tasks that belong to the job, duties that aren't necessarily in the job description but still need to be done, or things that the bus driver does, just because they enjoy it. Write on a post-it and rank. 5 min. individually, 5 min. gather and rank collectively.

What are issues or concerns in carrying out these duties?

If public transport would become self-driving, looking at the other duties of a bus driver: what would you need to be better able to fulfil these duties?

Concepts:
What are your thoughts on these concepts? For each concept, try to imagine yourself in that situation.

Closing:
Is there anything anyone would like to add?
If you would like to ask or share with me anything on a later date you can contact me at t.m.j.baselmans@student.tue.nl.
You can choose to withdraw the data I collected from you today at any time during the next 2 weeks through the same email-address.
I would like to thank everybody for their participation. Stay safe and healthy and have a good day!

Appendix E: Chair exercise

Note: the recordings made of this exercise cannot be shared due to privacy reasons.

Both sessions started with the same initial configuration of chairs (fig. 1), reminiscent of buses currently active in the public transport system in the Eindhoven area.

SESSION 1
The participants in the first session initially expressed their desire to look out the window, and proceeded to set up all chairs in lengthwise rows with their backs facing each other, allowing all passengers a clear view of the outside. In trying their first design they noted that they also valued personal space. They considered whether the chairs should be a continuous bench or distinct chairs. They thought a bench would eventually allow more people to fit, but preferred chairs as not to encroach on fellow passengers' personal space. Another value they saw in this configuration was that each passenger has enough space to store large or small items of luggage, without having to take up the seat next to them; they can simply store it in front of them or in the space below their seat (which in this layout is much easier to access). Finally, they noted that the chairs backs should not be too close together as the back of passengers heads would rub up against each other.

The second layout they made and tried was the opposite, in which all chairs faced inwards. This layout enabled more interaction between passengers and allowed bigger groups to sit together and communicate more effectively (unlike their previous layout). Again they brought up the topic of luggage, saying this layout would also allow people to brig bigger pieces of luggage onto the bus.

Next, I asked them where they would usually sit on the bus, and what types of passengers sat where. We started by designing for the people usually occupying the long bench in the back of the bus; bigger groups of people aiming to socialize and seeking a bit of seclusion from the front of the bus. Often these groups travel big parts of the bus line. In designing for this group participants came up with a layout which further enhanced these attributes, with the row of seats before the back row facing back. Participants noted that they had doubt whether the seclusion of this compartment would be desirable, because a layout like this might be "looking for trouble", exacerbating rowdy, loud behaviour. They noted these types of groups would often eat on the bus and make a mess. I asked whether food would be part of the bus of the future. They replied it might be if there were a way to make it less messy, for which they proposed plastic, easy to clean chairs or a mesh underside of the bus, making food scraps fall directly onto the road.

Next, participants explored passengers seeking a quieter ride, being able to focus on work. Participants envisioned an individual chair facing the window in a little cubicle with a desk. This would offer privacy and minimal distraction. To easily access a cubicle the chairs would have to swivel or slide back and forth into place. Once they had laid out this concept, I saw potential in the movement of the chair and pressed them to clarify how they

envisioned the chairs would move, and whether there were any other applications using this they could think of.

They came up with the option of providing a more flexible layout to the classic 2/4 system by allowing chairs to pivot at the base, making them reverse direction. When sitting in this layout, participants noted they would like to have a footrest as well, and that they liked the extra space.

Another thing one participant noted was that they liked sitting near the checkout machine, because everyone needing to check out at the same time can cause congestion at the doors. They suggested the possibility to check out of the bus at each chair to prevent this.

Additionally, they came up with chairs that could be folded up or down by the chauffeur. This would mean the chauffeur would decide where each passenger would sit by flipping up a chair. Both participants really liked this idea. They said choosing a seat was often hard and having one selected would offer peace of mind and less complexity. Also, they thought the bus would be more spacious if less passengers were sitting and that more seats would fill up if it were busy. This idea was met with a lot of enthusiasm.

As the exercise progressed their ideas seemed to get less conventional, but also rougher and following each other quicker, with less thought gone into each idea.
- Chairs sliding across the floor (on rails) and snapping into place once weight is put upon them, allowing for flexibility.
- Passengers sitting on each other's lap in a long row from the back of the bus.
- Sitting on the roof, in the outside air.
- Sitting in cubicles like those in airplane business class, with reclining seats, a little table and personal entertainment screen (fig. 8).
- Implementing more possibilities for movement and sports, like biking pedals or spinning bicycles on the bus (possibly allowing one to charge their phone).
- A smaller bus that is more akin to a beer-bike in size and shape, with the driver in a console in the centre, and all passengers in a circle around it.

