Customizing the Autonomous Vehicle Experience

Aspen Tng

Acknowledgements

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Duration

12 weeks
Individual Project

Tools

Notion
Figma
Messenger (User Interviews)

My Roles

Design Research
UX Design
UI Design
Visual Design

Design Process

Market Research
User Research
Synthesis
User Persona
Concept Development
Storyboarding
User Navigation Flow
Wireframing
Prototyping
Mockups

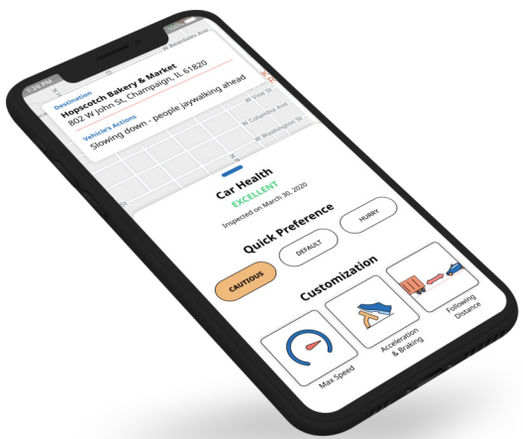
Overview

INTRODUCTION

Autonomous vehicles, the 550 billion-dollar industry, will soon become a main mode of our everyday transportation. This is expected to happen within the next 10-20 years and most of us are not ready. Similar to previous technologies, autonomous vehicles will only be for public use when the technology is stable, and it has passed the necessary tests. However, many of us remain doubtful and skeptical.

WHAT IS AN AUTONOMOUS VEHICLE?

Autonomous vehicles, also known as self-driving vehicles, refer to vehicles that are able to move from point A to point B through current traffic conditions without human intervention. This is made possible through actuators, complex algorithms, machine learning systems, and power processors[1]. Currently, these vehicles take the form of traditional cars, buses, and semi-trucks, but we can expect a change in physical form as the technology becomes more reliable (and fully autonomous).



PROBLEM

If autonomous vehicles will become part of our everyday lives, what can we do to remove skepticism and fear, and build trust so that they are well-received?

SOLUTION

A mobile app that allows passengers to customize their (first time) ride experience. New technologies typically find their way into the market as people gain exposure to them over time. Through an app, users are able to set preferences according their level of comfort and risk threshold. They will slowly embrace the technology over repeated experimentation of the configurations and over time.

Definition

6 LEVELS OF DRIVING AUTOMATION

According to the Society of Autonomous Engineers, there are 6 levels of automation in vehicles. These levels have also been adopted by the U.S. Department of Transportation[2].

For the first 3 levels, responsibility lies primarily on the driver. From L3 through L5, majority of the responsibility slowly shifts over to the machine.

L0

Zero Automation

Driver has, and is required to have, full control over the vehicle. There is no assistive technology at all, including power steering or anti-lock braking system (ABS).

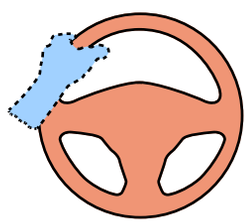
L1

Driver Assistance

There is basic assistance, such as ABS, adaptive cruise control. Majority of the responsibility is still on the driver.

L2

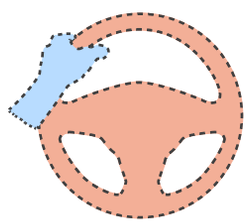
Partial Automation



This is the most common level of technology we have today (2020), where vehicles are able to steer, accelerate, and brake on their own. The driver still has to pay attention to the roads.

L3

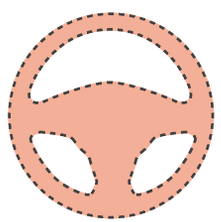
Conditional Automation



Drivers not required to keep their eyes on the road during certain conditions. The system will cue the driver to take over when there are scenarios that it is not able to handle or navigate.

L4

High Automation



The vehicle drives independently in majority of situations. A steering wheel is present in case of critical situations where the driver is required to intervene.

L5

Full Automation

The driver can be considered a passenger and is not required to perform any tasks at all. There are no steering wheels or pedals available.

Initial Research

STATISTICS

The autonomous vehicle industry is projected to be worth $556.67 billion by 2026. Autonomous vehicles will soon become a significant part of our everyday lives, and many believe that it'll become a main mode of everyday transportation[3] [4].

More than

90%

of vehicle crashes can be attributed to driver error[5].

There are approximately

35,000

deaths by vehicle accidents in the US annually[6] [7].

Cars spend

95%

of their lifespan parked and unused[8].

CURRENT PUBLIC CONSENSUS

Based on adults in the United States of America,

50%

think that autonomous vehicles are more dangerous than traditional vehicles operated by people[9].

53%

accepted the idea of self-driving trams or shuttles (in limited-use cases)[11].

66%

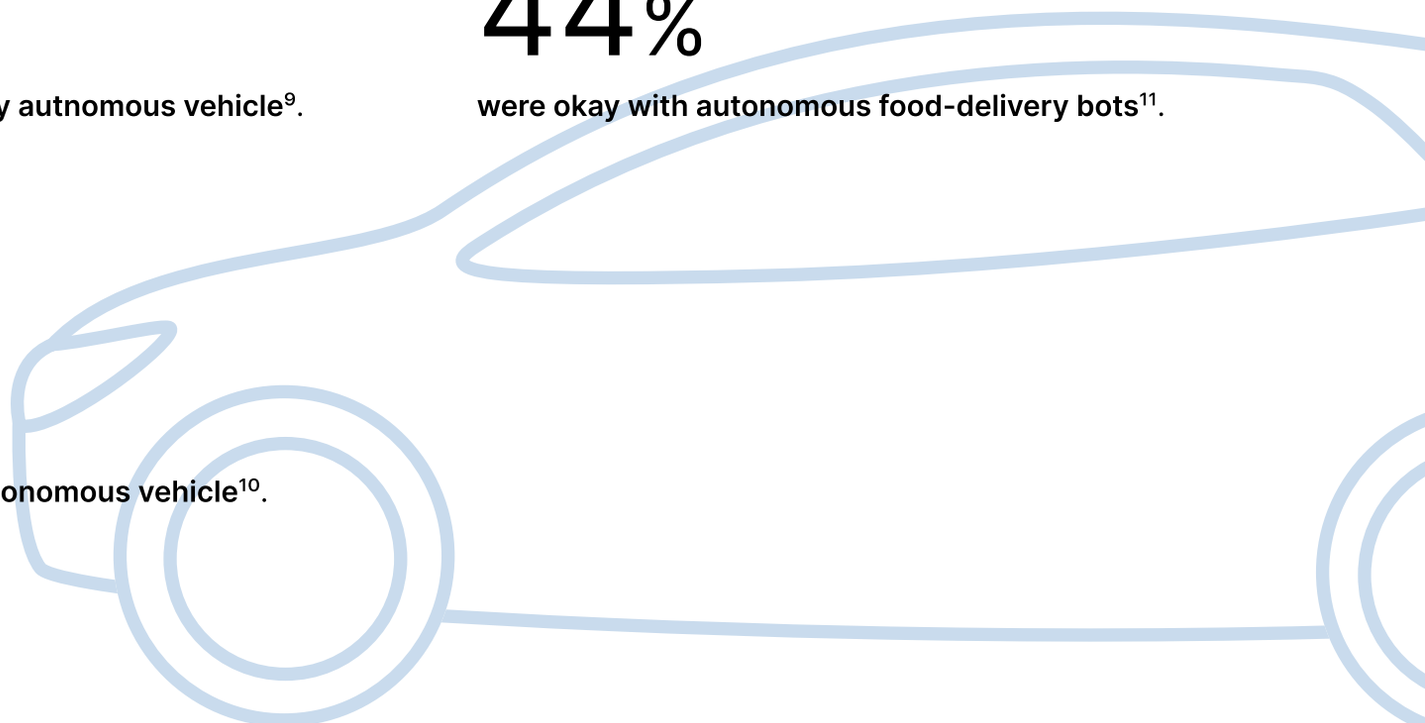
said that they would not buy a fully autnomous vehicle[9].

44%

were okay with autonomous food-delivery bots[11].

71%

were too scared to sit in a fully autonomous vehicle[10].



PROBLEM

Autonomous vehicles are on their way to becoming a main mode of transportation, as seen from the huge amounts of investment and research put into the industry. However, **people are not going to adopt them immediately because of fear and skepticism of this new technology**.

“...it takes one spectacular incident to make it much harder to win widespread acceptance...”

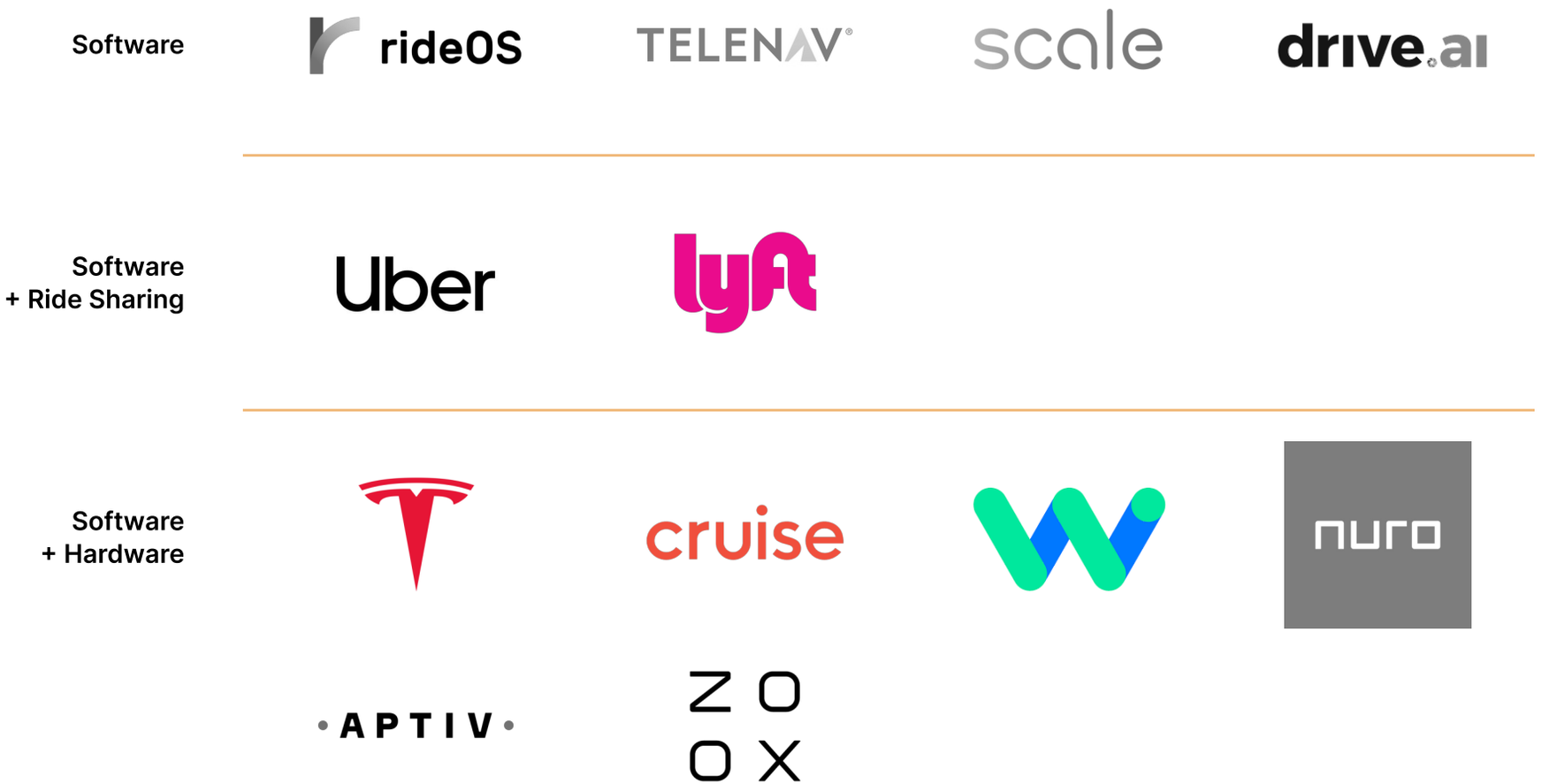
- Dieter Zetsche, Chief executive at Daimler [12]

