NIDO

A future user-centric Interior Design Approach for Changan Europe

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In collaboration with Changan Europe

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Glossary

- **L4AV:** Level 4 autonomous vehicle
- **L4AD:** Level 4 autonomous driving
- **USP:** Unique selling point
- **SAE:** Society of Automotive Engineers
- **AV:** Autonomous Vehicles
- **AD:** Autonomous Driving
- **VIP:** Vision in Product Design
- **CMF:** Colour, Material, Finish
- **Int:** Interior design department
- **Ext:** Exterior design department
- **UX/UI:** User Experience and User Interface department
- **ID:** Innovation Design

Executive summary

This thesis is conducted in collaboration with Changan Europe a Chinese Car company that has based their design centre in Turin, Italy. The core of this thesis is to create an interior design process for L4AD. The aim is to translate the research into a physical prototype to fit the automotive industry.

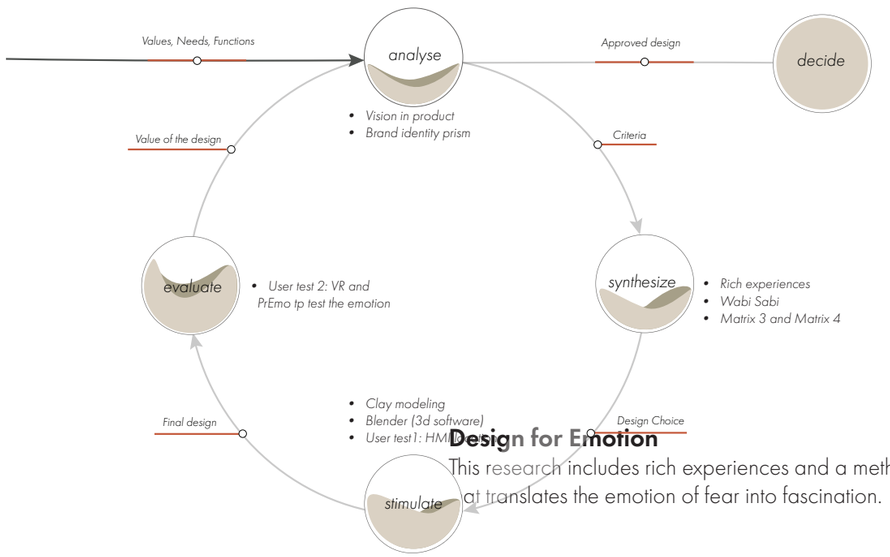
The leisure state that is provided by L4AD will challenge the current design process. The design will not only be focussed on the interior, but also take in account the implementation of the autonomous system.
The autonomous system will require more involvement from the UX department earlier on in the process to integrate the HMI system.

Autonomous driving technologies are developing at a high speed. Providing a possibility to improve road safety. “However, this transition also brings in new risks, such as mode confusion, overreliance, reduced situational awareness, and misuse” (Grondelle, 2021). This development in L4AD will change the relationship between the driver and the interior design. Whereas the driver’s role will change from being a driver to becoming a supervisor.

Developing a new design process

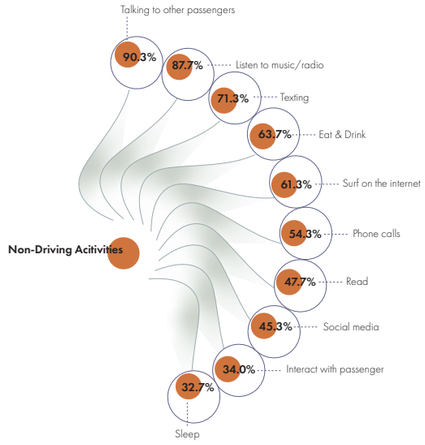
The backbone of this design process will be the basic design cycle. Which will be analysed and adjusted.

This results in a design process that is less linear as well as optimising the integration of UX design into the interior design process. Whilst going through the basic design cycle certain adjustments and suggestions are concluded in this report.



Analysis

The context analysis is used to find out what kind of technologies will be used during AL4D and how these impact the user. Where the company analysis maps out the brand and their current design process.



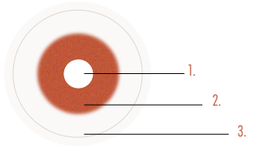
VIP

The method VIP (vision in product) is used to design a process that is fit for the future behaviours and attitudes of the user in 2040. Since the design process is focused on a future where AL4D is implemented, it is important to also know the future design context.

Design for Emotion

This research includes rich experiences and a method that translates the emotion of fear into fascination.

A method that will be validated by a VR user test in combination with PrEmo.



1. Emotion.
2. Concrete example with a general cause.
3. Cause created in a context you are designing for.

Wabi-Sabi

A method that is used to create a rich experience in the concept interior.

Matrix 3 & Matrix 4

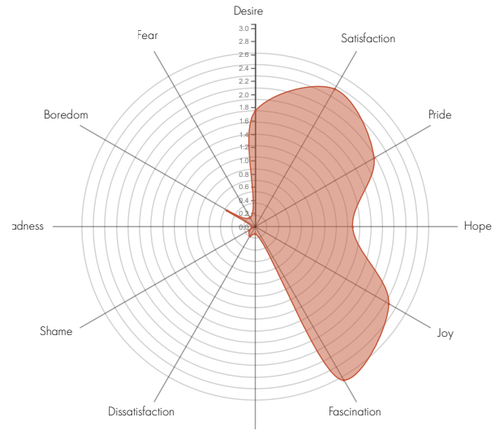
This method looks at different context levels of a design (meta, macro and micro) in a visual manner. The reason for choosing this method is that is comes close to the moodboards that are currently used in the industry, while adding some extra value.

Final design

Reflect the taken design decisions and focus points of the new design process proposal.

Evaluate

By user testing certain methods it is easier to validate if these certain tools are fit for the context and industry that they are aimed to design for. Which validates the value of this proposed interior design process.



When will we be designing for Level 4 Autonomous Driving?

2040

Scope of this project

2040
The time frame of this project is set around 2040. Although Markus Schäfer (Mercedes Chief Technology officer) stated in 2023 that L4 autonomy will be "doable" by 2030. (Vincent, 2023). Other researchers predict the entrance to the market will be dated around 2040. (Weigl, 2022).

This time frame provides a balance between a design that is easy to implement and at the same time gives space to think advanced & creates design freedom.

Interior design
The design process will be focussed on the interior designer within the company.
Other departments will be taken into the analysis but the execution on this process will be done for the interior design department.

SUVs
The company has specific brand names for different vehicle models. Changan is specified in premium SUVs and passenger vehicles. That is why this project's scope is set to focus on the interior of an SUV vehicle.

The European market
This project focuses on Entering the European market, since Changan Europe their current market is mainly Asia.

Affordable premium
When entering the European market with L4AV the aim is to focus on the affordable premium consumers. Current possible competitors within this market would be Skoda and Volkwagen.

Stakeholders

Changan Europe

Changan Europe is a Chinese state-owned manufacturer that also sells under the names Shenlan (EV), Oushan (mid-level SUVs and MPVs), Kaicheng (Commercial vehicles, light trucks and MPVs) and recently launched in 2021 Avatr (Premium EV). Whereas Changan focuses on premium SUVs and passenger cars. In 2006 their first Research and Design centre was founded in Turin, Italy.

Currently, Changan's market is predominately in Asia. After establishing their position in this market they are looking to expand to the European and US market as Yang Jie (sales and marketing Changan) predicted. This aim will be around 2028. (Rendell, 2017). Their EV brand Avatr released the Avatr 11 which is predicted to enter the European market in 2023.

In Mandarin 'Chang' means 'Lasting' and 'An' means 'Safety' (Changan, 2023). Changan has always adhered to the three principles of safety, emotion, and efficient experience (A&D, 2022). Changan is currently focusing on becoming greener and implementing smart technologies. With their plans to sell 35% of their cars on new energy sources by 2025 and exceed 60% by 2030 (Astana Motors, 2023).

TU Delft

The main priority for the TU Delft is that this thesis will be conducted on an academic level that will add value to the research in the field of industrial design. An academic level that presents new findings and outcomes on how the design process within the company can shape the future of autonomous driving.

Finding common grounds

When I decided to perform a thesis in collaboration with an automotive company I wanted to increase my knowledge of working in the automotive industry. As an integrated product design graduate, you are educated to have a scientific approach and look for problems within the industry on a larger scale. In the case of this project to find out how L4AD will influence the current design process and where certain knowledge gaps are located.

The challenge that comes with being used to this approach is how to make a design process be fit for the automotive industry. As a lot of information gets lost as soon as it is only written and not showcased in a physical/visual way. A personal challenge that I have tried to resolve during the writing of my thesis is: How can you translate scientific knowledge for the automotive industry?
The thesis is divided into two tracks that are aimed to resolve the challenge:

- ◊ ■ Development of the design process
- ◊ ■ Creating the physical concept

Besides this...

- User tests are included in different steps of the process.
- ■ Methods are explained and presented in a visual way.
- ■ The physical model helps to showcase the different steps in the design process.

Personal Values

Beside the automotive sector it is also important to look at a broader picture. What happens around us and what are the positive and negative impacts of our designs. The aim of a designer is most of the time how do I improve a current design or invent a new solution. With this thesis I would like to take the opportunity to dive more into the process of designing and maybe also find ways or solutions that are less focussed on mass production within the car industry. It might be a strange approach to decide to focus on an industry as the automotive industry whilst keeping a sustainable mindset. Although I am convinced that these kinds of areas in design offer the opportunity for improvement and change.

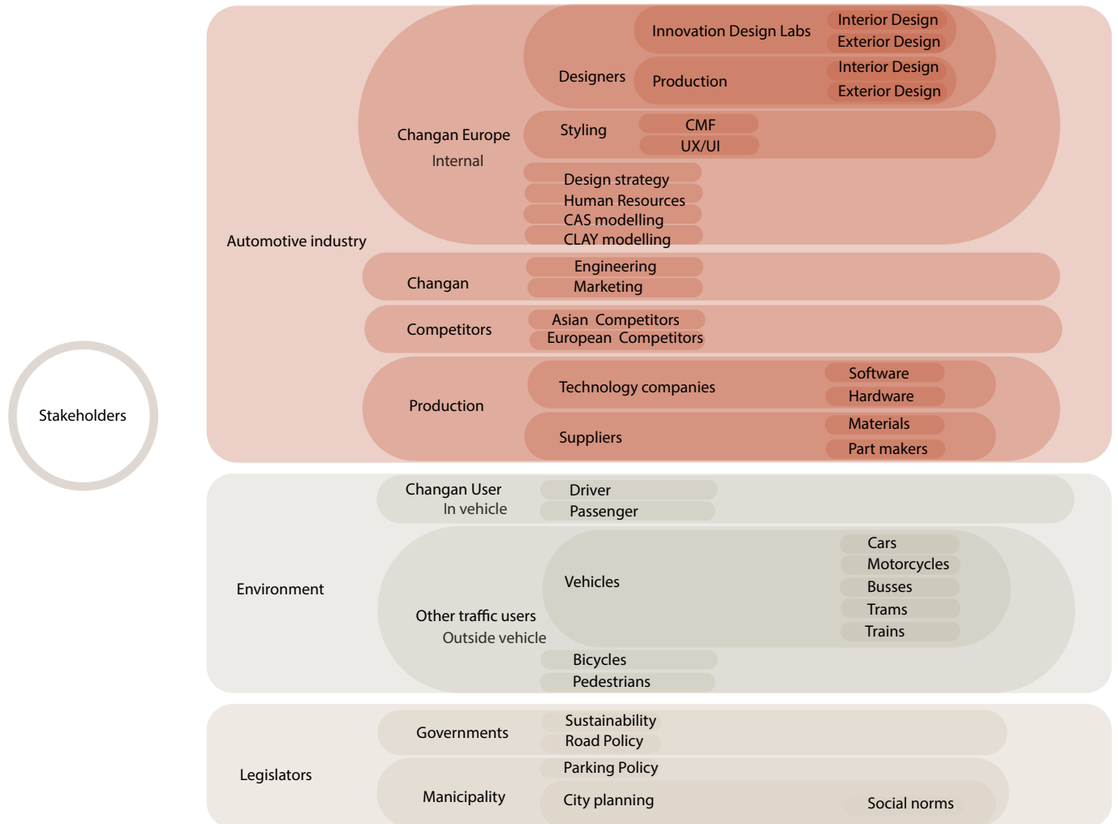


Figure 0 Other stakeholders

Developing a new design process

The approach

The analysis chapter(context analysis, future context analysis and company analysis) is needed to get an overview of what in the current design process needs to be changed to shape a design process for the future.

The design process is aimed to fill in certain knowledge gaps that are created by the introduction of an AL4V. As the self-driving system asks for different design requirements that need to be included in the interior design process.

1. What will change whilst designing an L4AD interior design process?
2. Where should these changes take place?
3. What methods can be implemented to solve these gaps?
4. Do the chosen methods give the aimed result?

The physical concept that is developed during the creation of this design process is to translate the research into a form that is fit for the industry. The concept aims to show some of the wide opportunities and different user states a AL4V is able to provide.

The design process

The ' basic design cycle' (Roozenburg & Eekels, 1998) is used as a general structure for this design process. This process can be divided into four steps.

Analysis

This is the research stage that is related to the design goal. This project will answer the question of:

How can Changan Europe shape its interior design process to enable the transitioning roles of the user in a L4AV?