SESSION 2
Participants in the second session were more hesitant in using the chairs to express their ideas right away. When asked to show what the bus of the future might look like, one replied that they thought the bus would not change much, considering that the bus had not changed that much in the past 30 years either.
The other envisioned radical change, of all people traveling sitting on their own, personal "egg" between their legs. The bus would be completely empty, without chairs, and just have spaces these personal vehicles would fit into and lock into place. The bus would be driver-less, but just a moving room.
On that note, a discussion arose regarding the implications of driver-less buses. We talked about how buses were likely to become smaller without drivers According to them, the advantage of large buses is that all passengers share the cost of having the driver. With this advantage out of the equation, buses would be more likely to take the shape of an on-demand taxi service, with just one or two chairs. Self-driving vehicles like this could also be modular, consisting of segments that can link up to become a bigger whole.
Another suggestion was that during peak hours, the bus would extend upwards or outwards, adding a second floor to the bus, or a trailer.

To engage them in using the chairs, I invited the participants to take a seat in their favourite positions on the bus. They both chose window seats facing forward in the front, 4-seat section of the bus.

Their motivations for this were wanting (leg)room, a seat by the window and to face forward.
Next, I asked them how to increase these values and to make them apply for more seats. One participant immediately suggested removing the seats next to them, creating a single file for more space. When I removed the chairs next to them, the participant renounced this idea.
The participants came up with the idea of slanting all chairs outward to make all chairs face the window more. Although they liked facing outward and having a bit more space to themselves, they also found that this layout felt a bit asocial and removed.
Participants noted that they would expect buses to make a move towards offering more different options for different types of passengers.

Next, I asked them to take the opposite values, and design for them; a bus for passengers who don't care about the windows, want to engage with the inside of the bus rather than the outside, don't mind being close to other passengers or facing backward on the bus.
To fulfil this task, the participants found the bus would need a big round table and seats facing inward. They built a layout of several inward-facing circles. The table would be for doing work, watching series or eating and drinking. Maybe there could be a mini fridge under the chairs and places to plug in appliances. Interestingly, one of the participants indicated they really liked this design, even more than the first concept in which I asked them to design for the values they find important.

Lastly one participant brought up a problem they had with working on public transport. They felt like they lacked space and a proper screen. He would prefer to have more room meaning it would be easier to type and look at their screen. To have a more office-like setup. Maybe they would like a standing desk. When thinking this through we thought we would need braces on the side and a way to make sure things don't fall or roll off the desk.

Appendix F: Plan semi-structured interview

I would like to talk about the future of buses in the public transport sector. For my final bachelor project, I have taken an interest in the development of future buses, and I am researching the visions and opinions of the public regarding this.

I would like to record the talk we're about to have. I will not share or publish this recording, but only use it to be able to listen back and transcribe what we talked about. In documentation of this project you will be kept anonymous and only referred to as "participant" followed by a number. If at any point within the next week you would like to withdraw the information you provided for this study, you can inform me. If you choose not to, the data -which is thus anonymous- will be used at the faculty of Industrial Design at TU/e for my final bachelor project.

Part one: open
What was the last time you rode on the bus, what can you tell me about that time? What stood out? What do you like about travelling by bus? What do you dislike?

The year is 2035 and you are getting ready to take public transport to your aunt out of town. How do you envision this? What do you do to plan your journey? What does the bus look like?
Are there things you would improve?
Are there things that definitely shouldn't change?

There is a lot of talk about self-driving cars at the moment, what comes to mind when you think about self-driving cars? What impact do you think this could have on the bus?

How do you think the role of the bus driver would change in a scenario where self-driving buses become a reality?

Part two: closed
What do you think of the following concepts?
Take your time to imagine entering and being in a bus that looks like this, what is it like? What are you doing, and how are you feeling?