Research

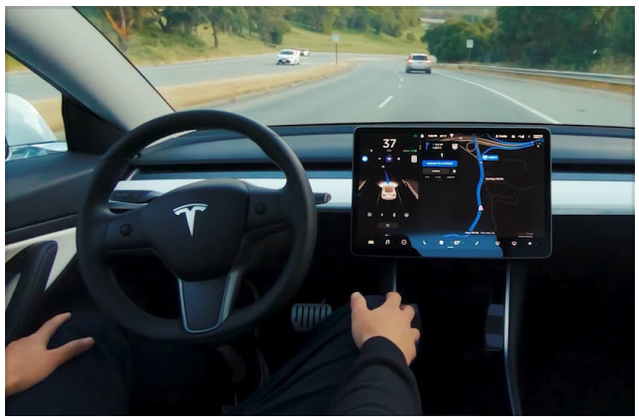
MARKET LANDSCAPE

The companies in the autonomous vehicle industry can be broadly sorted into 3 categories: software only, software with “borrowed” vehicles (ride sharing services), and full-stack companies that are creating new software and new vehicles.

For this project, I focused on 3 companies (Tesla, Alphabet’s Waymo, and Cruise) because they established companies that are creating both a new vehicle and developing software. I also looked into ride sharing services (Uber and Lyft) to understand the fleet models.



MARKET LANDSCAPE



Tesla was one of the first companies to develop the self-driving technology and it is probably the most well-known company in the commercial automotive space for it. Self-driving capabilities are constantly implemented through software updates. It is one of the earliest companies to launch the "maximum speed" feature[13] - an inspiration I looked into for this project.

Cruise is a subsidiary of General Motors, and is invested heavily by Softbank[14] and Honda. In January 2020, it unveiled a new all-electric production vehicle that will be part of an on-demand ride-hailing service. This L5 vehicle features 2 spacious benches[15], facing each other, with no steering wheels or pedals.

Waymo is currently testing its technology primarily in Mountain View, CA and Phoenix, AZ. Its cars have driven more than 20 million miles on public roads[16]. It recently launched its 5th generation Waymo Driver and announced a partnership with the Jaguar to use the I-PACE as its next fleet of vehicles[17].

Waymo has placed great emphasize on designing the ride experience through well-crafted in-vehicle screens and sounds. It ensures that riders know what the car is doing and it "anticipate[s] questions" passengers might ask[18].

Research

RESEARCH PAPERS

I read and referenced 11 research papers for this project. The information below is a summary of some of the key takeaways. The titles of the papers are listed at the end of this process book.

Scale of Trust

There is a scale of trust from distrust(negative) to trust(positive). Since self-driving vehicles are not widely available, the public still has a fairly neutral opinion of them. Extra care should be exercised to ensure that the level of trust only moves up the positive scale because entering the scale of distrust will make the task exponentially more difficult.

Parallel Experiences

Since self-driving vehicles are not commerically available yet, most people do not have opportunities to interact with them and their perceptions of them are drawn from similar and/or parallel experiences. This includes government policies and institutional and societal responses.

Time Factor

Similar other new technologies, acceptance of self-driving vehicles will have to be established over time (through good track records).

Perception of Trust

The perception of trust is how people feel about an object or situation regardless of how or what they actually are.

Privacy and Security

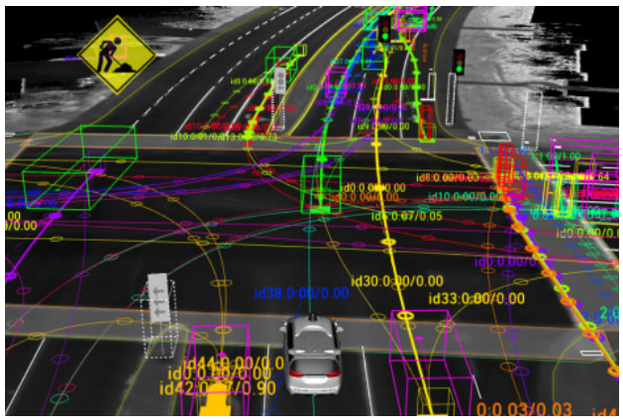
People are concerned with how information is stored. They want to know that vehicles are safe from hacking and there should be no technical glitches in the technology and ride experience.

Safety of Driving

complete self-driving > human driving > self-driving + human driving (L3/L4)

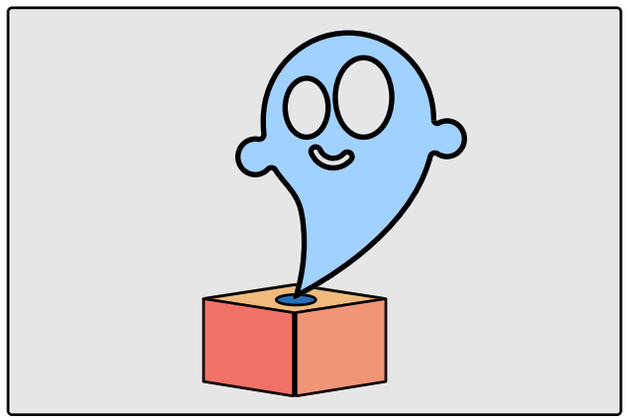
When drivers are cued to take over driving, there is a delay in response time before they reach the state of full alertness, and this process potentially causes more issues.

PSYCHOLOGY THEORIES



Algorithm Aversion

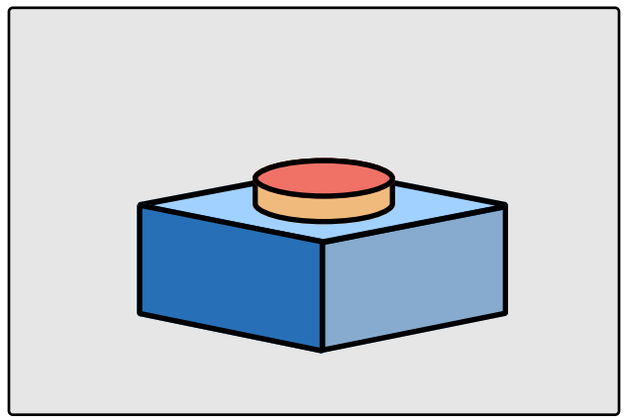
The idea that people often prefer decisions or actions by humans over those made by machines (that are created for that specific purpose)[19]. Human judgment is tied to the belief that one's ability can improve over time. This faith is enough for most people to pick decisions made by humans over machines, even when the results show otherwise[20].



Theory of Mind

This is the ability to attribute mental states to objects or people. It involves understanding the knowledge, beliefs, emotions and intentions of others, and making decisions based on them[21].

In current driving scenarios, drivers interact with others and react accordingly. In the case of self-driving vehicles, it is difficult to personify these machines.



Panic Button Effect

This theory refers to the reduction in stress of suffering if one believes that there is an option of escaping or controlling the situation, regardless of whether that option was used[23].

An option to stop the ride when travelling in a L5 autonomous vehicle is an important feature to include in the solution.

Research

USER INTERVIEWS

I conducted **user interviews with 10 people**. Here's the break down:

Driving Abilities

Occupations

Interview Format

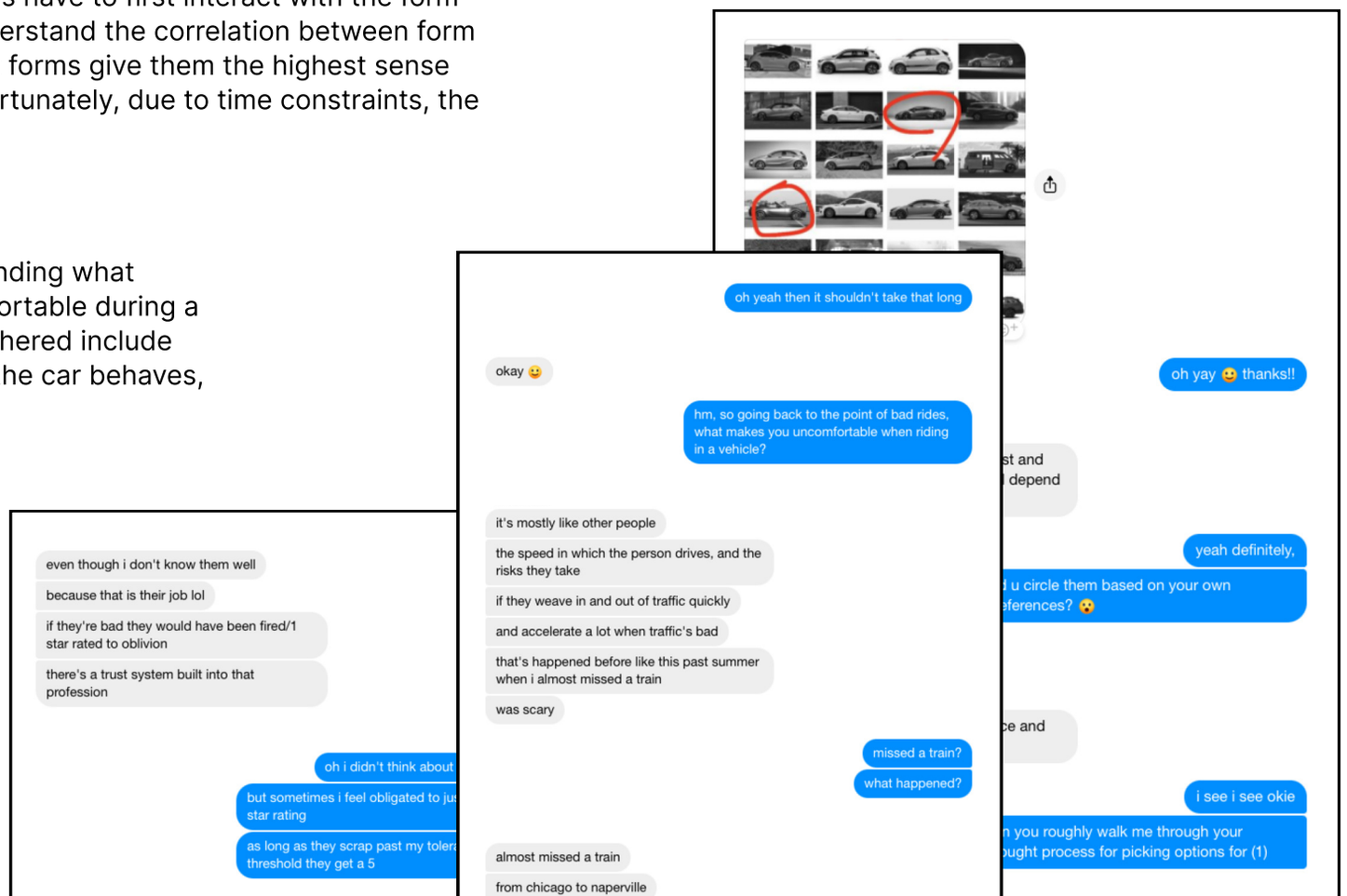
The interviews had 2 sections:

Section 1 - Exterior

Before entering the vehicle, passengers have to first interact with the form of the vehicle. This section was to understand the correlation between form and how a person feels about it - what forms give them the highest sense of confidence, trust and comfort. Unfortunately, due to time constraints, the results were analyzed but not used.