Since the thesis is about creating the design process itself certain topics will be analysed and later on implemented in other steps of the basic design cycle.

Design problem - *context analysis*

The first step in this thesis will explain the reason for focussing on the specific topic of L4AD, the autonomous system and how this will open up opportunities for the future commuter.

WHY is it necessary to develop a design process for L4AD?

- Chapter 1.1 Autonomous Driving
  Why autonomous driving?
  Sustainability aspects
  The six levels of autnomous driving
  Current levels of autnomous driving
  Focus on L4 instead of L3
  Autonomous level of this project
  User acceptance

What should be integrated in the design process?

- Chapter 1.2 HMI
- Mediator
- HMI functional requirements
- Use cases

Where should it be integrated?

- Chapter 1.3 Transitioning roles
- Preferred non-driving activities
- An extended living room
- Vehicle architecture

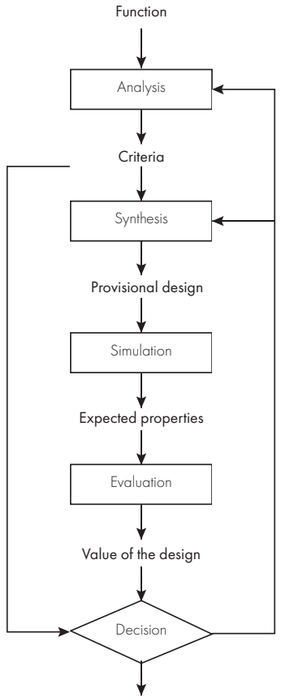


Figure 1 The different steps of the basic design cycle (Roozenburg & Eekels, 1998).

Build a future worldview - *Future context analysis*
As predicted the design process will only be able to be implemented in 2040 due to certain technologies and regulations. This makes it important to have a good overview of the consumer behaviours and attitudes of the future.

That is why the **VIP method** (Vision in Product) will be used to build a future worldview and find out how Changan can shape its strategy for entering the European market.

Analyses of the current design process - *Company analysis*
When there is a clear picture of the future context it is important to analyse the company's current design process. To find out where in the process these current changes need to take place.

Synthesise

In this stage, it is time to generate possible solutions.

With this initial research, a design process proposal will be developed. That suggests the possible steps an interior designer could take whilst designing for an autonomous level 4 vehicle.

The suggested design process takes the designer through different design loops and pushes the designer to validate their design decisions through suggested user tests and gives an overview of the areas where other design departments could be useful to include in the process.

The step focuses on two different tracks:

The design process.

The method that is used for answering the following questions is the Matrix3 & Metrix 4 method. To look at every aspect of the interior design.

- *Mobility* - What is the purpose of this design?
- *Architecture* - What will be the seating positions of this design?
- *HMI* - What information do I need as a designer to integrate an autonomous system into this design?

These are 3 questions that serve as the core for generating new ideas in this design process.

Physical model

To showcase the idea of how these questions could be answered the next part of the synthesis will take the reader through this process by answering the questions and ideating ideas from them.

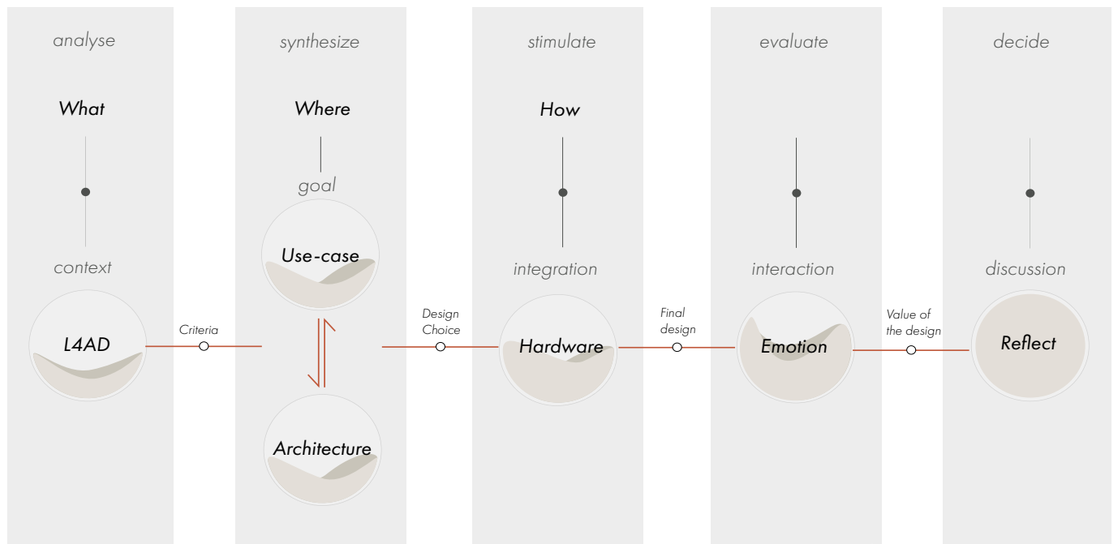


Figure 2 Proposed interior design process overview

Stimulate

This step will estimate and define the expected properties.

The design process.

- How is the current design influenced by the shape and interaction of the autonomous system?

By answering this question the designer will take into account how to integrate the autonomous system in such a way that is clear for the user and evokes the intended emotion.

Since the content of the use-cases are focussed on safety it is important to gain user acceptance by designing the right shape that will evoke the wanted emotion.

Physical model
To showcase the results the shape and interaction are defined and further developed to do user tests in the next step.

Evaluation

This is the moment to test if the design has the right shapes that translate/fit the intended emotion. This will be done by comparing the final design with the criteria that resulted out of the analysis phase.

For this step two methods are used
- *Clay modelling:* Evaluates the shape of the model.
- *VR testing:* To validate the overall emotion that is evoked by the interior design.

Decide: *During this phase the designer will compare the final design with the intended criteria made in the beginning phase.*

It is important to know that the design is not linear but circular (see figure 3). So the designer can go back to previous steps where needed to further adjust the design to increase the value and fit its design purpose.

For the design process it will be important to evaluate and recommend further steps that could be researched or included to optimise the process.

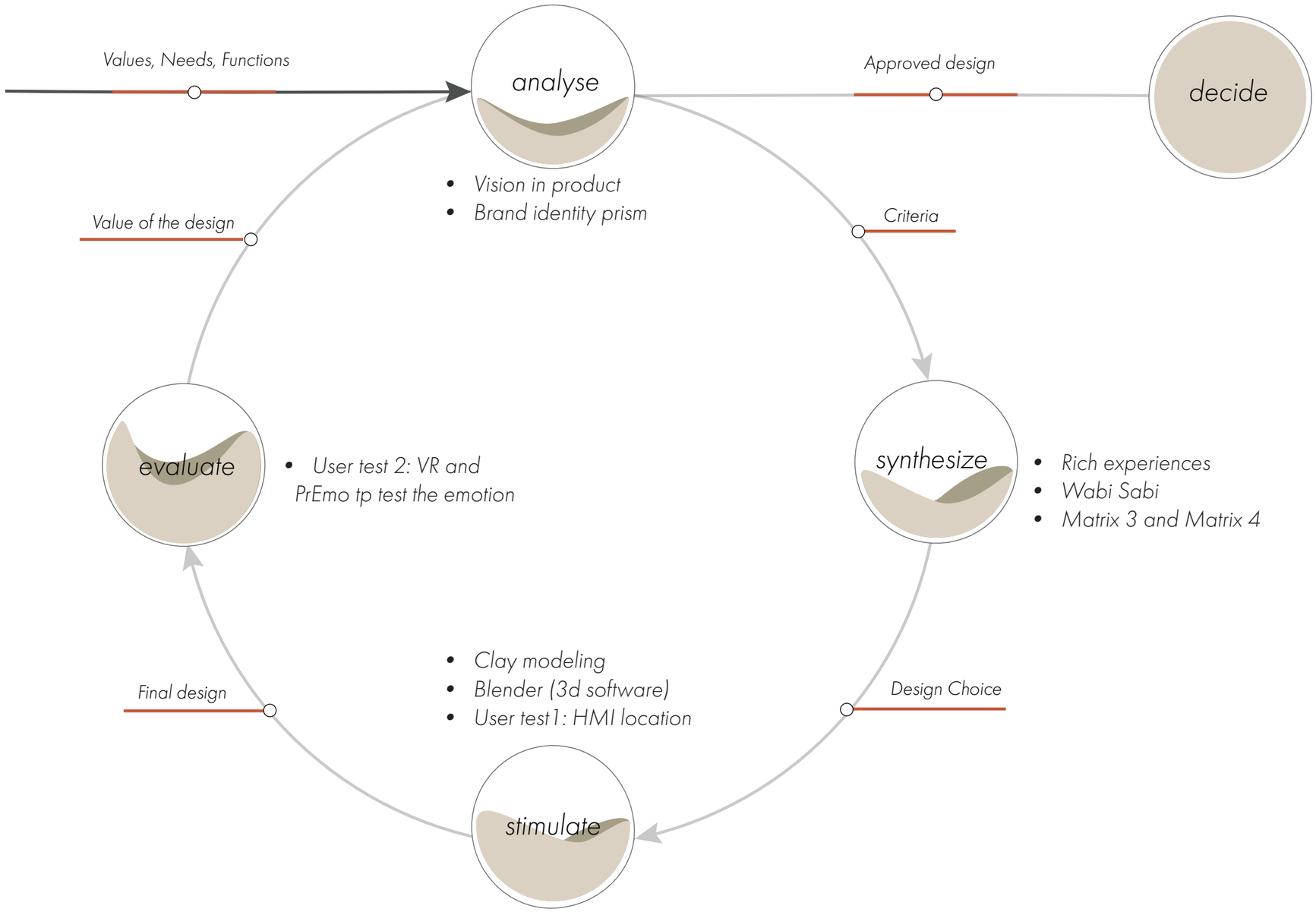


Figure 3 Proposed interior design process circle with methods

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  - ◊ Chapter 1.1 Autonomous Driving

- **What** should be integrated in the design process?
  - ◊ Chapter 1.2 HMI
    - Mediator
    - HMI functional requirements
    - Use cases

- **Where** should it be integrated?
  - ◊ Chapter 1.3 Transitioning roles
    - Preferred non-driving activities
    - An extended living room
    - Vehicle architecture

- Chapter 1.4 Perception of Premium
- Chapter 1.5 Entering the European Market

Chapter 1.1 Autonomous driving

Why is it necessary to develop a design process for L4AD?

1.1.1 Why autonomous driving?

Around 1.3 million people die in road crashes every year according to the world health organisation (WHO, 2022). In 2016 of the total number of road accidents, 57% were caused by human error, whereas 90% was a contributing factor (Sam, 2016).

AV's have the potential to reduce the risk of accidents and improve safety. Next to the safety potential autonomous driving utilises the time spent on secondary non-driving activities (Brenner, 2017).

1.1.2 Sustainability aspects

There is a wide debate on how to define 'sustainability' and 'sustainable impact' whilst looking at transportation. A widely accepted term is when environmental concerns are carefully balanced with environmental concerns. (Maheshwari, 2021).

Safety access, congestion, land use and fuel consumption are the primary issues in this area (Richardson, 200). Yigitcanlar and Dur's sustainability assessment model states the issues as key indicators which are transit usage, the capacity to cycle and walk, and the reduction in vehicle km travelled (Yigitcanlar, 2010).

Autonomous vehicles (AVs) will cause carparks to decrease by 62-87% through optimised parking. This will reduce the use of land which can be used for other purposes by for example stimulating the walkability and bikeability. (Maheswari, 2021).

The traffic flow will increase by 40% which will cause shorter minimum highway driving. Next to this Platooning (driving 0.3-0.5 sec. distance instead of 2 sec. recommended for human-driven vehicles) will lower the energy consumption on the highway by 3-25%. Lastly, self-driving cars are expected to be safer in the future. (Nguyen, 2019).

1.1.3 The six levels of autonomous driving

The SAE (Society of Automotive Engineers) defined six levels of autonomous driving. Starting from L0 (no driving automation) until L5 (full driving automation).

L3 is seen as the first level of automation where the driver can also perform other tasks. This level is still limited as the driver must be able to take over at any point. With L4 the driver is able to drive fully autonomously under limited conditions. For example highways, airports, and low speed zones.

The difference between L3 and L4 is the length of being able to drive fully automated. If the driver does not respond to take back control in time (by for example falling asleep on the highway), the automated system will achieve a minimal risk condition by taking the driver off the highway and parking the car on the side of the road.