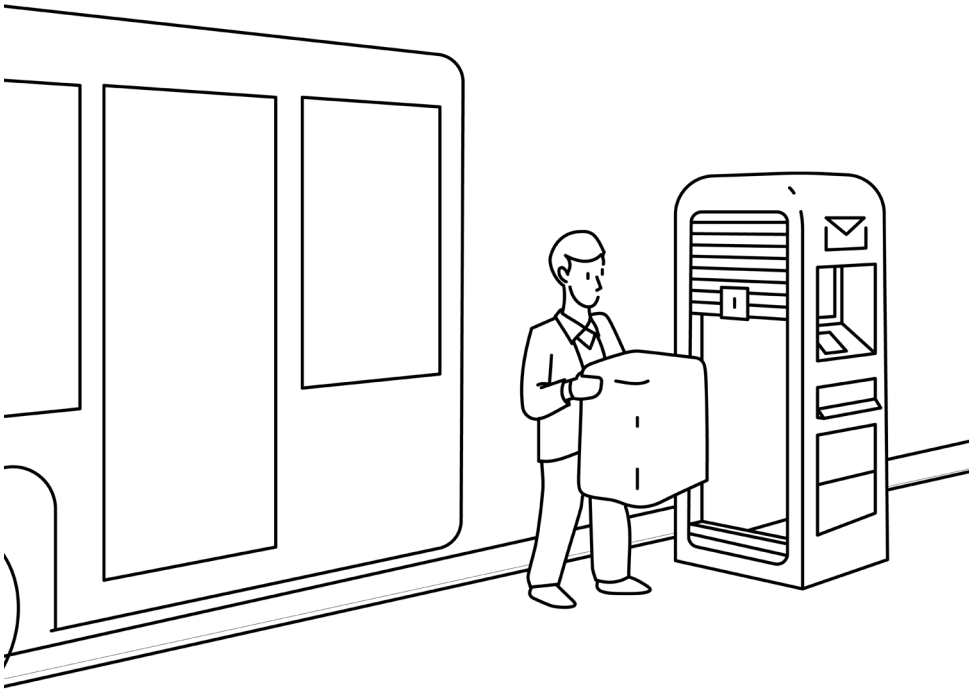
Part three: semi-open

In the Netherlands we are on the brink of opening buses and trains to the public again. Many people are worried about staying safe while travelling on the bus, what do you think about this situation?

We have covered a lot of different topics, is there anything else you want to talk to me about?

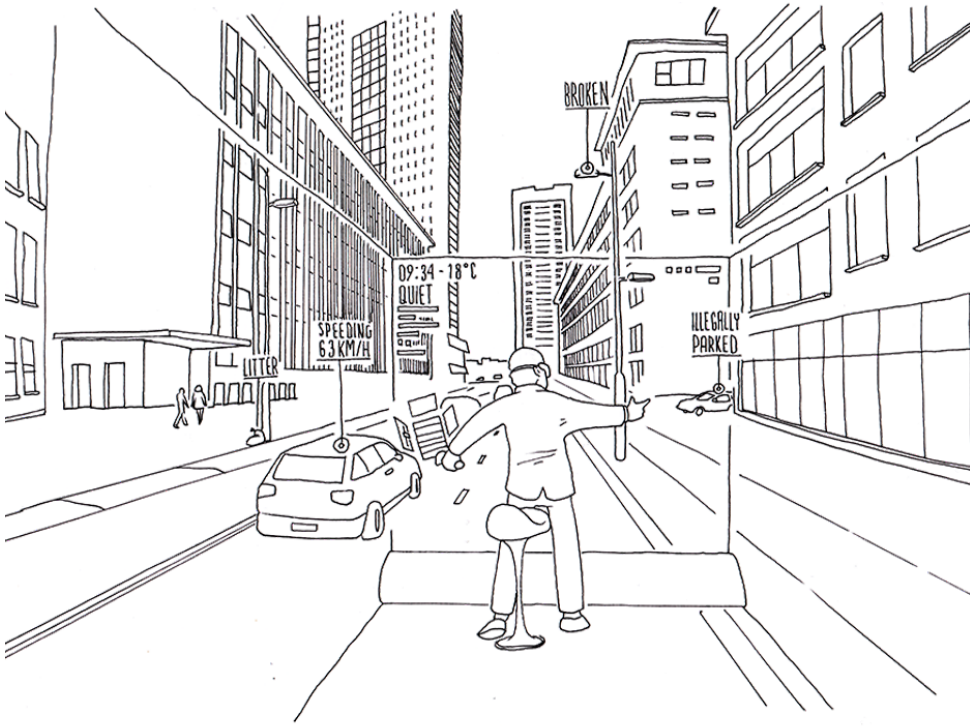
If you would like to ask or share with me anything on a later date you can contact me at t.m.j.baselmans@student.tue.nl.
You can choose to withdraw the data I collected from you today at any time during the next 2 weeks through the same email-address.
Thank you so much for your participation. Stay safe and healthy and have a good day!

Appendix G: Rejected concepts



In this concept, the bus driver of the self driving bus helps the mail delivery service by bringing batches of mail to containers near their bus stops. It would save postmen time travelling back and forth between the depot.

It was rejected early on in the process on the basis that it would take valuable time at the bus stop to unload mail and secure it, holding up passengers and not adding value for them.



In this concept, the bus driver is wearing VR goggles with a live feed of the bus' surroundings. They can make live annotations of points of interest like broken infrastructure, suspicious situations or litter which get relayed directly to city council. They essentially become a mix between surveillance camera and community police officer.

It was rejected because it made the bus driver more intimidating and less approachable for passengers, who at this point had become the main focus of this project.

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