Section 2 - Interior / Ride

This section was focused on understanding what makes people feel confident and comfortable during a ride in today's context. Information gathered include physical structure of the interior, how the car behaves, and interactions with the driver.



USER PERSONA

Claire Wilson

“There's a trust system built into that profession (ride sharing)”

“[I’m] worried about driving on campus as it is a high stress situation. [I’m] worried if the car knows the way especially because there are many one-way streets”

SUMMARY

Claire is a Junior in college and has done tech internships in the Bay Area. She keeps herself updated with news about the latest technologies and categorizes herself as a ‘late’ early adopter of technology. She does not drive during the school year and uses the car 2-3 times when she goes back home for breaks.

ABOUT

Age	21
Gender	Female
License	January 2018 (1.5 years ago)
Current Location	Champaign, Illinois, USA
Hometown	Chicago, Illinois, USA
Driving Frequency	2-3 times a month

VEHICLE PREFERENCES

Prefers to be a passenger

Stressful to drive | Less responsibility | Not confident in driving abilities

Factors for trusting autonomous vehicles (notes below)

Familiarity vs Time | Believe in the system | Lack of confidence

Believe in the System
When a system/ecosystem is launched (current ridesharing services or future autonomous vehicle fleets), it should have passed all the minimum criteria and safety checks.

Lack of Confidence
If they don’t trust themselves with the vehicle, they are more willing to put this responsibility on someone or something else.

Familiarity vs Time
People will trust and form relationships with systems over time. The higher the frequency of exposure to autonomous vehicles on the streets, the faster they are adopted. (think: initial concept of Uber/Lyft & Airbnb).

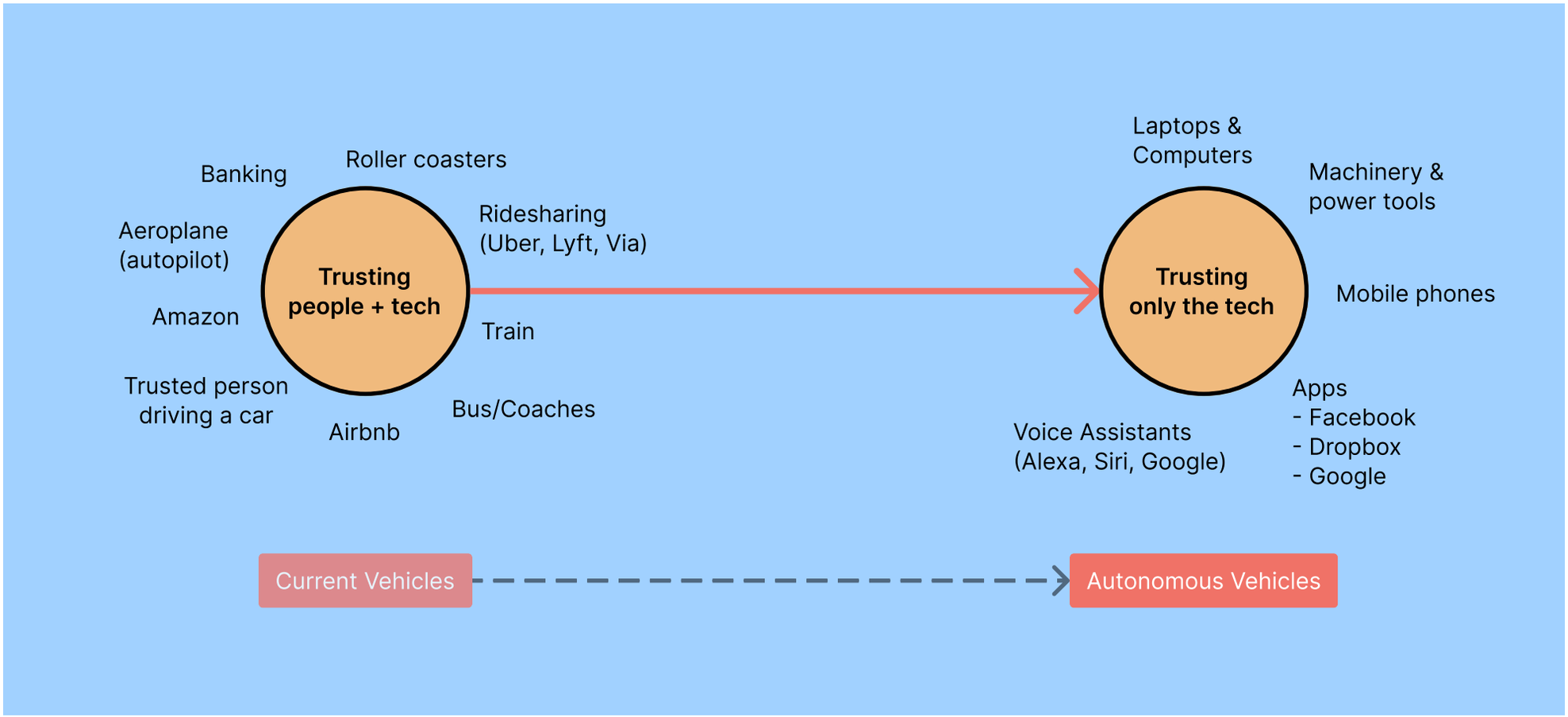
WILLINGNESS TO TAKE A RIDE (at this moment in time)

Short Distance (15 minutes)

Long Distance (3 hours)

DESIGN BRIEF

Imagine that you're seated in an airplane cruising at 35,000 feet on autopilot, or seated a coach travelling to your new destination, or seated in a roller coaster being swung around at high speeds for entertainment. In any of these scenarios, **you have almost no control over your vehicle, yet you trust it** (enough to be sitting in it). This is perceived trust. **How are we able to map this experience to an autonomous vehicle?**

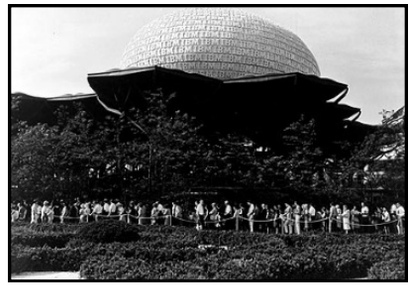


How do we assist this transition of trust?

Concepts

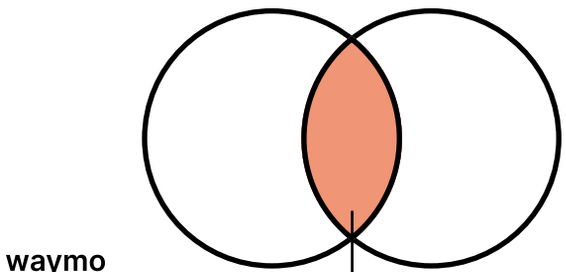
BRAINSTORMING/IDEATION

Through the use of mindmaps, venn diagrams, sketches and other visual aids, I tried to make sense of the information I gathered from user interviews and the rest of my research. I also looked at similar and parallel experiences and historical events (e.g. IBM Pavilion in 1964) for inspirations.



continuous education ⟷ **familiarity with car / more willing to be in it**

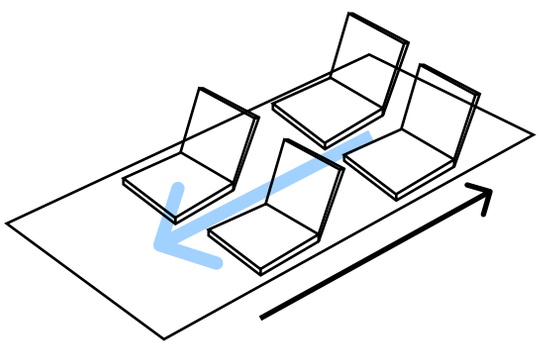
human control ⟷ **trust** no choice but to trust vs. something I can do myself (risk taking)



Eye contact
"theory of mind"

waymo
display shows what the car is doing

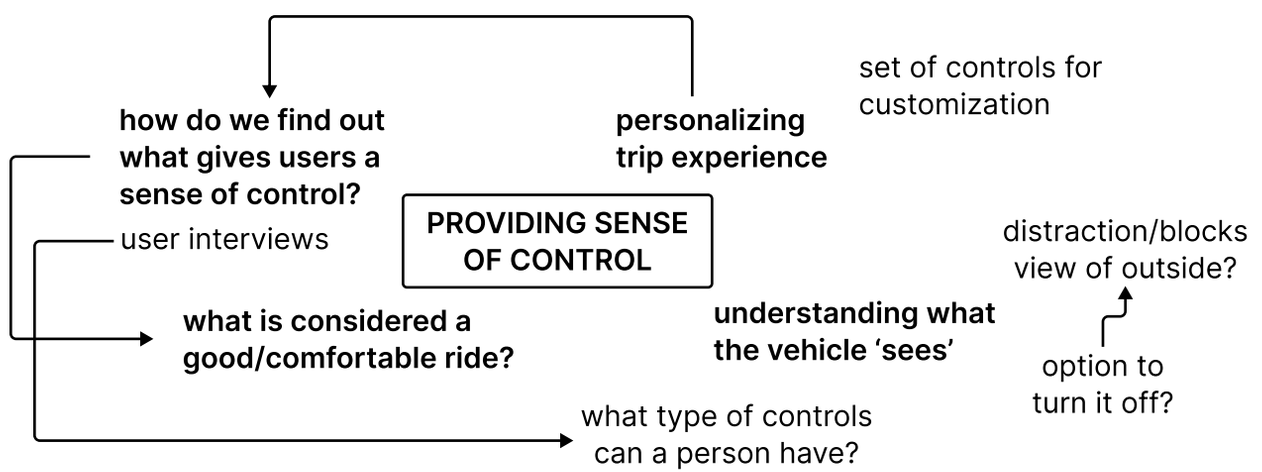
Is there an overlap?
information focused? - elevators?
VR?



sitting in a bus

sitting further back
= feeling safer?