L5 is an automated system where the automated system will drive under all conditions (SAE, 2021)

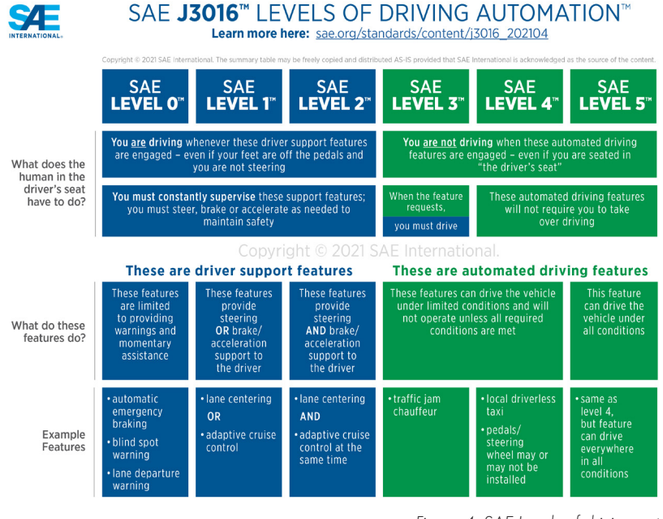


Figure 4. SAE Levels of driving automation Level 3

1.1.4 Current level of autonomous driving

Level 3
Mercedes-Benz Drive Pilot
Mercedes-Benz is the first brand to bring a level 3 automated car onto the market with a system called 'Drive Pilot' in the Mercedes S-Class. Due to regulations, it has only been approved in Nevada, U.S. and Germany with a speed limit of 60 km h. The driver must keep their face visible to the camera otherwise the system will disengage. This allows the driver to talk to the person next to them but does not allow the driver to take a nap or ride in the backseat of the vehicle. (Mitropoulos, 2022).

Mercedes-Benz Intelligent Park Pilot 2
Installed in the S-Class and EQS of July 2022. Level 4 unmanned autonomous parking by activating the function in the Mercedes Me app (Young-sil, 2023).

1.1.5 Focus on L4 instead of L3

Volvo EX90 2024 'Ride Pilot'
will be equipped with technology that doesn't require the driver to have their hands on the steering wheel or their eyes on the road. This function can only be used on highways.

When being asked if the system is currently at level 3, Volvo announced: "We do not use levels to describe autonomous functionality as we believe it is unclear for consumers. In all Volvo Cars, a car will be either autonomous (meaning the driver can rely fully on the vehicle to drive and use their time for something else) or not (the driver needs to be driving). Ride Pilot will achieve the former." (LaChance, 2022). Earlier on CEO Hakan Samuelsson has already stated to skip the L3 automation and focus on L2 and L4 (Hetzner, 2020).

Audi A8 Traffic Jam Pilot
In 2017 Audi had the first production SAE system level 3. Due to road regulations, the feature was contingent and did not get approval from local authorities.
They stated they would not work further on the L3 automation and focus on L4 automation instead. Other AV companies including Waymo and Cruise also exclusively work on L4 automation. The reason for this is 'mode confusion' when the user has to take over the wheel again (Hawkins, 2022).

1.1.6 Autonomous level of this project

In this project, the focus will be on L4AD.
Level 4 – High automation: The car can drive itself full-time, only when it encounters problems it cannot handle, it will stop on the side of the road. If the driver doesn't react at first.

The European Transport Safety council currently aims to be the first to legislate L4AV on the road. Still "There is a big scrutiny on how these vehicles perform in the field," says the commission's official (Posaner, 2022).

It is of great importance to make level 4 successful in use before focussing on level 5.
Next to this, it is important to facilitate driver autonomy, specifically towards chosen driving modes, as they are primary components for achieving user acceptance (Christoph et al., 2019).

Figure 5 Mercedes-Benz S-class

With L4AD the scope is limited which eliminates, difficult weather scenarios and high trafic. This will build the user's confidence and make Changan Europe reliable and have safety as a guarantee (Murray 2018).

Genesis G90 and Kia EV9 –"Highway Driving pilot"
With a maximum speed of 80 kmh, allows you to change lanes, navigate to its destination and allows the driver to take their hands off the steering wheel on the highway. Expected to be released at the end of April 2023 in South Korea (Young-sil, 2023).

BMW X7 Highway Assistant
Attentive hands-free driving on limited access highways with a maximum speed of 85 mph. Expected to be released at the end of April 2023 and only be available in Europe.

1.1.7 User Acceptance

Riener describes the definition of acceptance in an autonomous driving context as "AV acceptance is a person's behavioural intention to use an AV" (Riener, 2022).

In this thesis project the scope is focussed on how do people trust the system by its physical shape, not by reinventing the autonomous system.
The main factors for the user's acceptance of autonomous vehicles are social influence, system characteristics, and individual differences.

In the end, the 'use intention' of an autonomous vehicle is created by the subjective norm, trust, personal innovativeness, relative advantage, compatibility, enjoyment, and price evaluation.

A few ways to increase user acceptance are:
- Getting a review from an end-users point of view that the implemented technology is trustworthy leads to lasting acceptance.
- "As drivers gain more experience with highly reliable automation, their level of trust is expected to increase"(Lin et al., 2018).
- The compatibility is higher when the system is based on current mobility patterns.
- Early adopters tend to perceive AD as easier, more useful and easier to use (Riener, 2022).
- The more pleasure people get out of driving an autonomous vehicle the greater the user acceptance will be (Tan, 2022).

A negative influence on user acceptance is privacy. Where the user worries about processing personal data (Nastjuk, 2020). Another factor can be that people feel bored or experience a lack of stimulation (Riener, 2022)

Chapter 1.2 HMI

What should be integrated in the design process?

1.2.1 Definition

HMI (Human machine interface) in a vehicle can be defined as "a set of all interfaces that allow the user of a vehicle to interact with the vehicle and/or devices connected to it." (Wetzel, 2013).

The HMI in a vehicle is a communicator between the automated operation system and the driver. One of the important factors in an HMI system is that it keeps the user aware by giving the right amount of information about vehicle operations.

When driving in an autonomous level 4 vehicle the HMI should make the user aware of the two different phases (Debernard, 2016):

- Phase 1: The automated driving phase. Where the machine is in control of the vehicle so the user can engage in secondary activities.
- Phase 2: Phase 2: The transition from autonomous to manual. Where the system has to make sure the user is cognitively and physically prepared to take over the driving.

To prepare the user for this transition it is acquired to create 'situational awareness'. This can be created by giving the driver updates about what happens outside the car, how the vehicle prepares for the situation, and how it will respond (Debernard, 2016).

1.2.2 MEDIATOR

MEDIATOR is a 4-year project led by SWOV (Dutch Institute of Road Safety Research) that focuses on creating a system that mediates between the automated functions and the driver.

This project analysed the task transfer from automation to human and the other way around, maintaining the trust of the user in the system, and maintaining/improving the fitness of the user and the machine. Where it searches for the optimal balance to decide who is fit to drive. This will prevent overreliance and mode confusion (Christoph, 2019).

1.2.3 HMI Functional Requirements of MEDIATOR

The outcomes of this research suggest functional and non-functional requirements.

The non-functional requirements include:

- Minimise the learning effort by using general/familiar affordances.
- User acceptance by preserving human autonomy. As the research of Debernard stated to give the user the feeling they are still in control.
- Good user experience which includes user acceptance, trust, and high usability.

For the functional requirements, there is the possibility of conflicting functions as it has to be implemented in one HMI system.

For this reason, a common syntax is included. The syntax exists in three hierarchy levels.

1. MUST (mandatory).
2. SHOULD (desired).
3. WILL (somewhat desired).

General requirements where the HMI...

- MUST perform all original HMI functions of the vehicle.
- SHOULD make the driver aware of the current automation levels through primary and secondary (ambient) look and feel.
- MUST fulfil the interaction with the driver as much as possible within modes. These are transfers between modes, corrective and preventive interactions, etc.
- SHOULD negotiate with the user. This can differ from low seductive negotiation to forced take-over (no negotiation) depending on the circumstance.
- The following use case (see figure 19) is relevant for L4 vehicle automation, Use case 10, smooth transition TtS (time to sleep) to SB (stand by).

To give a clear overview of Mediators findings and user-tests that are performed over the years. These tables (see figure 6-18) are created to give the reader a quick visual overview. A disclaimer is that tests are based on current technologies that might not all be relevant when creating a design process for 2040.

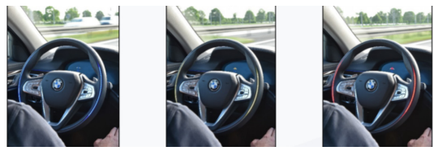
NON - FUNCTIONAL REQUIREMENT

MUST

• Minimize learning effort	General/familiar affordances
• User acceptance	User has the feeling their still in 'control'
• Good user experience	• User acceptance • Trust • High usability

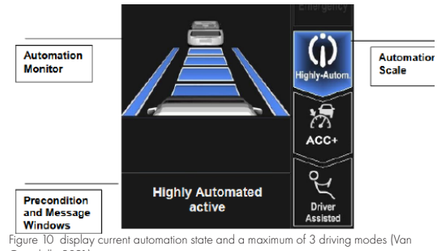
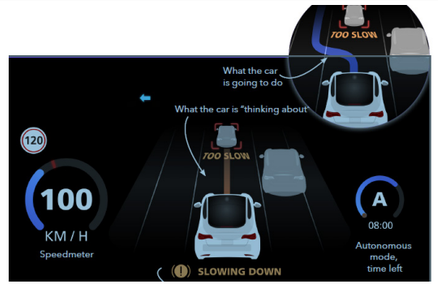
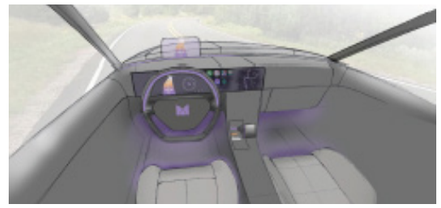
FUNCTIONAL REQUIREMENT

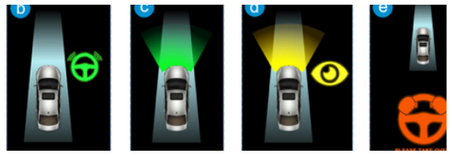
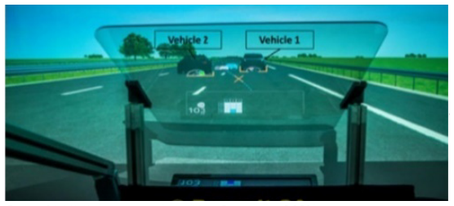
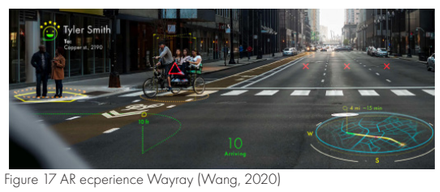
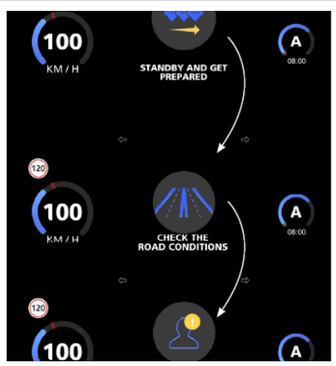
MUST

• Awaken the driver & prepare for the transfer.	 Figure 6 Wakeup light (Van Grondelle, 2021) • Ambient light
• Prepare & guide user for takeover.	 Figure 7 HUD layout (Van Grondelle, 2021) • A heads-up display (HUD)
• Inform driver whilst engaging in non-driving activities.	 Figure 8 BMW HMI (2020) • Ambient peripheral cues
• Early alert before take over.	 Figure 9 Takeover warning (Wang, 2020) • Alarm with different frequencies

FUNCTIONAL REQUIREMENT

SHOULD

• Avoid mode confusion.	 Figure 10 display current automation state and a maximum of 3 driving modes (Van Grondelle 2021) • Maximum of 3 overarching driving modes.
• Communicate when a disagreement occurs (between user & machine).	 Figure 11 HMI communication and further explaination about the choice of the system (Wang, 2020) • Forced feedback.
• Warn the user about upcoming takeovers.	• Auditory & Vibrational feedback.
• Reflect current autonomous state.	 Figure 12 mediator design of the current autonomous state (Van Grondelle 2021) • Icons or ambient light.
• Communicate time for takeover.	 Figure 13 Depleting bar on the steering wheel (Shan, 2021) • Number or depleting bar with a decreasing time.

FUNCTIONAL REQUIREMENT	WILL
• Offer Tts mode for time periods less than 4.5 minutes.	• L3 Autonomous driving as an option for periods < 4.5 minutes.
• Communicate the reason for mode switches.	 Figure 14 automation availability and activation (Van Grondelle, 2021) • Icons describe road situations.
• Communicate every move (lane changing or overtaking).	 Figure 15 Communication of present and future actions (Van Grondelle, 2021) • Icons or integrated lights.
• Show current road detection (decision-making).	 Figure 16 HMI decision making (Van Grondelle, 2021) • HUD (highlight other road users).  Figure 17 AR ecperience Wayray (Wang, 2020)
• Amount of presented information.	• Different modes.
• First-time use.	 Figure 18 Information on HMI step by step guide (Wang, 2020) • HMI guide through all functions.

1.2.4 Use cases for L4AD

Since this project focuses on L4 automation this process will be based on the Mediator's use case 'Time to sleep (TtS)'. This use case is based on a 'long out of the loop' scenario in a higher level of automation. The driver can be engaging in other activities for a long period or even fall asleep.
The challenges of this use scenario:

- "Bring the driver back in the loop after full disengagement" (Christoph, 2019).
- Predict the time in advance to safely complete this task.

As portrayed below the use case of Time to Sleep will be mostly located on the highway and is best implemented for longer periods of time. Which makes the design process focus on designing for long distance travel.