not seeing the front

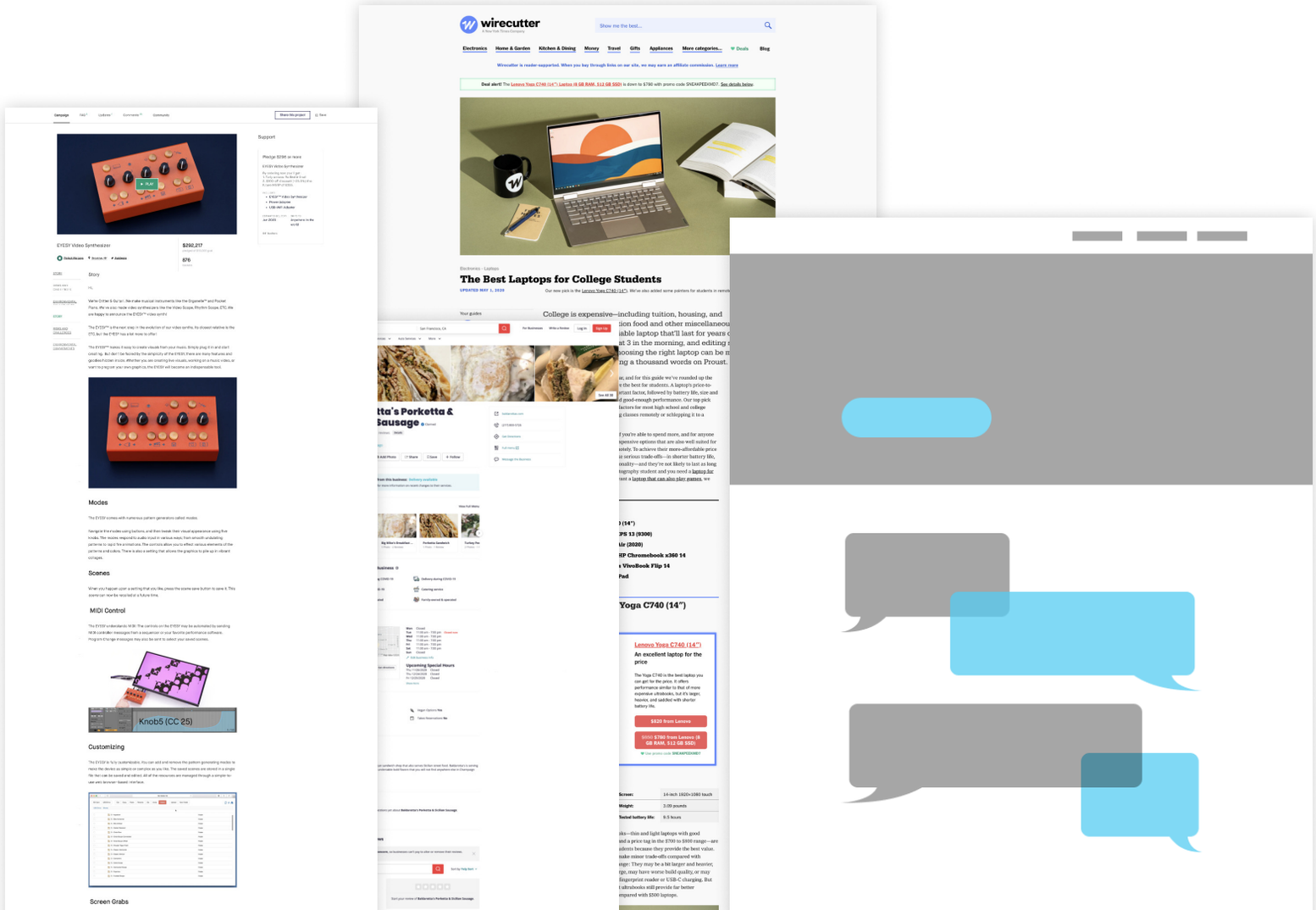


Concepts

#1 EDUCATIONAL WEBSITE

When people want to make purchases of an item that they are not well-informed about, they would often learn about it through online reviews, forums or videos. These pieces of information will educate them about the product and help them make better informed purchase decisions.

This concept of an educational website will allow people who have taken a ride in an autonomous vehicle to **document their experiences**. People who are interested or curious about the experience can **use this website to learn more about it**.

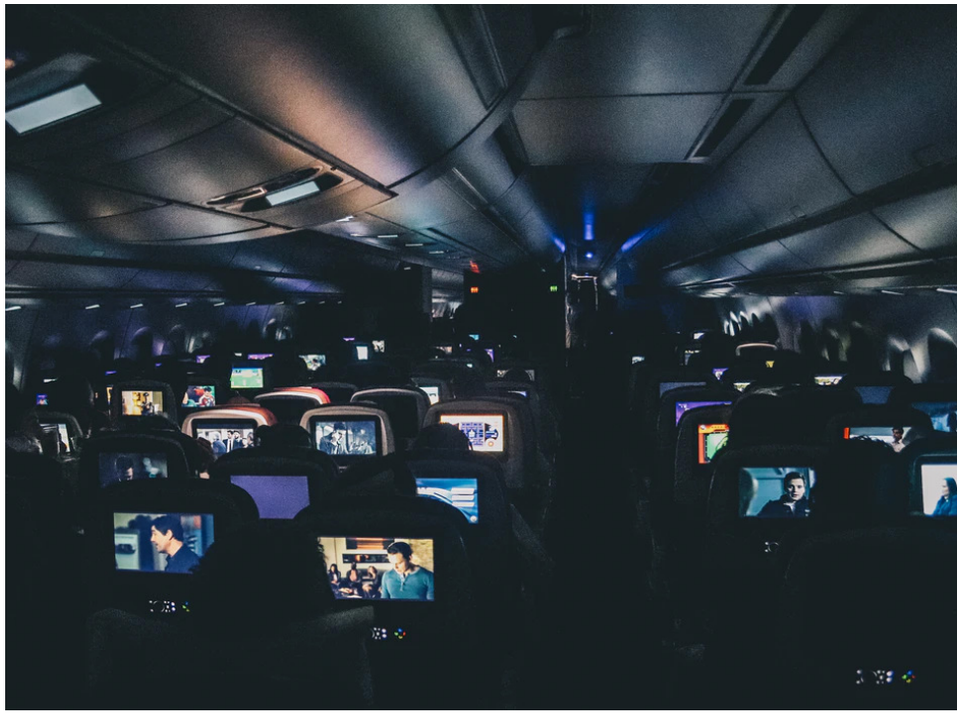


Concepts

#2 “MOVING PEOPLE BACK IN SPACE”

The concept is to **“move people back in space” so that they are “seated” as far away from the front as possible**. This experience can be created either physically or virtually (through augmented reality or virtual reality).

When I was trying to understand why riding a bus can feel like a safe experience even though passengers have no control of the vehicle, I **hypothesized that that not being able to see the front of and beyond the vehicle removes a layer of anxiety**. Later on, one of my user interviewees mentioned that he would prefer to either sit facing or at the back of the vehicle, so that he will **not be able to see the front and “lose the need to trust”.**

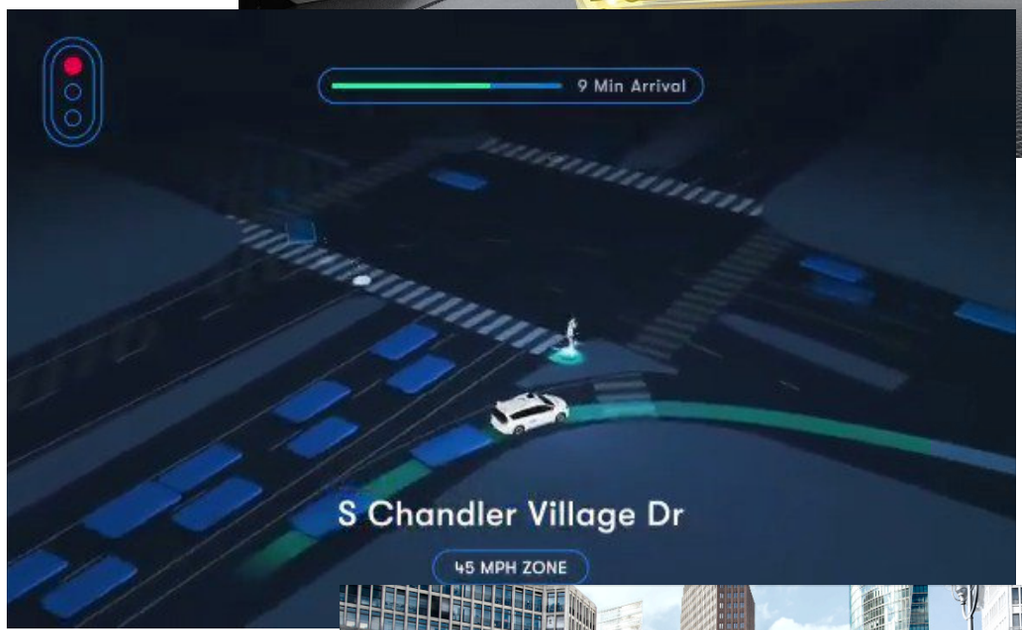


Concepts

#3 AUGMENTED REALITY WINDOWS IN VEHICLES

The concept is to allow riders to understand what the vehicle is “seeing” and doing and its reasons for doing so at that moment in time and immediately after. This can potentially be done through augmented reality windows.

People like to be in control and like to know what is going on with systems. Waymo currently has an excellent system of informing riders about what the vehicle is currently doing and why they are performing certain actions. However, passengers view their vehicle on the screen from a bird’s eye perspective. I wanted to explore **the possibility of providing this information and more, from a first-person perspective through the windows of the vehicles**. Think of it as vehicle heads-up display, but for all windows.



Concepts

#4 CUSTOMIZING COMFORT LEVELS

This concept is to allow passengers to customize preferences and settings of their autonomous vehicle ride.

For people new to a product, the ability to test or do trial runs help them to understand the product much better. It also serves as an educational tool to let skeptics know that the vehicles will “listen” to them and help them ease into the experience of using these vehicles.

For people who are seasoned riders, they can customize advanced options to match their preferences. Think of the concept like a music equalizer; people are able to toggle settings (within limits) to make their music sound the way they want it to.

Chosen Concept

CUSTOMIZING COMFORT LEVELS

I chose **concept #4 Customizing Comfort Levels**. This app can be used by both first-time riders and seasoned passengers. It goes beyond the purpose that concept #1 serves and it also serves as a great foundation that concepts #2 and #3 can be build on.

Through this app, riders can continuously interact with the driverless vehicle to learn that it is safe and it follows commands issued on the app. With a mobile app, instead of an in-vehicle screen, riders are able to begin their customization before the vehicle arrives.

This autonomous vehicle option will also ideally work together with current ride-hailing services in a fleet model, so that the option can be advertised when riders are choosing the type of ride. The setting preferences will be tied to the user's account, and not the vehicle.

Assumptions for Solution:

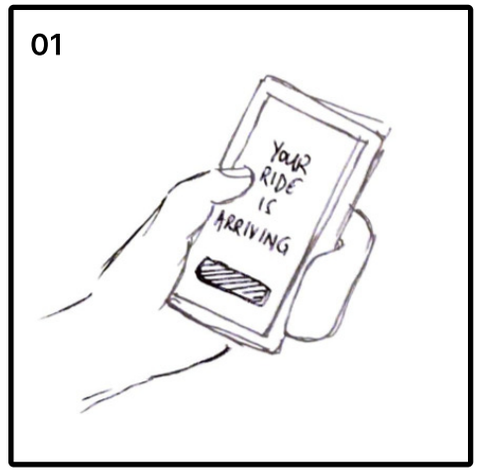
All passengers commute alone; settings are tagged to individuals.

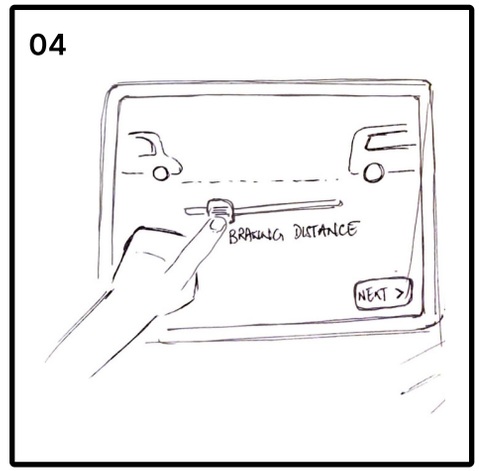
No in-vehicle screens (unlike Waymo vehicles).

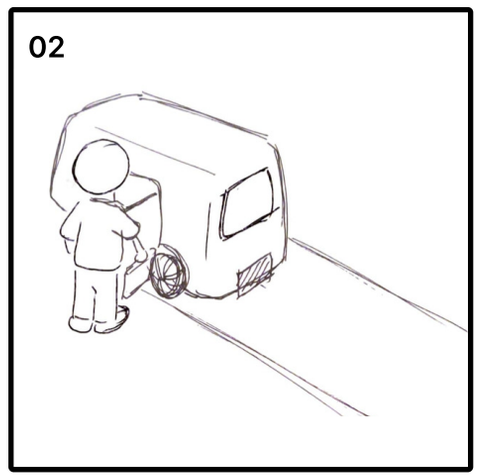
Feature will be build to work with existing services (Lyft & Uber).

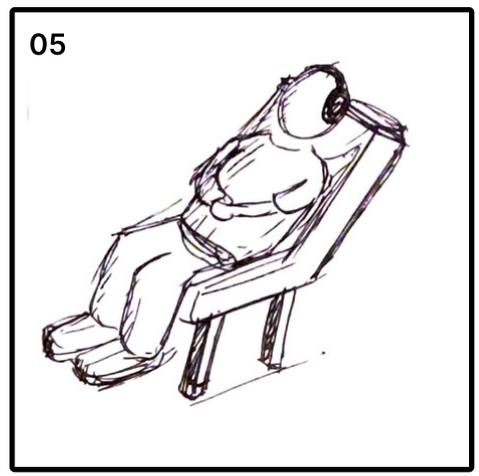
Service follows a fleet model and vehicles are L5 autonomy.

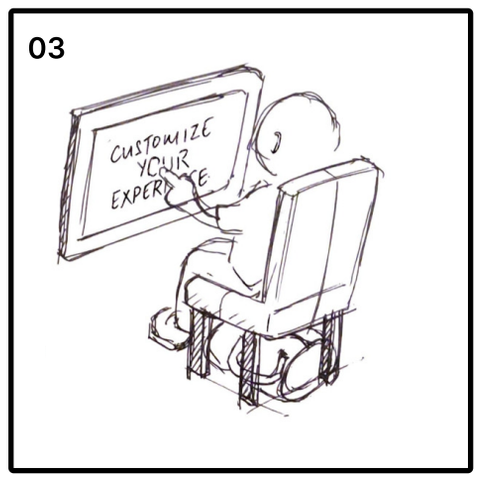
Autonomous driving technology is stable enough for public roads.











This is a quick storyboard of the initial concept.

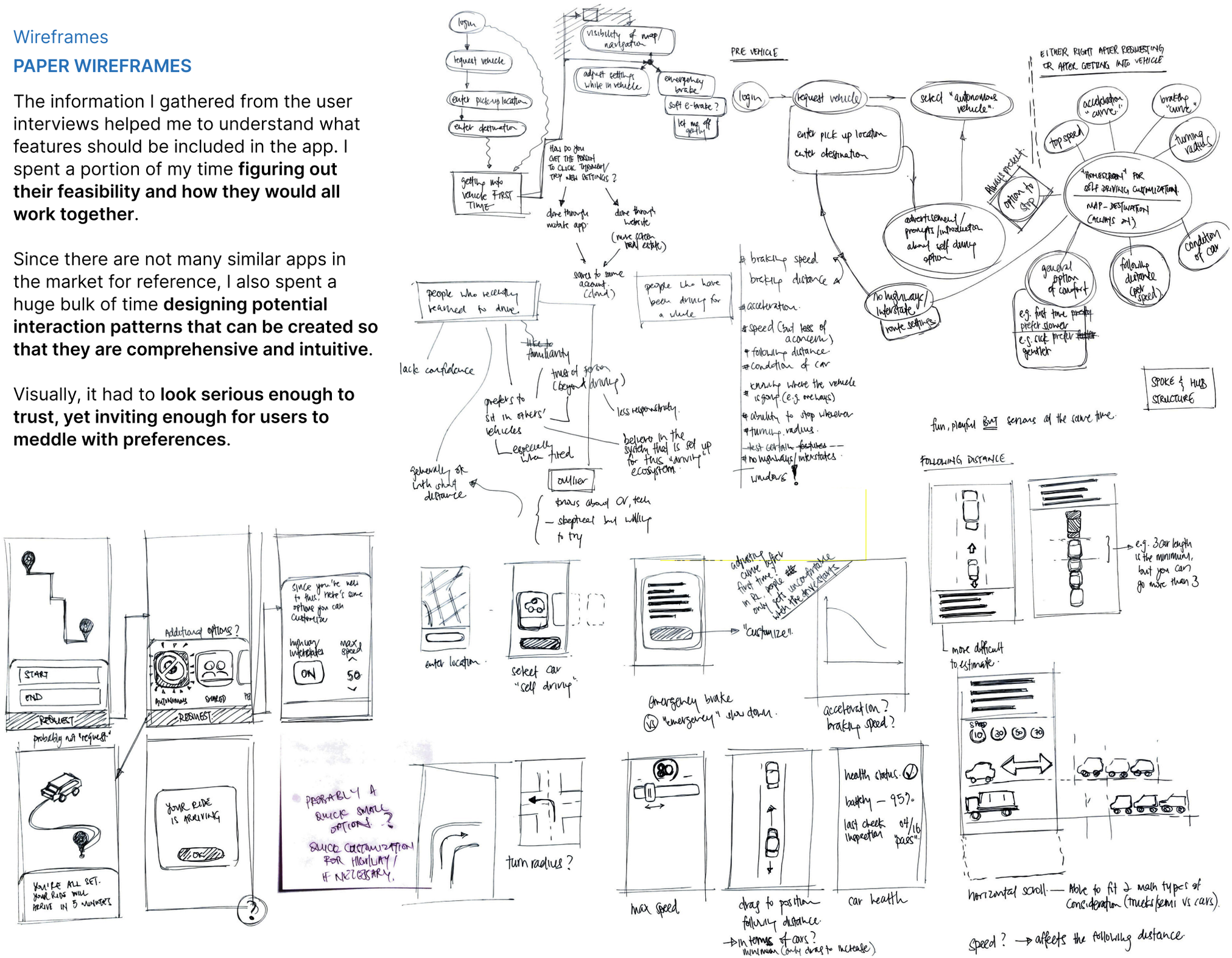
Wireframes

PAPER WIREFRAMES

The information I gathered from the user interviews helped me to understand what features should be included in the app. I spent a portion of my time **figuring out their feasibility and how they would all work together**.

Since there are not many similar apps in the market for reference, I also spent a huge bulk of time **designing potential interaction patterns that can be created so that they are comprehensive and intuitive**.

Visually, it had to **look serious enough to trust, yet inviting enough for users to meddle with preferences**.



Wireframes

USER NAVIGATION FLOW

This is the finalized user flow for the mobile app. Users will be first introduced to the “autonomous vehicle” option after requesting a vehicle.

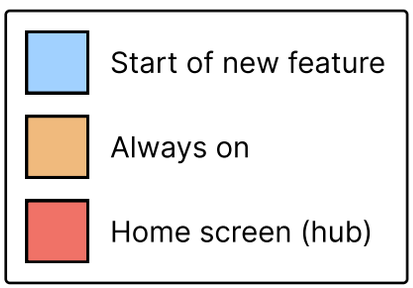
The navigation pattern I decided on was the **“hub and spoke” pattern, where all settings are accessed through the home screen**.

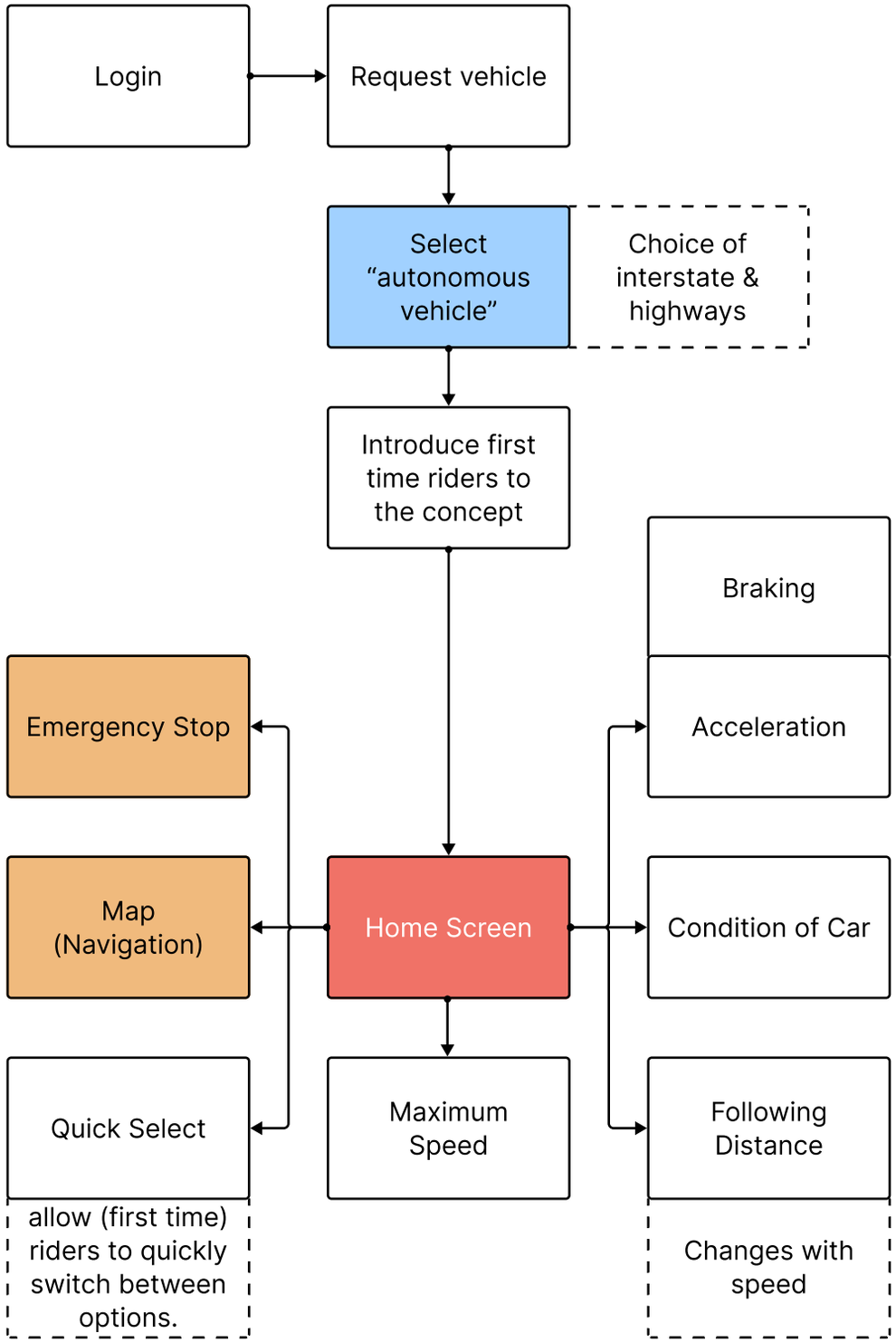
Since the ability to stop the vehicle any time is important, there is an “emergency stop” that will always be present on the screen. The navigation map keeps riders updated on the vehicle’s actions.