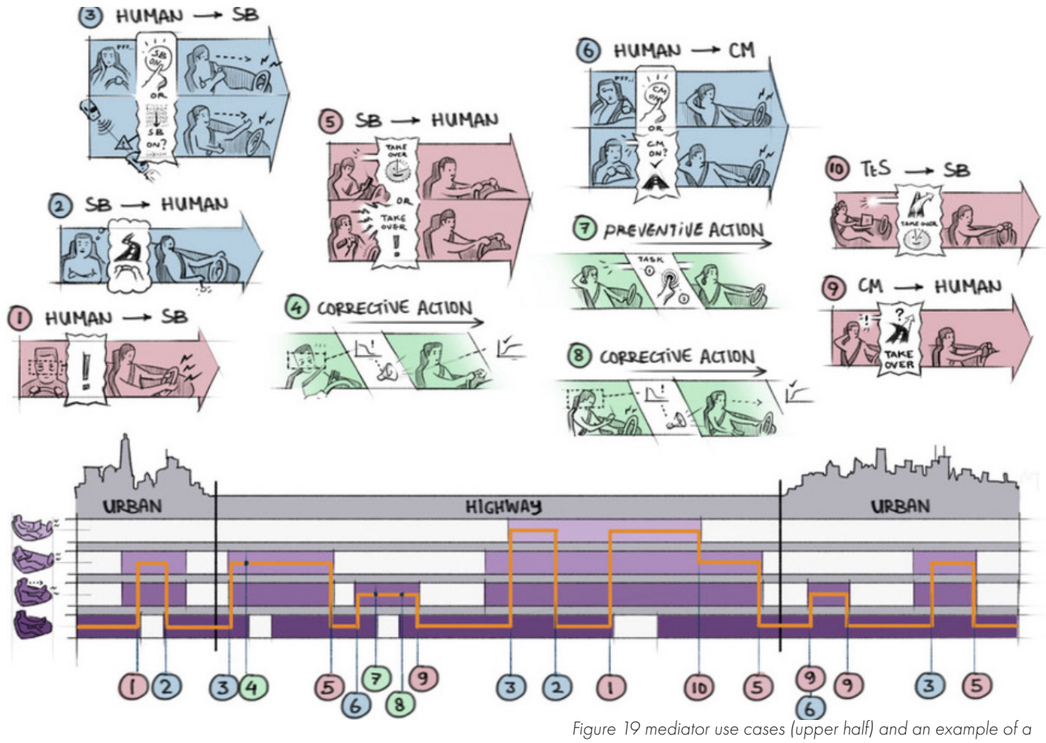


Figure 19 mediator use cases (upper half) and an example of a scenario (lower half)

Chapter 1.3 The transitioning roles of the user

Where should it be integrated?

1.3.1 The role through the Years

The role of the user inside the vehicle has changed over time. It is important to get a good overview of what that role was from the start and how it has developed until now. This way it is easier to predict what the role of the user will be in the future.

The first steam carriages appeared in 1830, where it was required to have a crew of at least two people. One had control over the gauges to scan the state of the engine while the other drove. (Britannica, 2023) Developments made the second driver only disappear around 1910.

The date of the first car however is set in 1886 invented by Karl Benz, which had three wheels and was powered by an internal combustion engine. After this two-seat vehicle appeared where the passengers and drivers were facing each other. In French it is called 'vis-à-vis'.

Followed by the 'dos-à-dos' which means shoulder-on-shoulder seating. This was seen as the first family car, where the passengers in the back were isolated from the driver and the road. They would be facing the rest of their surroundings and wouldn't be confronted with the car's mechanical parts.

Which later changed to the seating that we know today. The passengers were still isolated from the rest of the vehicle but were also facing toward the road. The main reason for this change was comfort, where passengers could anticipate the road ahead of them.

The car kept increasing in comfort throughout the years. First by adding windshields in 1904. Later on, radio and air-conditioning were added. In this way, the users kept being more isolated from their environment. Considerably making the interior move towards a living room.

In 1958 the cruise control system was invented. This changed the role of the driver in a new way, where the system took over the role of accelerating by maintaining the car at a constant speed. This can be seen as the start of an autonomous level 0 vehicle. The automation of the car causes the driver to have fewer tasks while driving the vehicle. (Möser, 2022).

As the SAE describes, will the role of the driver change as the Automation levels of the vehicles keep developing. Until L2 Automation the driver is still responsible for the vehicle in any situation which makes them stay in the 'drivers role'. Whereas in L3 the user will supervise in small periods of time. This is extended in L4 autonomous driving. There will be times when the driver is driving the vehicle or interacts like a passenger. Since the system communicates this with the user there will be a supervisory role during transitions. This is the time when the user has to get ready to take back control. (SAE, 2021).

	No Driving Automation 0	Engaged Level of Driving Automation				
		1	2	3	4	5
In-*Vehicle User*	*Driver*			In-*vehicle fallback-ready user*	*Passenger*	
Remote *User*	*Remote driver*			Remote *fallback-ready user*	*Driverless operation dispatcher/remote assistant*	

Figure 20. User roles while driving the automation system are engaged.

1.3.2 Non-driving Activities in an L4AD

Based on the research of Pfleging (Pfleging, 2016) and Weigl (Weigl, 2022) the visual on the left was created to showcase participants their preferred non-driving activities. The participants could fill in multiple answers. That's why all activities are shown as percentages out of how many participants out of the 100% preferred a certain activity.

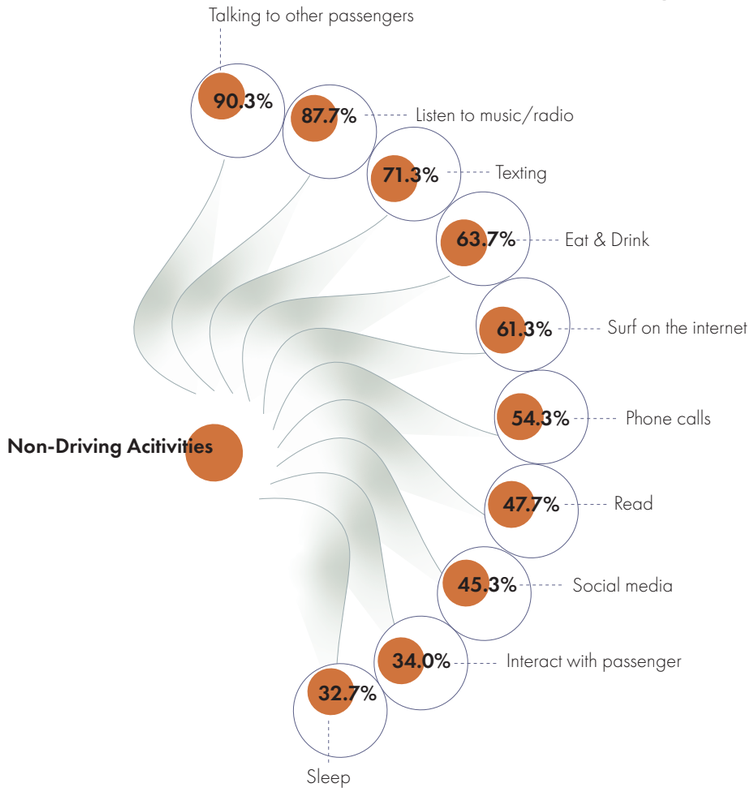


Figure 21. Showcase participants preferred non-driving activities.

1.3.3 An extended living room

Nowadays the engine and the mechanical part of the car are not visible in the interior. The completely enclosed passenger compartment makes the passenger separated from their surroundings.
(Möser, 2022).

A Level 4 autonomous interior design requires an interior that supports driving and non-driving-related activities. With the possibility to also engage in non-driving activities, people tend to perceive the interior space as an "extended living room". (Tang, 2020).

The main requirements are a more **flexible** and **adaptive** design.

Seat design
- A more multifunctional and adaptive seat design
- Possibility for seat expansion.
- (related to the rest-activity).
- Rotatable seat. (interact in other activities: work, studying, playing games).

Dashboard
- Moveable steering wheel. (to make space for other activities).

(Tang, 2020).

1.3.4 Vehicle architecture

The research of Kwon, J. Y (2021) about the spacial components of a face-to-face seating arrangement in an autonomous vehicle gave the following results:
The top 3 preferred activities were: sleeping and reclining, face-to-face conversations and watching videos. The percentage of conversations whilst using the table in this case was 33% of the total conversations that were held during the tests.

Overall the face-to-face position was preferred where some participants felt the need to have an option of also facing the driving position.

"It is important to recognize that face-to-face seating arrangements are not just to facilitate conversation but can be seen as an environment in which each passenger can conduct other in-vehicle activities individually" (Kwon, 2021).

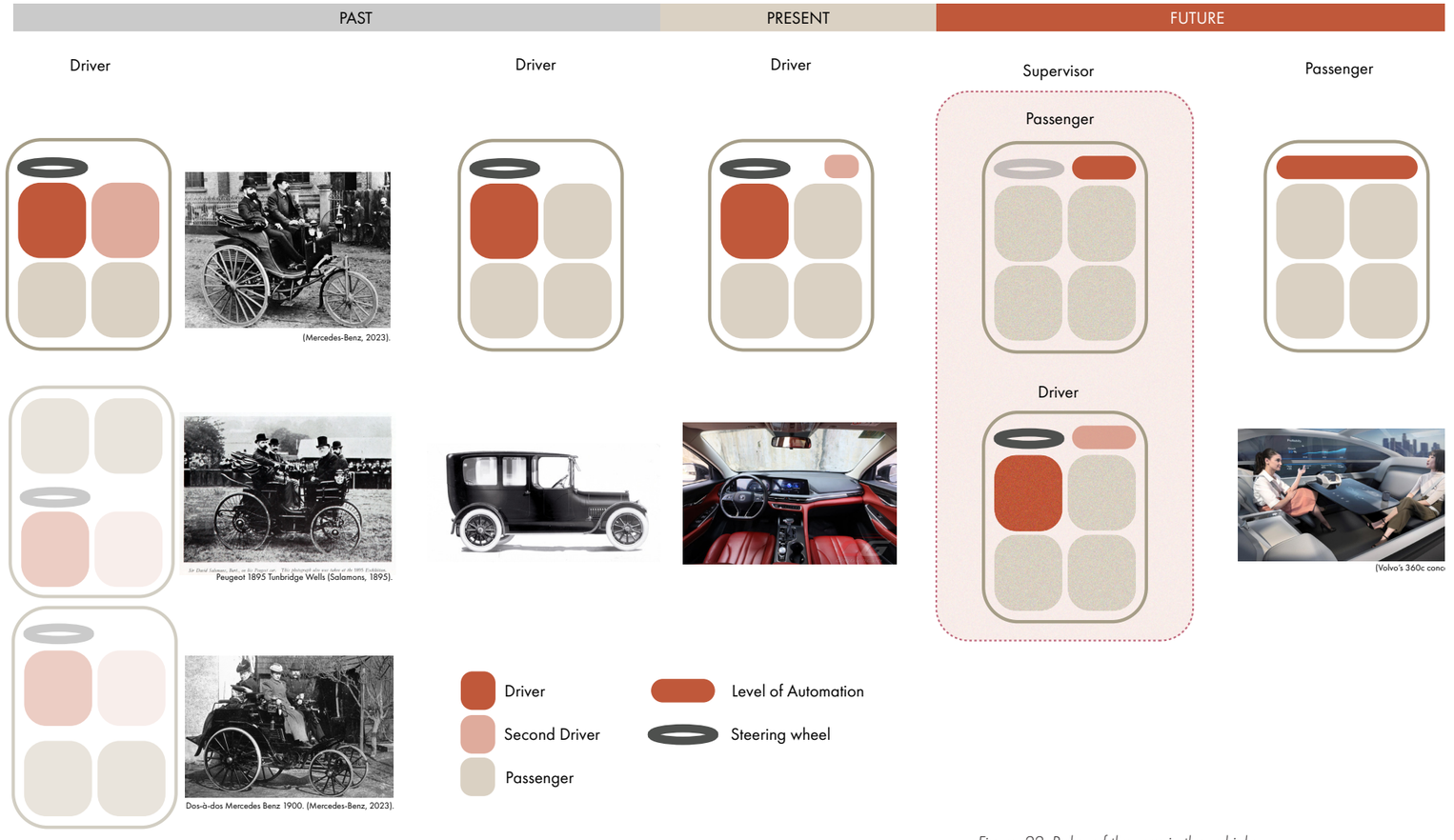


Figure 22. Roles of the user in the vehicle.

Chapter 1.4 Perception of premium

1.4.1 What is premium?

A premium car is defined as “a vehicle that provides luxury- amusing or engaging features beyond strict necessity at increased expense.” (Sharma, 2015). Premium vehicles use higher quality equipment, offer more comfort and include innovative technologies compared to the average segment. To still meet the price of being an affordable car these models are produced in larger volumes.

1.4.2 Luxury vs. Premium

The difference whilst comparing it with luxury with premium is the exclusivity and price. Rolls-Royce, Ferrari, Lamborghini, and Aston Martin are placed in the luxury segment. Brands that are known for their ‘mass’ luxury by providing premium vehicles are BMW, Mercedes, Jaguar, and Audi. (Sharma, 2015).

1.4.3 Premium Vehicles in the European vs. Asian Market

Changan currently designs for the Asian market, where consumers have a different perception of what makes a car ‘premium’. In China, status is very important. That is why their premium cars have more space, features in the rear seat, comfort, and include an extended wheelbase. The extended wheelbase is to make the vehicle still comfortable whilst being chauffeur driven. The Asian market consists of larger vehicles in general compared to the European Market. (Warren, 2014).

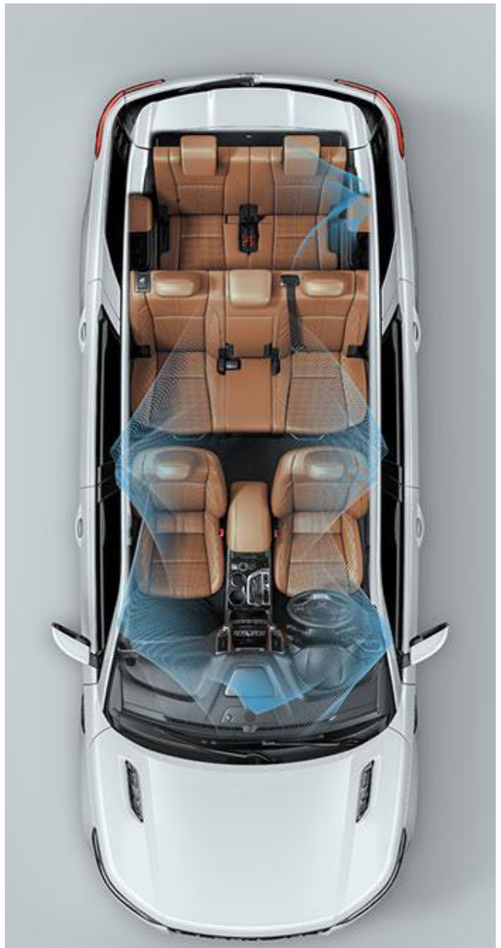


Figure 23. Changan CS95 “7 seater” (Changan, 2023)

Chapter 1.5 Entering the European Market

1.5.1 Country of Origin Effect

The Country of Origin effect is defined as the overall perception a customer has towards a product that is produced by a certain country. (Bartikowski, 2019). This contributed to the success Western car companies had when entering the Asian market. The perception is based on the country’s production and marketing strengths and weaknesses. (Roth & Romeo, 1992, p. 480).

Back in the days when Japanese and South Korean car companies entered the Western market they had to overcome this quality gap that was established by the already existing car brands in Europe. For the Japanese brands, this COO image took 50 years. Whereas it took Korea 20 years to overcome this quality gap. Since China is a well-established manufacturer nowadays the quality gap is no longer present. (Zeynalabdi, 2010).

1.5.2 European Perception of Chinese EVs

Berylls researched the chances of a Chinese brand successfully entering the European market. Entering this market with an EV model is predicted to have the highest success rate. This resulted in 25% of premium consumers considering a Chinese brand when purchasing a car and 50% believing Chinese OEMs will be successful in Europe. (Berylls, 2022).
Alexander Klose (a former Volvo & Ford executive) states that previous failed attempts of Chinese car companies to enter the European market won’t hurt Chinese EV makers today. Nowadays customers are more accustomed to seeing electronics that are made in China (Carey, 2021).

This shows a leap of faith where German customers have a certain level of trust or expectation in the Chinese OEM’s technical leadership in developing EVs. The only resistance to purchasing Chinese brands is the quality and service (Berylls, 2022).
The second obstacle Chinese car brands have to overcome is the years of brand identity European brands already established. Entering a new market will be tough since the brand is not generally known. Alexander Klose believes the barrier will be lowered as soon as other Chinese EV brands enter the European market.

Due to China’s ‘benefit in scale,’ their EVs can be produced in good quality at lower prices. China’s car market is twice the size of Europe. Which leads to lower manufacturing costs and faster innovation. The second reason is the European Union regulations that are designed to help manufacturers sell “high-end, high-profit models” (Winton, 2022).

Reasons of Purchase

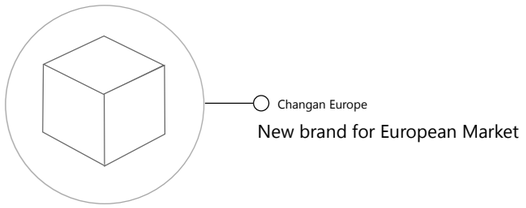
- Value-for-the-money (45% premium / 54% general)
- Range (19% premium / 41% general)
- Charging time (11% premium / 47% general)
- Design (33% premium / 8.3% general)

1.5.3 Brand identity prism

Since Changan does not sell their cars in Europe yet, they have not established a brand identity in this market. The brand identity prism of J. Kapferer is normally used to give an overview of the brand identity of a brand. In this case it will be used to scope the brand identity Changan could aim for while entering the European market.

This brand identity prism consists of three external and three internal methods. For the external facets it is not possible to take a brand in account that is not on the European market yet. To solve it would be more interesting to focus on well established brands in the European market then explain Changans current brand identity on the Asian market.

That is why the external facets are based on two other European brands that fall in the aimed competing sector of affordable premium. These brands are Skoda and Volkswagen.



The extended explaination of this research can be found in appendix A (brand identity prism steps).

1. Spacious interior, Emotional immersing.
2. Peaceful and caring, Guiding.
3. Unique, ahead in technology.
4. Warm family interactions
5. Family-oriented
6. Progressive and Confident

The brand essence will be located in the centre of the prism. This captures how Changan wants to be identified by the user. Changan = embracing. When users buy a Changan vehicle they want to have this embracing feeling where you can let go of all your worries and experience the premium quality, technologies and space for an affordable price with their family.

To provide this experience the interior has to be interactive, adjustable and simple. Therefore the following statement for Changan is made:

"Changan embraces their customers by its caring and guiding character that provides a progressive, emotional immersing and unique design.

This statement will serve as an abstract guideline to reflect the impact a future product of Changan should have on the user.

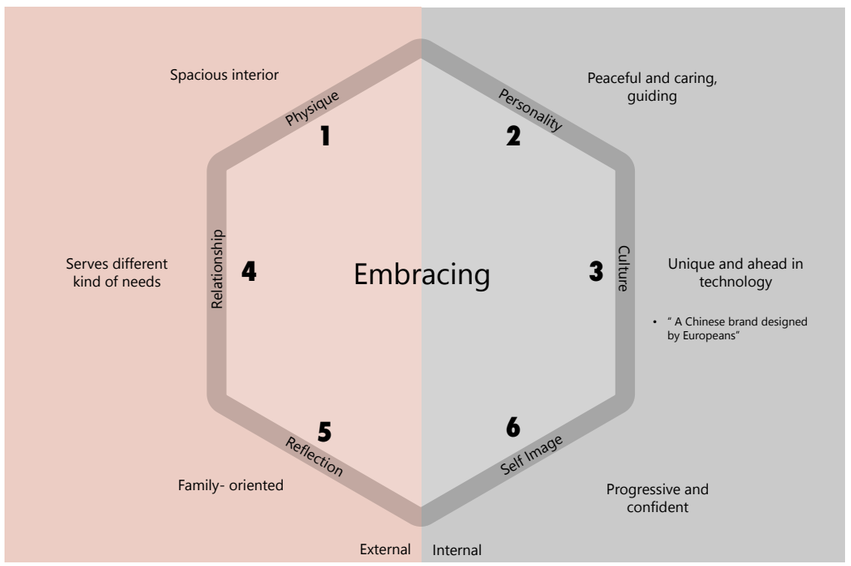


Figure 24. Brand Identity Prism

Chapter 2. Future Context analysis

Vision in Product

Vision In Product

2.1 Approach

Currently we are still not sure what the future of 2040 will look like. To make a profound prediction of the future context the design process will be implemented in the method Vision in Product (VIP) design will be used. (Hekkert,2016).

VIP is a design approach that is not only context-driven, but also focuses on the interaction between the user and the product. This will help the future design process by building the criteria and vision for an AL4V design. By implementing VIP into the design process it will give the interior design process more meaning and value.

This integration fits well with the outcomes of the analysis that the design should be more human-centred and integrate the UX design earlier on in the process.

2.2 How does this method work?

First of all the process starts with defining the domain/scope of the project. As Hekkert and Van Dijk stated in their VIP method book, the aim or scope of a project is: "a description of the area where you aim to make a contribution".

In this project the domainthat is set as:
"The life of an affordable premium consumer of 2040."

It is important to not limit the domain to a specific product usage and only focus on the consumer. Since this method will focus on the future consumers' attitudes and needs in 2040.

The VIP method consists of two phases: The deconstruction phase and the design phase. The deconstruction phase consists of three parts that analyse 'The existing product'.

First, it starts at the product level, then moves through the interaction level to finish at the context level. After this follows extensive research to create the future context in a well-argued manner. The future context will be created in a few steps.

- Clustering the context factors that result from extensive research.
- Create a framework and choose a direction that offers a brand opportunity .
- Summarise the strategy in a mission statement.

Which will form the base element for designing a desired human-product interaction. Where the next step is formulating appropriate product qualities for this desired interaction.After finding the future context, a desired human-product interaction, and the appropriate product
qualities it will be time for the concept development. When entering this new phase, it is important for this project to also keep including external findings in the fields of HMI and Autonomous driving.

2.3 The deconstruction phase

In this project, the brand Changan will focus on a different market (Europe instead of Asia). The focus on the deconstruction phase will be relatively small. The method of VIP is user-focused where the past context of the user is also looked at from a European scope perspective. The steps that are included in this research are the Brand analysis, on a product level the HMI and Autonomous driving developments, and the current user interactions inside of the vehicle.

2.4 Context

Context factors
The VIP analysis is used to get a new and unique design approach to enter the European market of 2040. For this 67 relevant context factors are gathered that fit the domain of this project. (See appendix B).

The context factors consist of states, design principles, developments and trends. By clustering the factors (including their driving forces) a framework for the future can be constructed. This framework leads to the Vision and design direction.

2.4.1 Clustering

By clustering, the relationships between different factors are analysed. The clusters that are defined represent findings in the future context. Some factors in the clusters overlap since all factors are in relation to each other given the current scope.

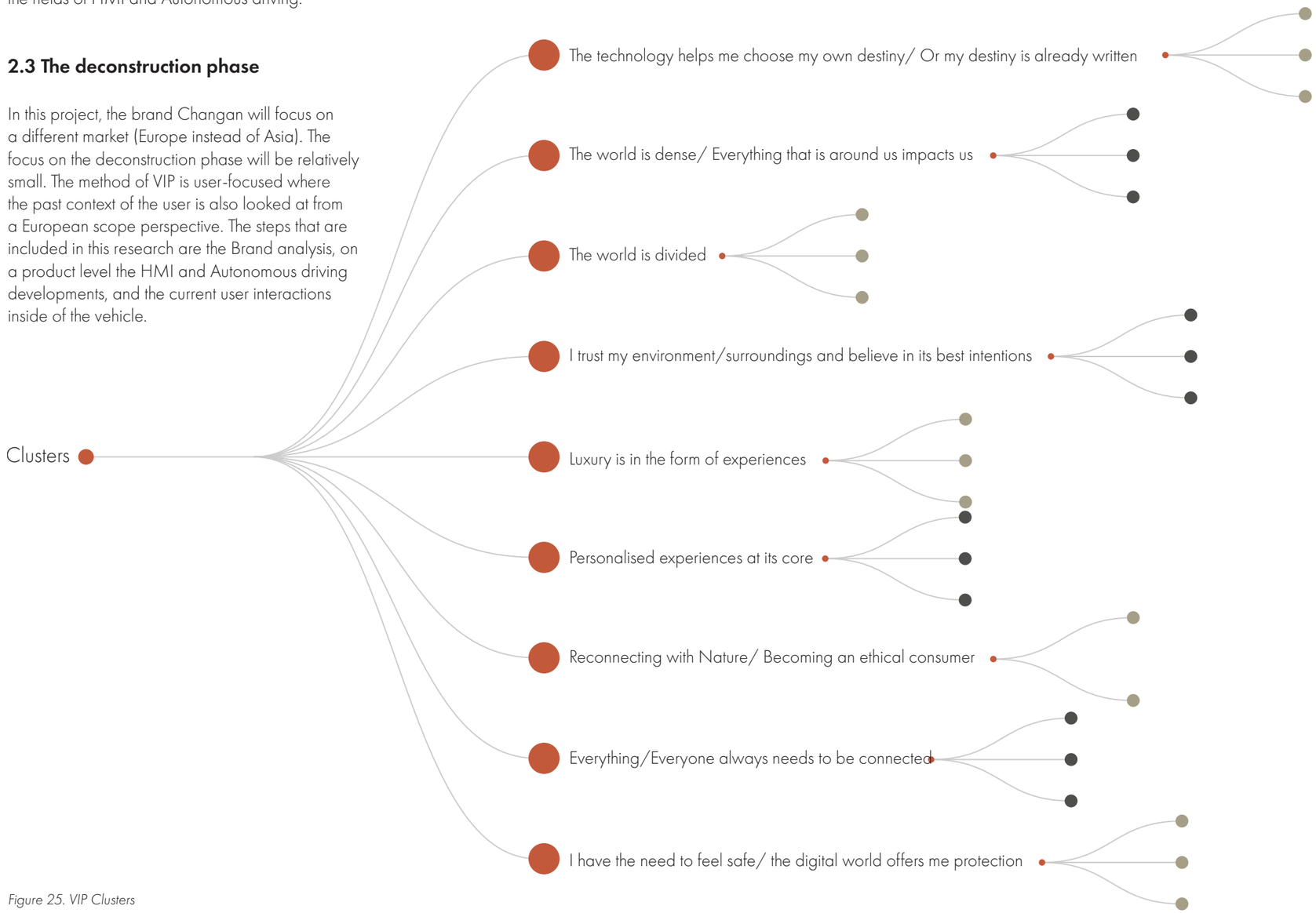


Figure 25. VIP Clusters

2.4.2 Framework

With a framework, we can recognize the attitudes/ behaviours of the future user inside the given domain. Which will later help to stimulate these behaviours or attitudes in the design. The framework will guide us to know who we are designing for by giving four different design targets.