Below is the list of customization options included in the app. “Turning radius” and “Inching” were features that I considered, but was not able to design feasible interaction patterns for within the duration of this project.

List of Features:

Emergency Stop
Map for Navigation
Maximum Speed
Acceleration
Braking
Following Distance
Condition of Car
Turning Radius *
Inching *

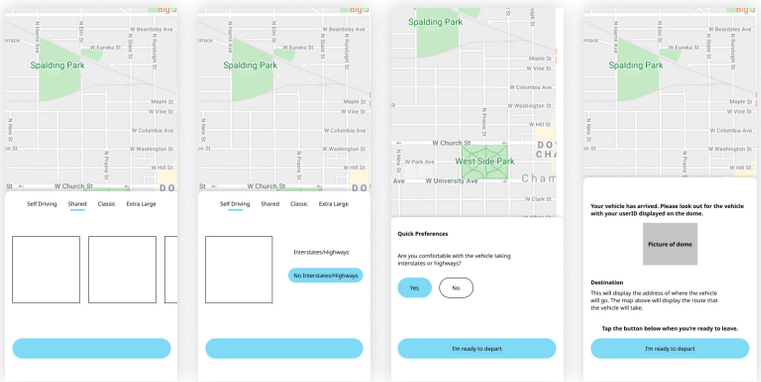




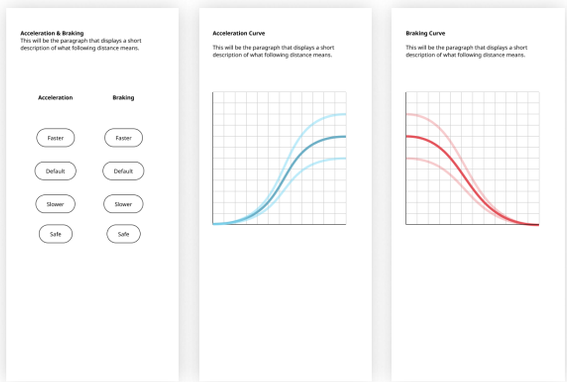
Wireframes

MEDIUM FIDELITY WIREFRAMES (FIGMA)