2.4.3 Framework axes

For this framework, there are two defined axes. Both axes are based on the storyboard that is produced from the 9 given clusters. The first axis is based on the "Desire to Trust" autonomous vehicles. Whereas "Accordance" is the way the user trusts the system without paying attention or questioning the vehicle versus "Exigency" is where the matter is urgent to be trusted and paid attention to.

The other axis is the "Sense of experience". "Personalised entertainment" where the experience is approached by the user in a passive interactive way versus "Re-engaging with nature" where the user seeks out the experience in an active way by searching for interactions through natural elements.

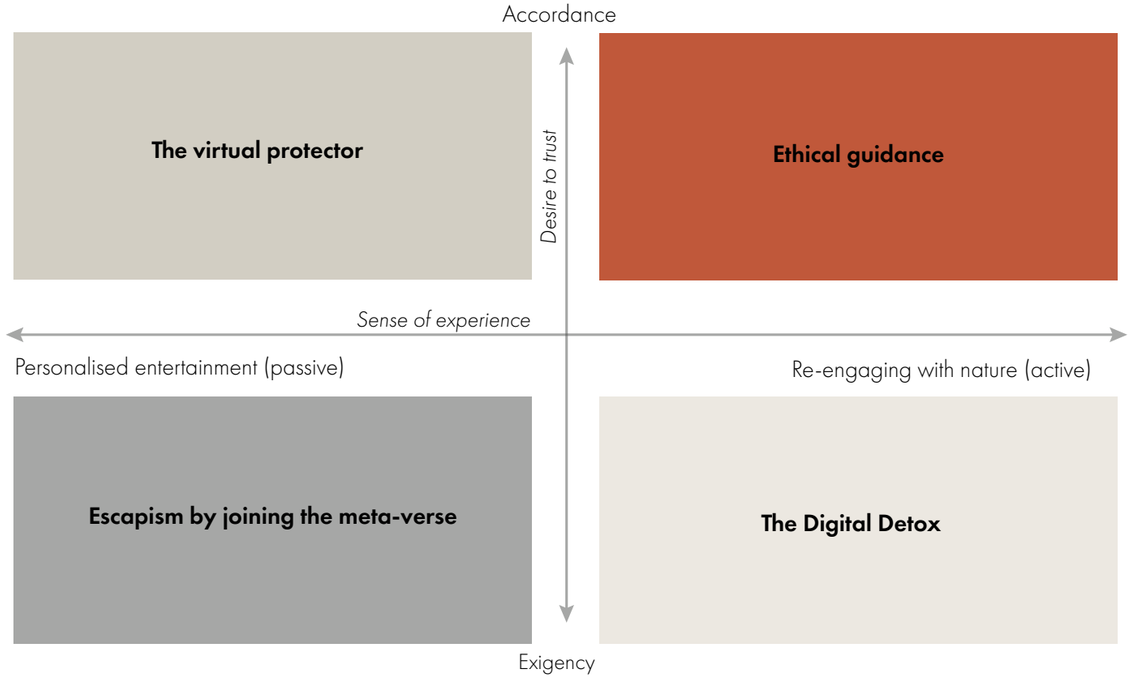


Figure 26. Frame axes.

2.5 Mission statement

The mission statement represents the position you take to act upon this future world. Where the different design targets are portrayed above this will be a decision of the designer. To make this decision a few factors were taken into account.

- The second reason for customers to choose autonomous driving after safety in Europe is sustainability (See Chapter 1). When the customer has this reason to purchase a vehicle it is important that the rest of the vehicle also represents ethical life choices and stays away from big virtual screens.
- One of the aims of this project scope is to design a family focussed vehicle (See figure 24 Brand Identity Prism). Where "the virtual protector" and "escapism by joining the meta-verse" are focussed on the individual the other two design targets are more down to earth and focussed on the interaction between the passengers.
- The actively seeking entertainment and accordance are both the most beneficial areas in the sense of introducing autonomous driving. Where the seeking for entertainment will keep them more active to later on focus on the road and the "accordance" user is more accepting of the autonomous system.

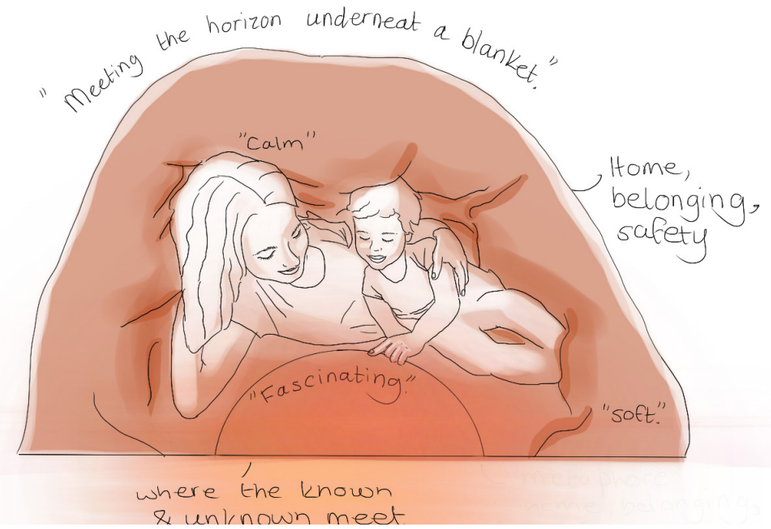


Figure 27. The Nido design interation

Next to these factors this will also be a place to include the designers personal values. Where there is a great need for designers that try to implement the aspect of sustainability more into their design choices. Where the challenge will be focussed on minimal means, maximum effect.

By evaluating the framework and adding the personal values as designer, the most beneficial design target for this framework will be the ethical guidance. Which results in the following design statement:

In a domain of affordable premium consumer of 2040...

"We want the user to re-engage with nature by Consciously Indulging".

- *Re-engage with nature : A design that follows the "Wabi Sabi" Design principles.*
- *Consciously: design that follows the principle of minimal means, maximum effect.*
- *Indulging : A design language that focuses on the interaction between the users.*

2.6 Design Interaction

The next step is to imagine the interaction without taking into consideration what you are going to design yet. The interaction is focused on how you want the user to interact with the product. An analogy is used to make this interaction more understandable. The interaction should make the user feel like meeting the horizon underneath a blanket.

The horizon is a symbol for the place where the unknown and known meet. This bridge in the design will be formed by the autonomous system that will be implemented into the interior design. Since the horizon is located underneath a blanket this will form a protective frame for the user to translate the possible outcome of fearing the technology and translating this emotion into fascination.

2.7 Product Qualities

With the given analogy for this design it is important to focus on certain product qualities. These qualities will form the base for the design language that will be used in the concept creation.
To make it feel calm and soft the product qualities will be:

- Earthy tones.
- Soft seating and textures.
- Natural shapes (Wabi sabi).
- Minimal amount of digital screens.

What is going to change in the future?

Chapter 3. Company analysis

- Chapter 3.1 Current design process
- Chapter 3.2 UX maturity

3.1 Current design process

When designing a design process for the future it is important to analyse Changans current companies design process. Several departments were interviewed to get a good overview.

Since Changan currently focuses on the Asian market most of their research will be done at their location in Chongqing, China. For optimising the communication between the different departments and their different locations (Italy and China) they have a few methods.

Next to online calls between the two locations, they organise visits to China including people from different departments. As well as letting some of their colleagues work remotely in China and Italy.

In the current design process UX/UI design and CMF are communicating with the other departments but are not integrated into specific design processes.

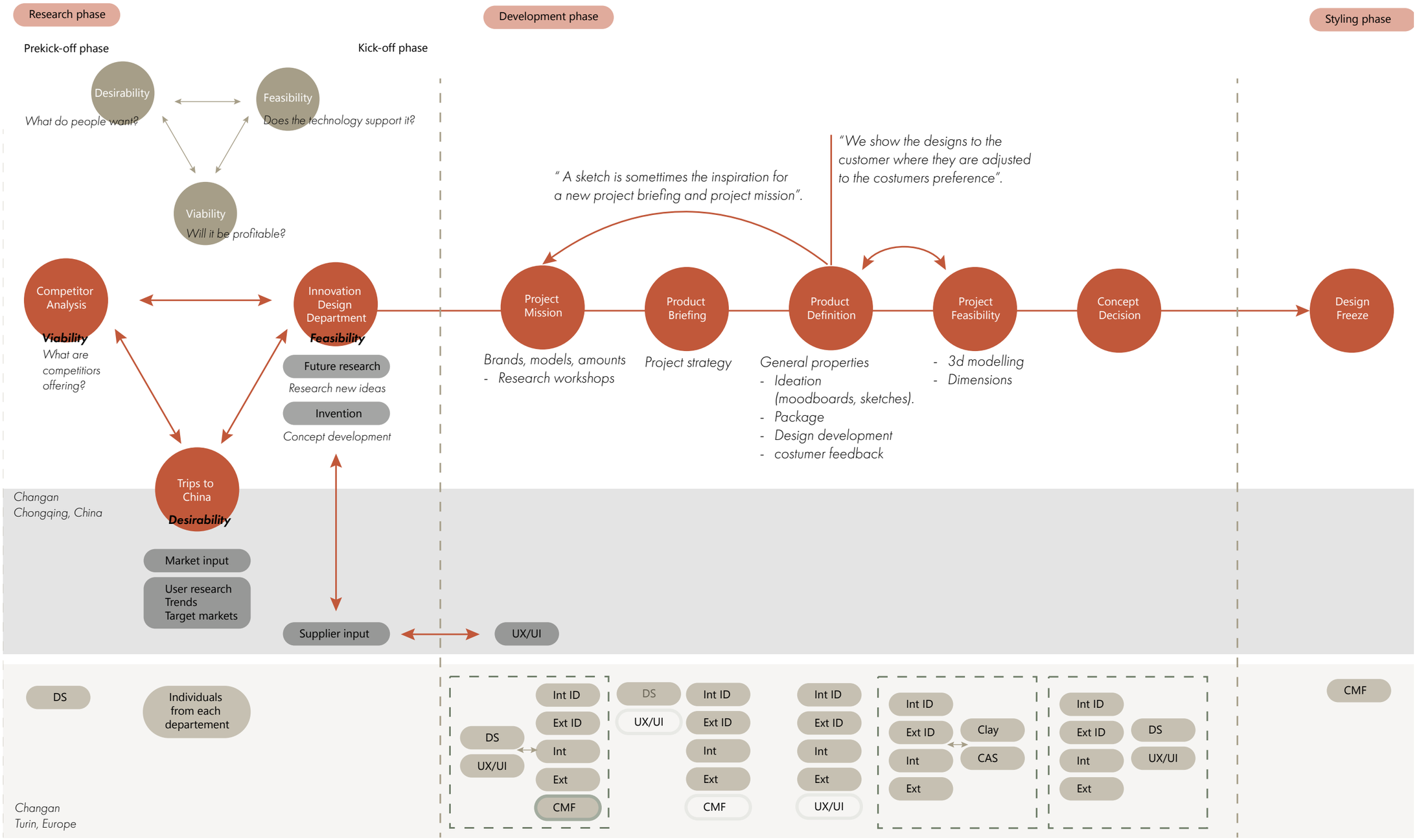


Figure 28. Current design process at Changan Europ

3.2 UX Maturity

The UX maturity model describes 5 different levels of integration of UX design within other departments of the company.

Where the current stage of UX maturity (Chapman, 2014) in Changan is currently located between stage 2 (awareness) and stage 3 (adopting). During one of the interviews it was stated "Currently UX fills the screens, but does not influence the shape of the interior".

There are six indicators to improve the UX design in a company, which are:

- *Timing: earlier involvement in the design and development process.*
- *Expertise and resources: Something that will likely change when Changan moves its market location to Europe.*
- *Techniques and deliverables: To get a better user understanding.*
- *Leadership and Culture: Does the company see the value of UX in design.*
- *Connected and Integrated: Integration between other departments.*
- *Design thinking: Consistent customer experience driven.*

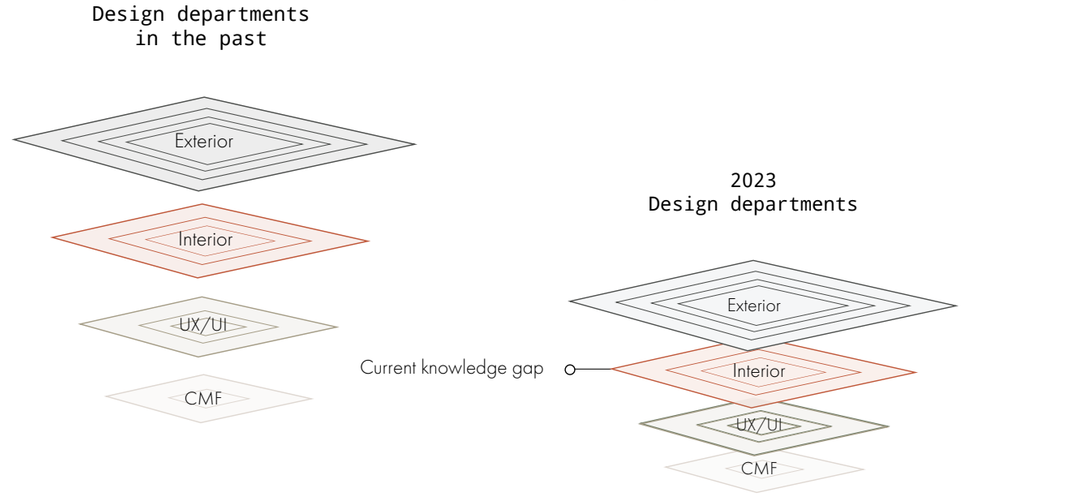


Figure 29. Design Departments over time

Design Criteria

UX needs to be integrated earlier on in the design process

Context analysis

The autonomous system has to interact with the driver about...

- The current autonomous state.
- Smoothly transition from automated driving to manual driving.
- The decisions that are made while driving autonomously.

By this way the driver has the feeling that they are still in control which optimises the user experience which includes user acceptance, trust and high usability.

With driving autonomously the driver has the possibility to engage in non-driving activities. To provide these needs the interior will change to a more extended living room. The main preferred activity is communicating with other passengers.

To provide this the original architecture of the vehicle has to change. Out of the research in Chapter 1.3 resulted in users having an increased need to have face-to-face conversations. Where 33% of the participants used a table while engaging in these conversations. The option of facing the driving position should still remain in the design since this project focuses on L4AD.

Other interior changes that can provide these preferences are:

- Multifunctional and adaptive seats
- Possible seat expansion
- Rotatable seats
- A movable steering wheel (that leaves space in the front to use for other activities).

Future context analysis

Next to the functional requirements the design of the future will aim for a certain goal by including a mission statement.

In a domain of affordable premium consumer of 2040

"We want users to re-engage with nature by consciously indulging".

This will be executed by focussing on a vehicle that stimulates family engagements in a way that follows certain design principles:

- Re-engage with nature: Using the Wabi-Sabi principle. (Further explained in Chapter 5).
- Consciously: Minimal means, maximum effort.

Company analysis

To implement all these new functions into the interior design process it is important to look at what needs to be changed in the current design process.

- The autonomous system needs to be integrated into the vehicle's interior.
- The autonomous system requires more flexible and adaptive seating and seating positions.
- These integrations are needed in different positions of the interior.

As a result of these changes the UX design needs to be integrated earlier on into the design process.

Context synthesise

- Chapter 4. Rich experiences
- Chapter 5. Wabi-sabi
- Chapter 6. Matrix 3 & Matrix 4 method
- Chapter 7. Concepts
- Chapter 8. Design choice

Chapter 4.
Rich Experiences

4.1 The Method

To test if your design evokes the intended emotion the method "Rich experiences" is added into the design process. "People can enjoy negative emotions". (Fokkinga, 2021). As most designers try to stay away from negative emotions as much as possible there are a lot of entertaining activities that include the presence of a negative emotion. Think of for example bungy jumping, solving difficult puzzles or watching sad movies.

Why do we still enjoy these activities? Because we know that we are protected by the negative consequences. To make a design as enjoyable we need to make use of a protective frame. There are four methods for adding a protective frame to your design:

Safety-zone frame
This frame creates a "distance between the person and the stimulus that evokes the negative emotion". (Signated seating outside the splash zone of a water attraction).

Detachment frame
Observe an event without participating. In this way "people are dealing with a representation of a negative stimulus rather than the stimulus itself". (Watching a scary movie).

Control frame
In this situation they are in a danger zone but are convinced about their physical and mental abilities to handle the situation. (Being an experienced driver compared to a driver that is just in the beginner phase).

Perspective frame
With the perspective frame the perception of the experience of the negative emotion gets influenced by the overall context of the situation. (Running for a charity fund. The negative emotion of the pain stays but the good cause converts the sensation.)

figure 30 Safety-zone frame

figure 31 Detachment frame

By using a protective frame the negative emotion of anxiety evoked by driving autonomously will be turned into a "rich experience" which translates to the emotion fascination. User testing is necessary in this process to analyse if the protective frame results in the intended outcome.

4.2 The Approach

1. Choose a negative emotion
2. Design for the negative emotion
3. Protect from the consequences

1. Selecting a negative emotion for the design by creating a mindmap. (see figure 34)

Although there are a lot of ways to improve the user acceptance of autonomous driving. (See Chapter 1). Autonomous driving will remain to have the negative emotion that some people will not trust the system. In this way there is a fear without a concrete cause which is called anxiety.

Emotion: Anxiety: evoked by autonomous driving.

2. Design for the negative emotion.

Concrete example with general causes.
The fears for driving autonomously are located on different levels:

- The fear of a non functioning system: A fear based on technology.
- The fear of misunderstanding the system: A fear based on UX design.
- The fear of losing control: A fear that is based on a personal perception caused by technology, UX design and Interior design.
- The fear of a limited space for non-driving activities: A fear based on the interior design.

Since the scope of this project is not focussed on integrating the autonomous system, but based around designing an interior process that provides the space for this integration. The emotional fears of a non functioning system and the fear of misunderstanding the system will be hard to measure whilst user testing.

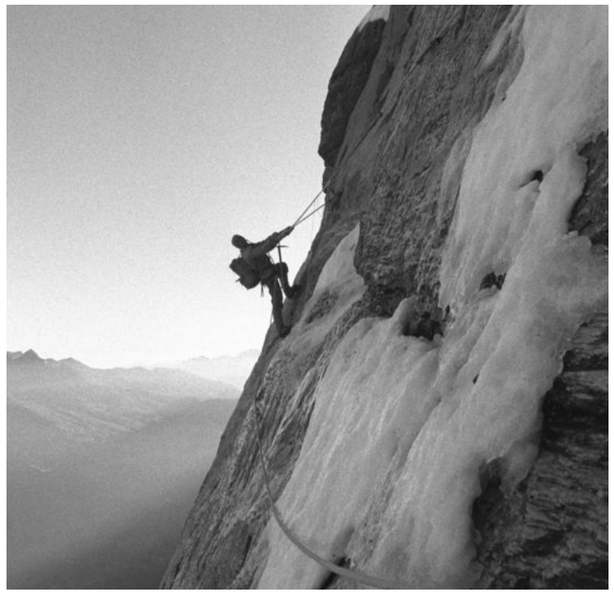
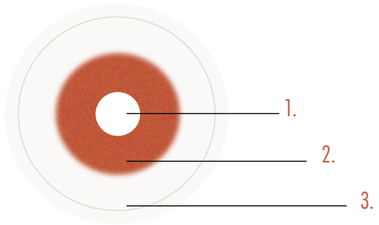


figure 32 Control frame

figure 33 Perspective frame

Although the fear of losing control would be one of the most interesting questions. It will not be a question that can be solved solely looking from an interior design process perspective. Since this project focuses on optimising the interior design process, it is important to choose an emotion that is related to interior design of the related concept.



1. Emotion.
2. Concrete example with a general cause.
3. Cause created in a context you are designing for.

Concrete cause in the context of your design. The chosen threats that appear in the context of this design process are ones related solely to the interior of the vehicle. Which are non adjustable seating, no table, not having a steering wheel in the autonomous mode and an unclear location of the HMI.

The design concept that is created to further explore the implementations of this design process focussed on providing an architecture that stimulates the user to interact with other users by providing adjustable seating, a table, a movable steering wheel, rotatable seating and a clear location of the HMI integration.

figure 34 Negative Emotion Mindmap

3. Protect from the consequences.

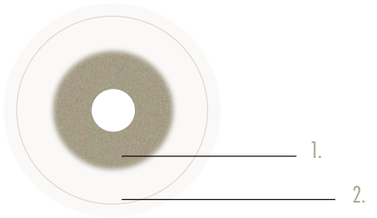
The next step of this method is to add a protective frame. In the mindmap of figure 35. different protective frames are explore in the context of the concept design.

The context that is used in this step is taken from the previous chapters and include the mission statement.

In the step of this design process (Synthesise) the method Wabi-Sabi is implemented to serve as a detachment frame. The choice for this frame is based on the mission statement.

The method Wabi-Sabi is aimed to detach the user from this anxiety by representing an environment that takes the user in a more observing role by focussing on the HMI instead of the road whilst driving autonomously.

To see what direct guidelines the interior design is implemented by using this method see Chapter 5 “Wabi-Sabi”.



1. Four protective frames
2. How to explore these frames in the context you are designing for.

figure 35 Protective frame mindmap

Chapter 5. Wabi Sabi

5.1 The Method

Wabi-sabi is a traditional way of defining beauty. A method that is so hard to understand because it mostly focuses on the feeling of a design. Where the English translation comes the closest to the word “rustic” “as simple, artless, or unsophisticated ... [with] surfaces rough or irregular” (Koren, 1994) still it might be argued as a limited approach to the wabi-sabi aesthetic.

Since the method of Wabi-Sabi is focussed on a philosophical relationship the individual has with a product it can expand the life-span of a product by surpassing the pleasure cycle of boredom or disinterest (Ostuzzi, 2011).

In a world of producing constant status symbols and goods that reflect on the user’s identity Wabi-Sabi will be a useful method to use as a designer when steering the consumer into a different direction. As stated in the mission statement (Chapter 2) there is a need for more conscious designs that re-engage with nature. (Ostuzzi, 2011).

Where most designs nowadays are focussed on perfection, Wabi-sabi does the opposite. The imperfection will lead to a more personal and intimate relationship with a product. By creating a space of intimacy it will also change the users perception of being more in the present, which leads to more engagement between the passengers in the vehicle. (Suzuki, 2021).
Further implementations of this method will be represented in the following chapter 6. Matrix and Matrix 4 method.

5.2 Material Qualities

- Warm
- Earthy
- Simple
- Irregular
- Intimate
- Natural process suggestions
- Shapes inspired on nature
- Natural materials

figure 36 Ryogen-in temple, japan

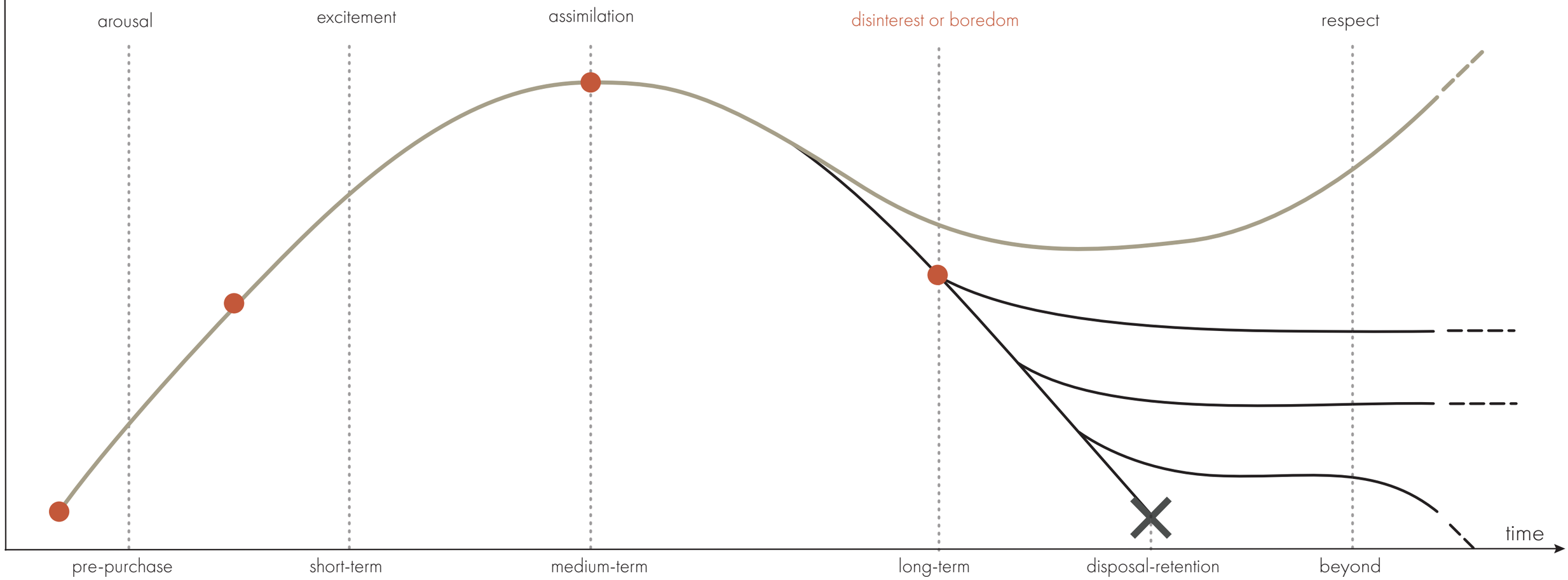


figure 37 Pleasure/dissatisfaction cycles

Chapter 6. Matrix 3 and Matrix 4 method

The relevance of this method in the design process

The reason to choose this method for designing an interior design process is that it can also be perceived on different levels. Where mobility can be seen as the meta level of the design, architecture as the micro level and the HMI as the micro level of an interior design. Within this method the architecture and HMI will also be analysed on both meta, micro and macro level.