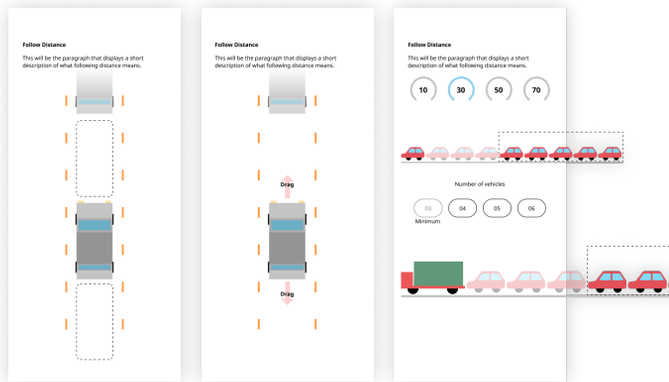
Option for Rides



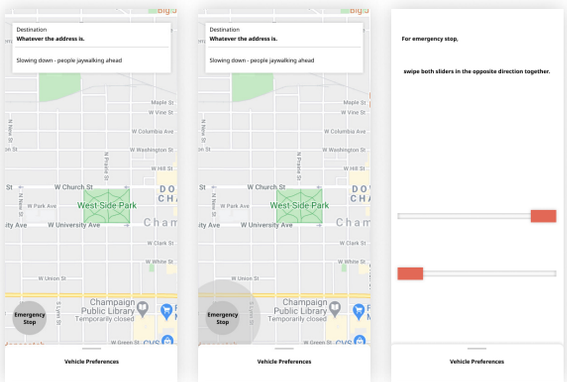
Acceleration & Braking



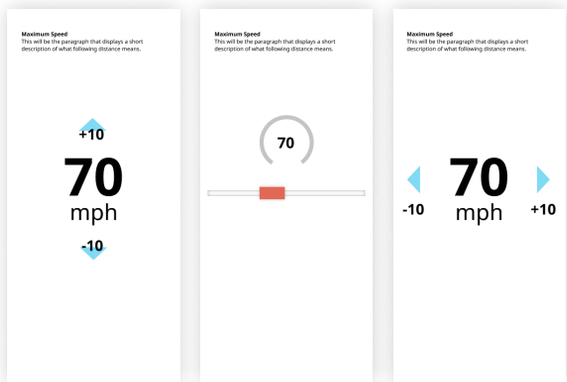
Maximum Speed



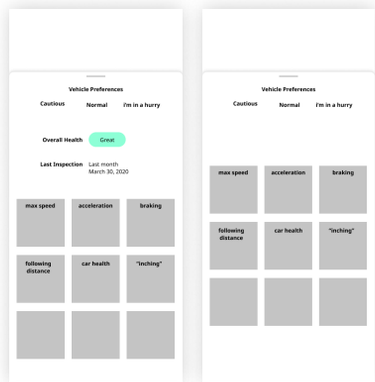
Emergency Stop



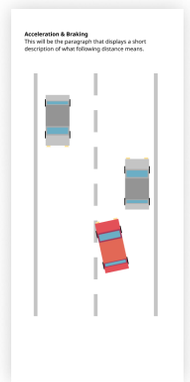
Following Distance



Home Screen + Car Health

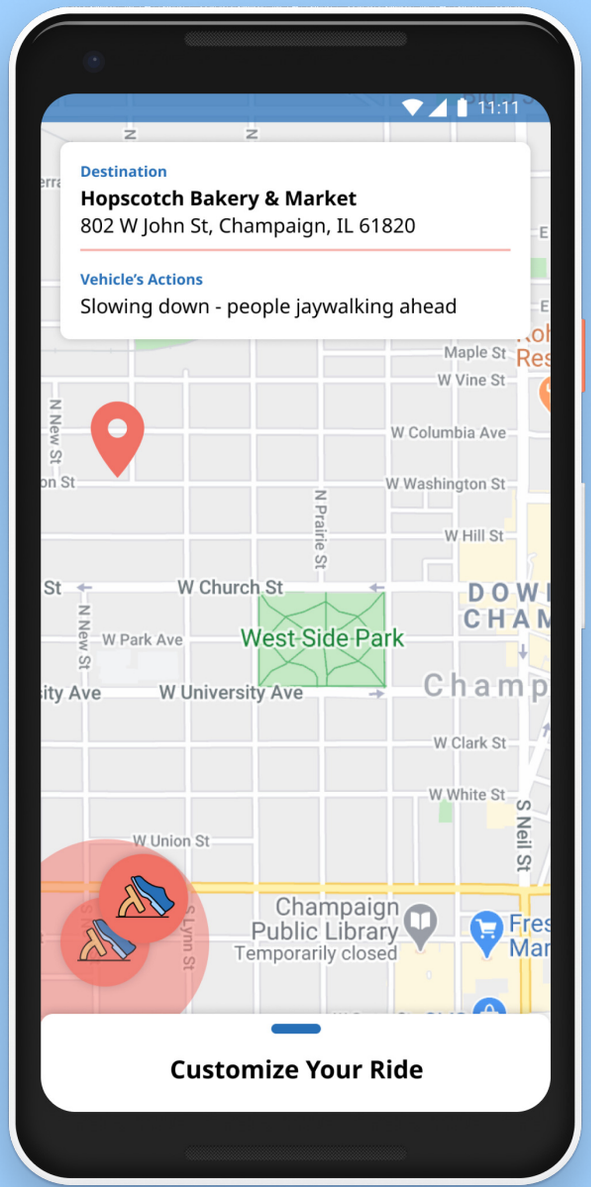


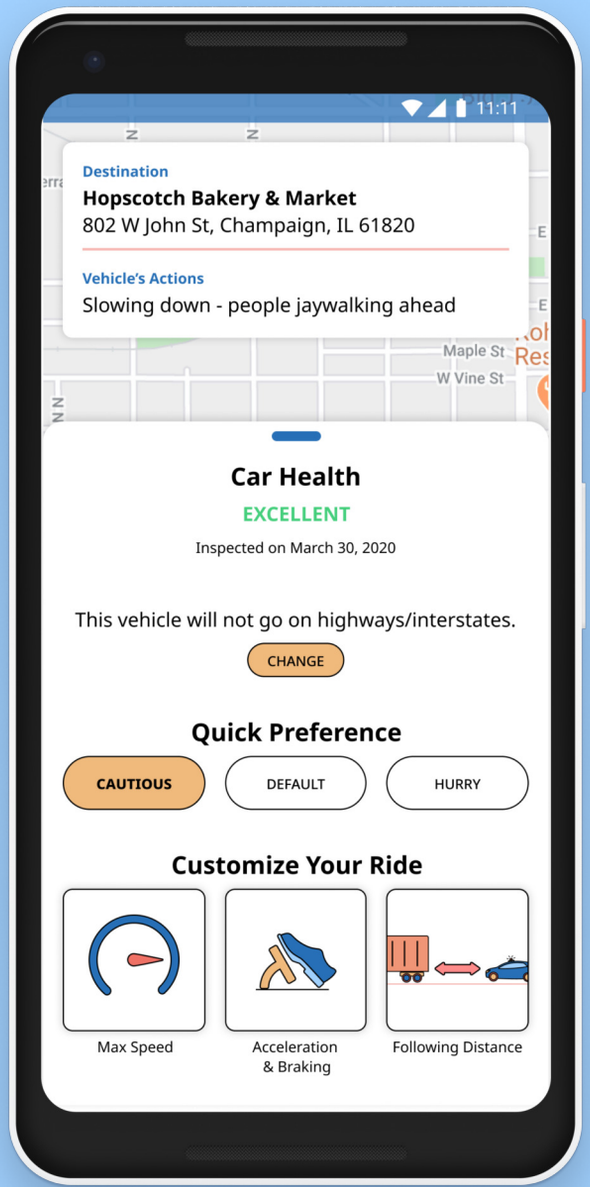
Inching

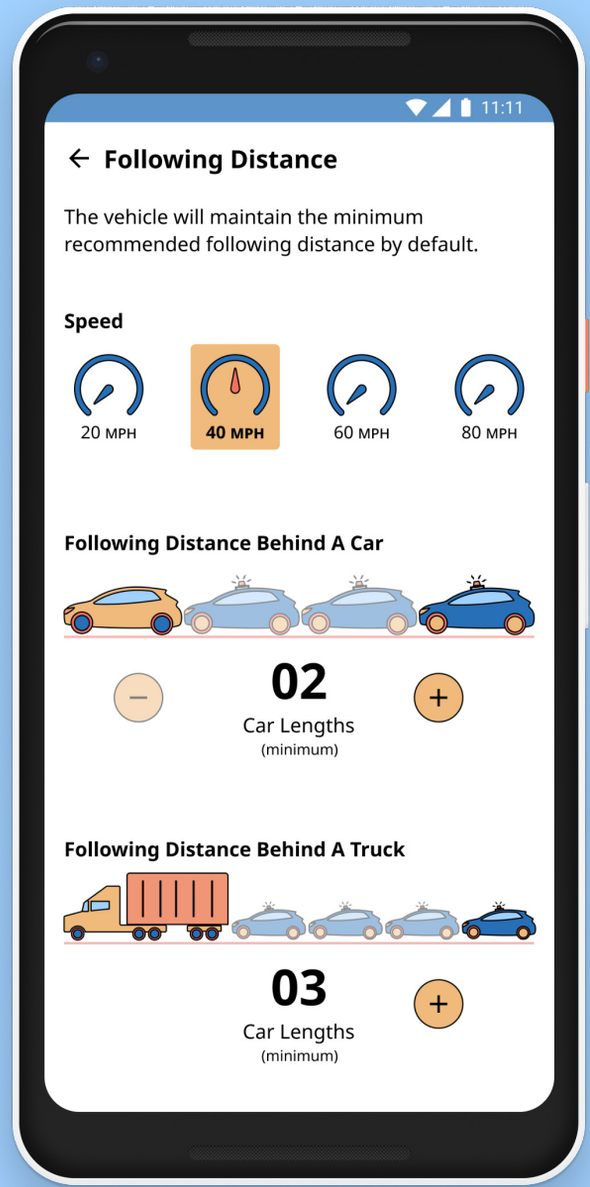


* Not included in final design

Final Design

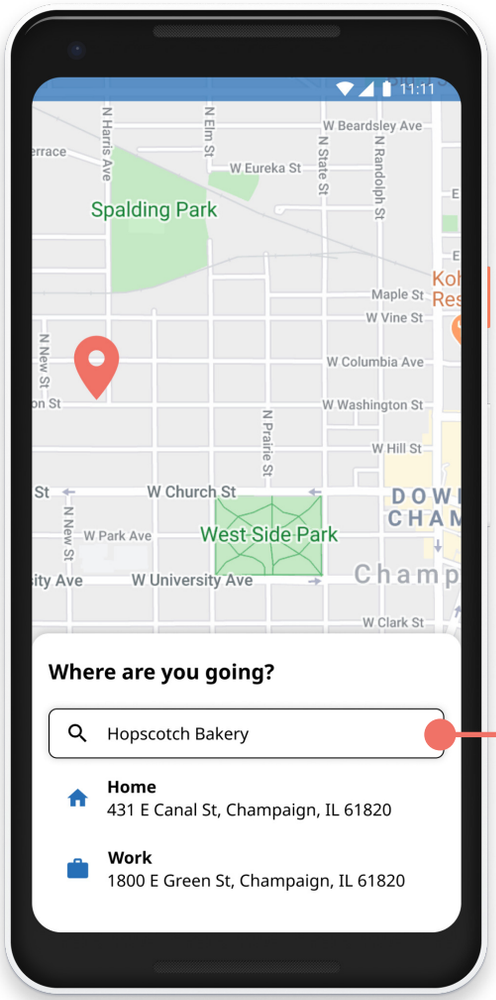




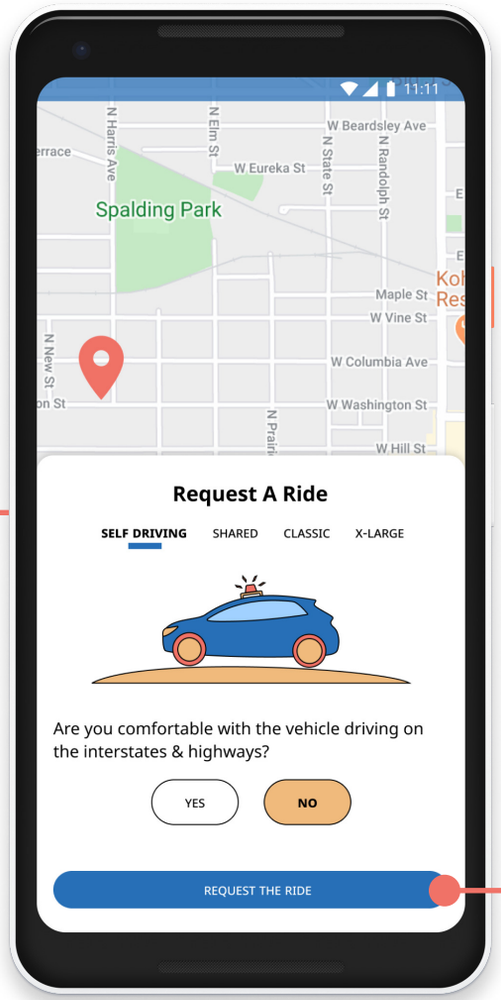


Features

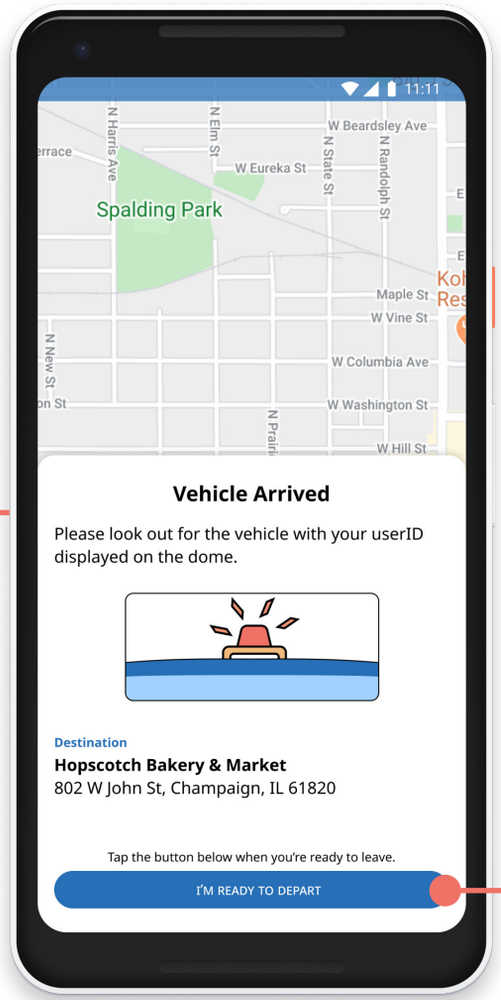
REQUESTING A RIDE



The way to request for a ride is similar to that of current ride-sharing services.



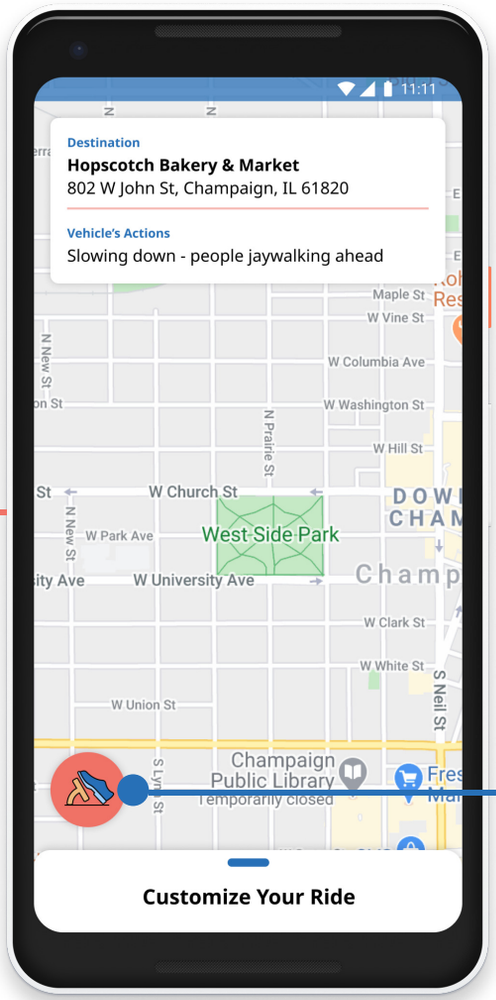
Upon requesting, riders are first presented with the option of “autonomous vehicle”. Riders can specify if they are comfortable with highways.



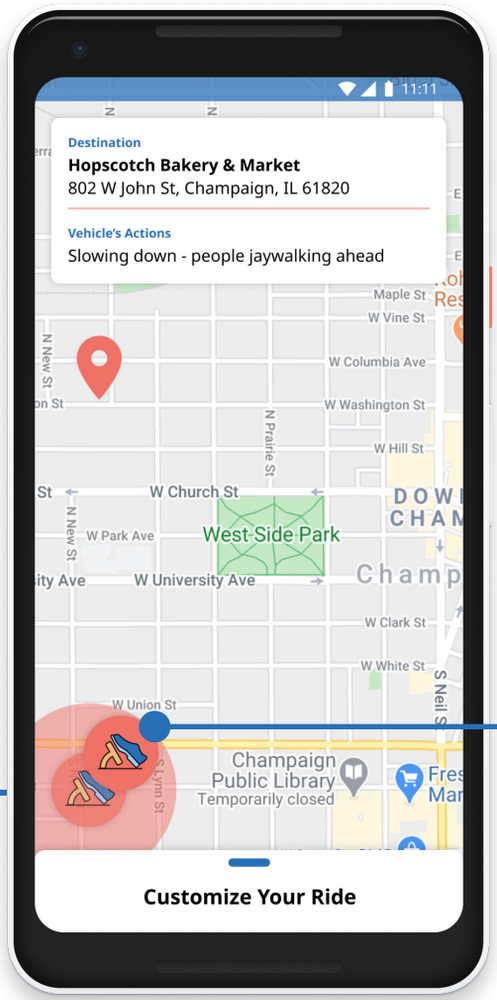
The dome is how the Waymo Driver currently indicates who the vehicle is waiting for.

Features

EMERGENCY STOP



This is the "emergency stop" button that riders can activate at any time during the ride.



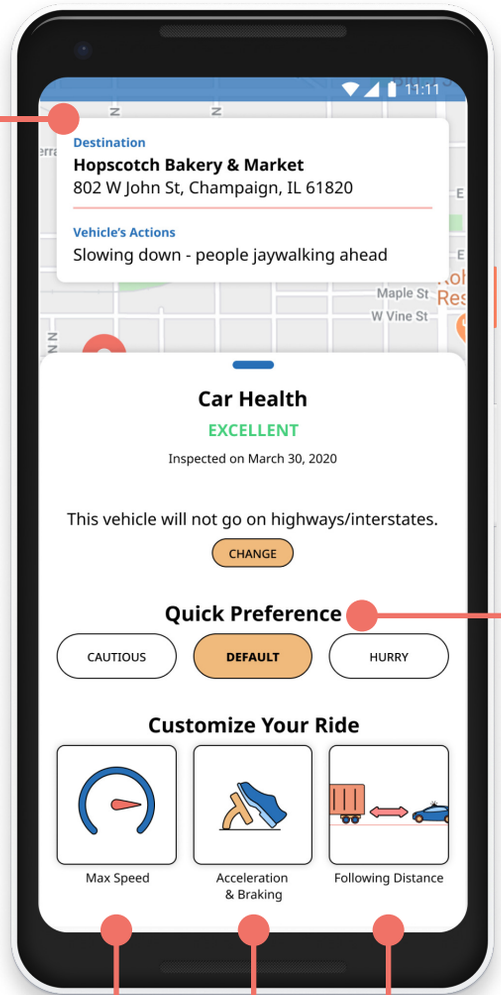
To activate the stop, press the button and swipe away from the center. This is similar to how calls are taken on Android phones.

Riders have to swipe the 2 sliders in opposite directions simultaneously. This is similar to turning off an iPhone. However, the extra slider (in the opposite direction) decreases the possibility of accidentally activating it. Hand placement was also considered.

Features

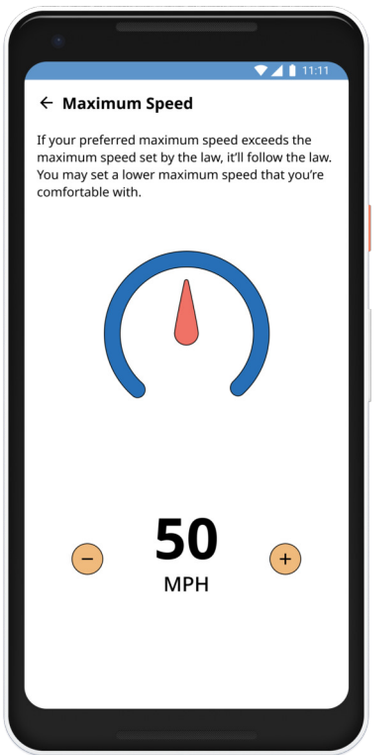
CUSTOMIZABLE SETTINGS

Destination and Vehicle's Actions are always available to keep the passenger updated.



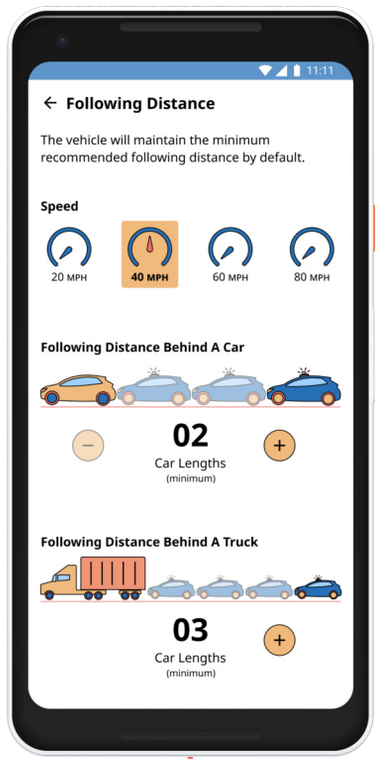
Quick Preference

These are quick preference presets that passengers can select before doing advanced customizations.



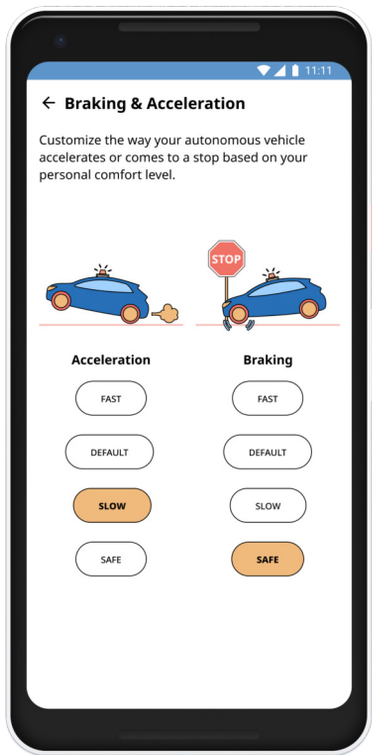
Maximum Speed

Riders are able to set a maximum speed that they are comfortable with.



Following Distance

Distance is represented with cars lengths, so that it is easier to visualize from the point-of-view of a passenger.

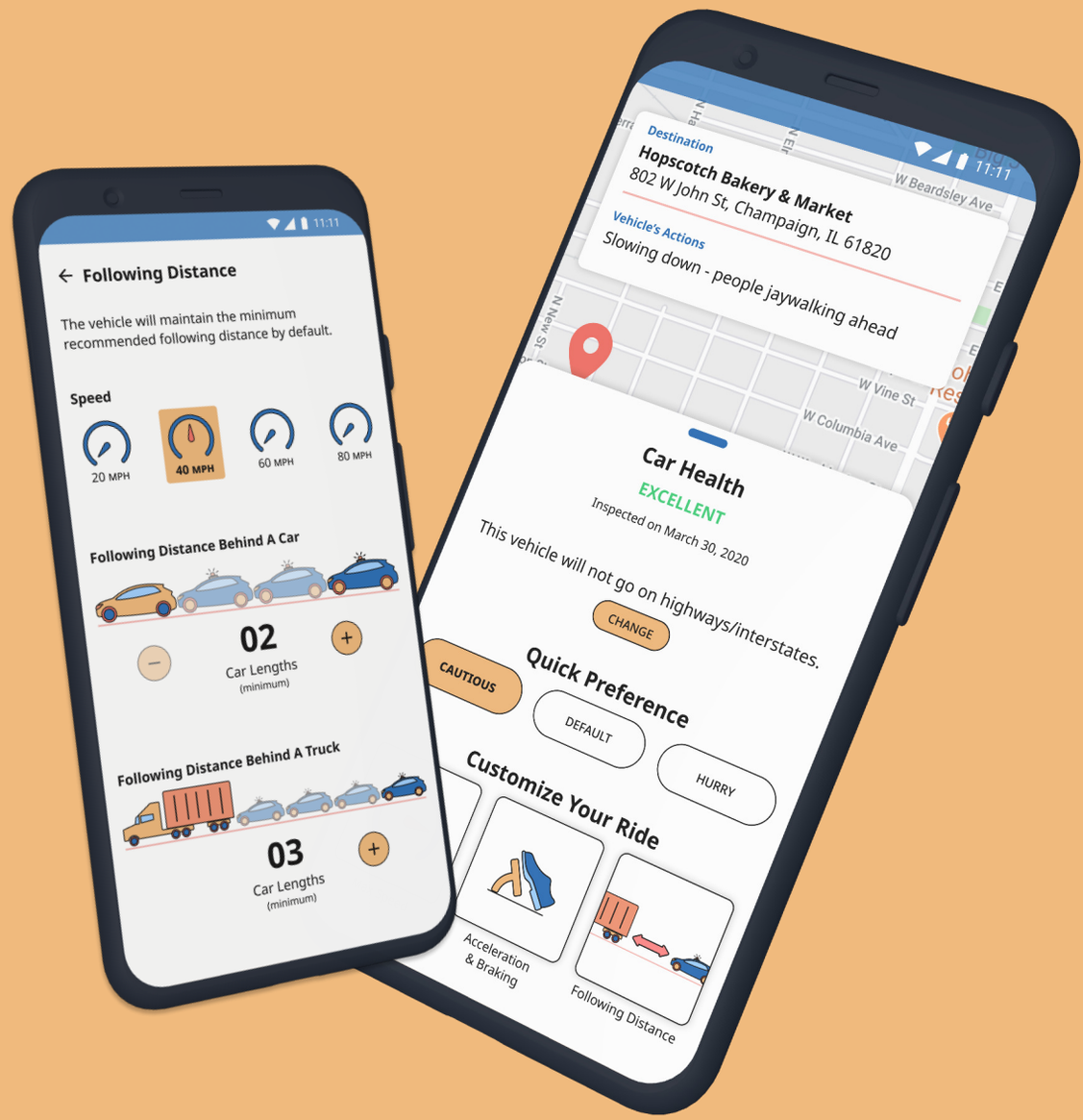


Braking & Acceleration

These comfort levels are based on feelings. This screen is designed for passengers to meddle and feel what they are comfortable with.

Thank You!

You can try out the app through an interactive prototype at:
https://tinyurl.com/aspentng-self-driving



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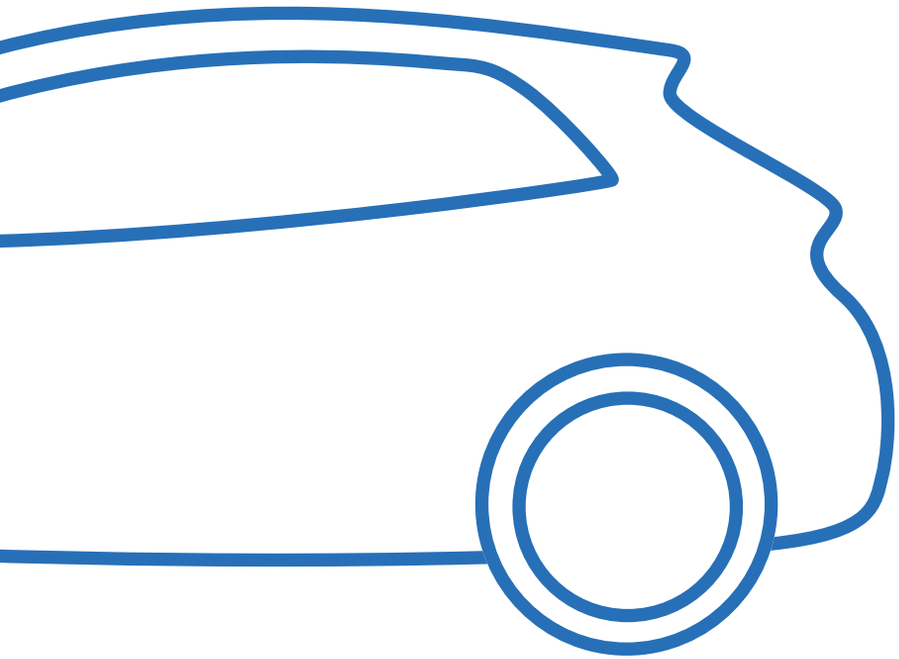

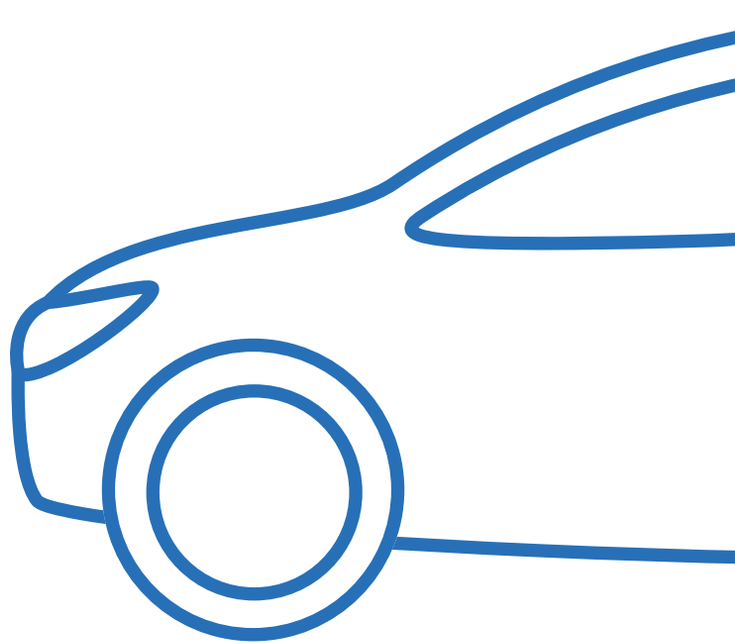

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