By summarising the research of the previous chapter in a visual way it is easier for the designer to understand what changes should be implemented and what is the purpose of the design. Since this design process focuses on a passenger vehicle the levels are (see figure 38):

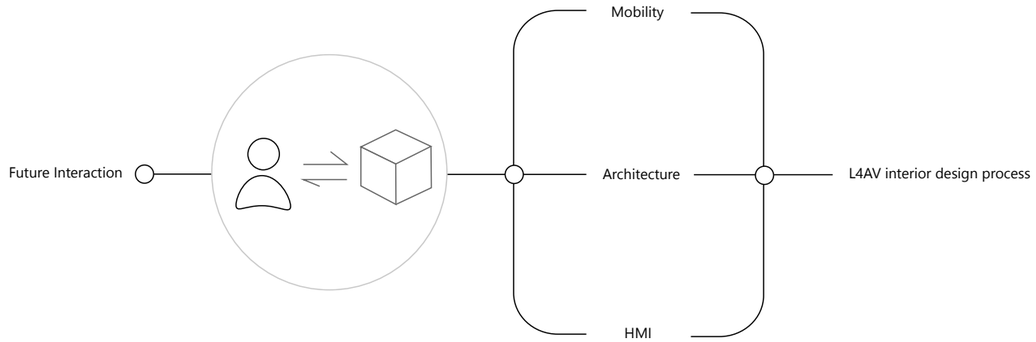


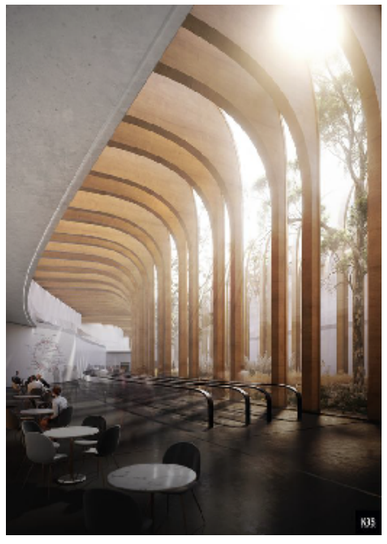
figure 38 Visual overview Matrix 3 and Matrix 4 method

What is the purpose of my design?

This level looks at the overall interior aspects of an L4AV in society.

Meta Level
Mobility
L4AD

Purpose of travel



Longer distances
Spaceous structure

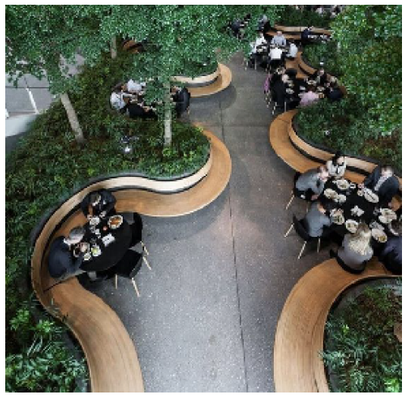
The future user will use the autonomous vehicle mostly on highways which makes this form of mobility more fit for longer distances.

Destination

Two types of focus
Inside and outside the vehicle

The final part of this design is the flexible purpose of a design. An autonomous vehicle opens the opportunity for a different kind of use that creates a second living space for users besides being heading towards their intended destination.

Flexible purpose



An extended living room

figure 39 Moodboard Meta Mobility

A part of the design that is mostly overlooked is how a vehicle looks from the outside to the inside. Although this might be a crucial part of the design to recognise the USP of a design from the outside and make the outside of a design fit the inside.

What will be the seating positions of this design?

This level looks at the overall interior aspects of an L4AV architectural meaning.

To fit the preferred non-driving activities of the user the new interior should have the interaction of a conversation pit. Where people experience maximum comfort and have the experience that is beyond driving and feels more like a living room. To provide this the space should be used optimally and have seats that provide multifunctional activities.

Meta Level

Architecture

5 - seater

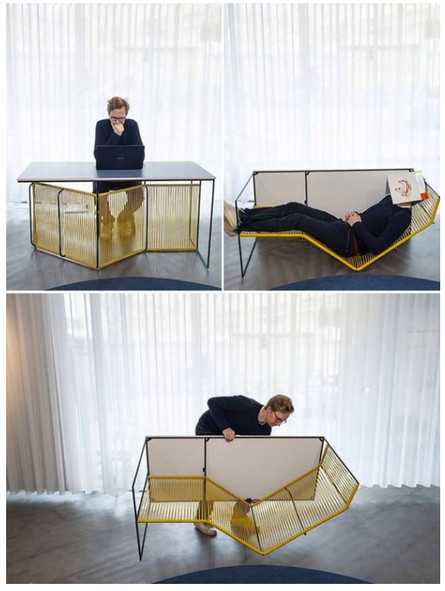
Table that provides more than only a workspace

Optimal use of space

User interaction

The coversation pit

Adjustable



Multifunctional seating

figure 40 Moodboard Meta Architecture

Architecture

5 - seater

The meta level of the architecture can be perceived by:

Macro Level

Micro Level

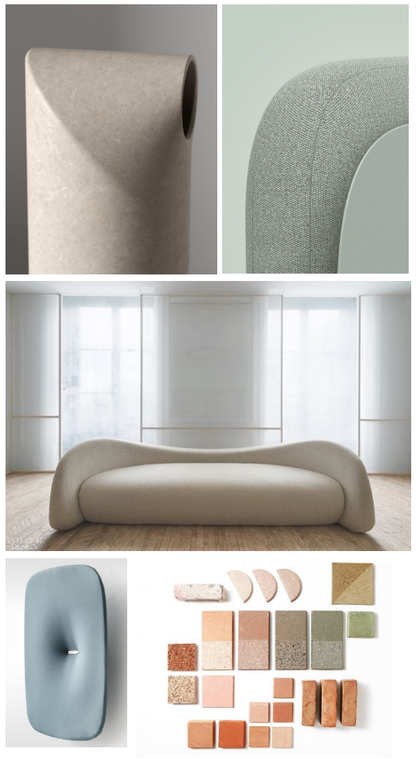
Shapes

Round shapes with stronger edges

Textures & Materials

Able to feel vibration in certain parts of the material,

Colors



Muted and soft colors to provoke an intimate feeling

Details

Balance between unity and variety, smooth connection between parts

figure 41 Moodboard Macro and Micro Architecture

HMI - What information do I need as a designer to integrate an autonomous system into this design?

Where is it important to let the user feel like they are still in control? The system should take away possible fears and transfer them into a fascinating experience by making the interaction with the system a playful experience.

Meta Level

HMI

L4AV

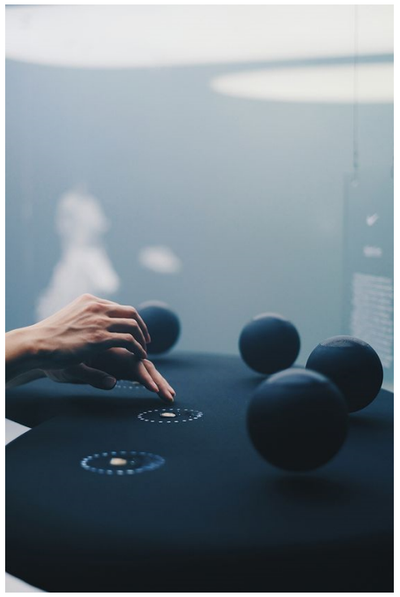
Method design for Emotion

Create fascination

User perception

Feeling in Control

User interaction



A playful conversation

figure 41 Moodboard Meta HMI

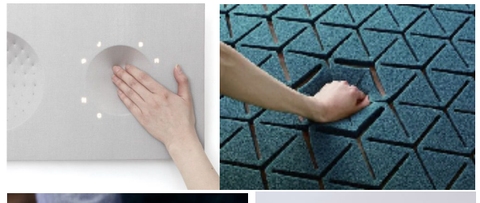
HMI
L4AV

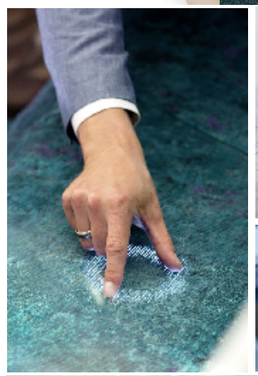
What information do I need as a designer to integrate an autonomous system into my design?
As discussed in Chapter 1.2 the HMI has specific requirements for use-case scenarios. To fit the user needs of a L4AV and anticipate the new seating architecture, specific qualities are brought to attention in a visual form.

Shapes

Natural lines to guide the movement

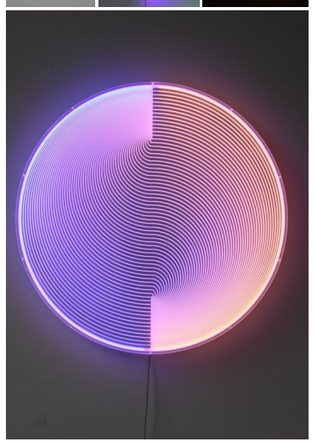
Textures & Materials





HMI integrated in the interior, moving material

Colors and Lights

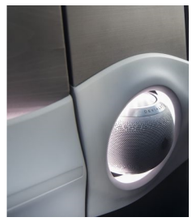


Ambient and Purple lights to point out the autonomous

Clear direction

HMI Visable in the back of the vehicle

Details



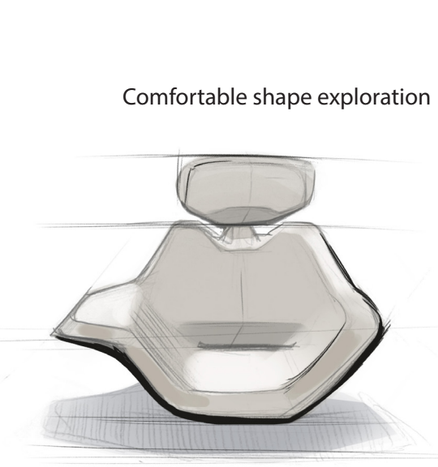
Layers to make the light visable in daylight

figure 42 Moodboard Macro and Micro HMI

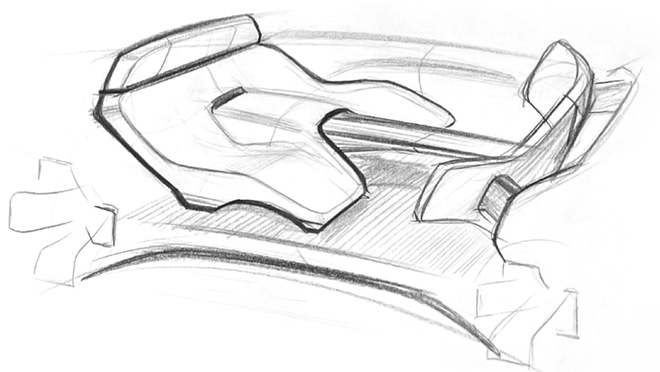
Chapter 7. Concepts

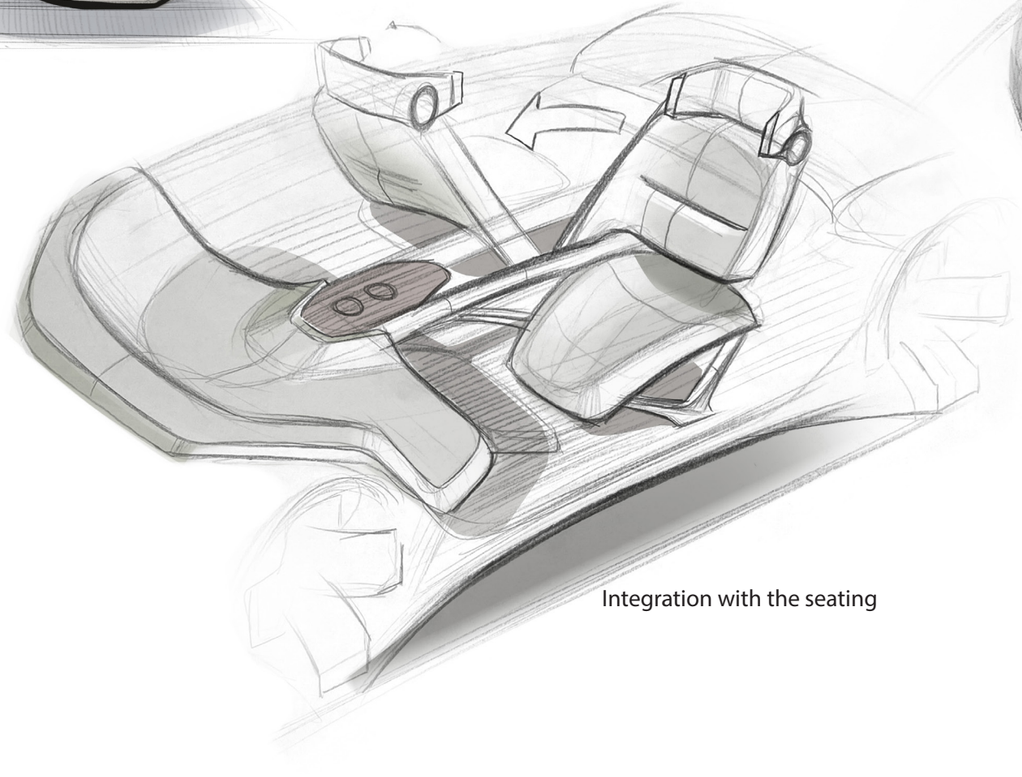
Rich Experience, Wabi Sabi and Matrix 3 & Matrix 4 are implemented in the development of these design sketches. Which first existed of a wide range of ideas and later focussed on three different concept directions. These concepts are compared with each other in the next chapter to come up with one final design choice.

Comfortable shape exploration



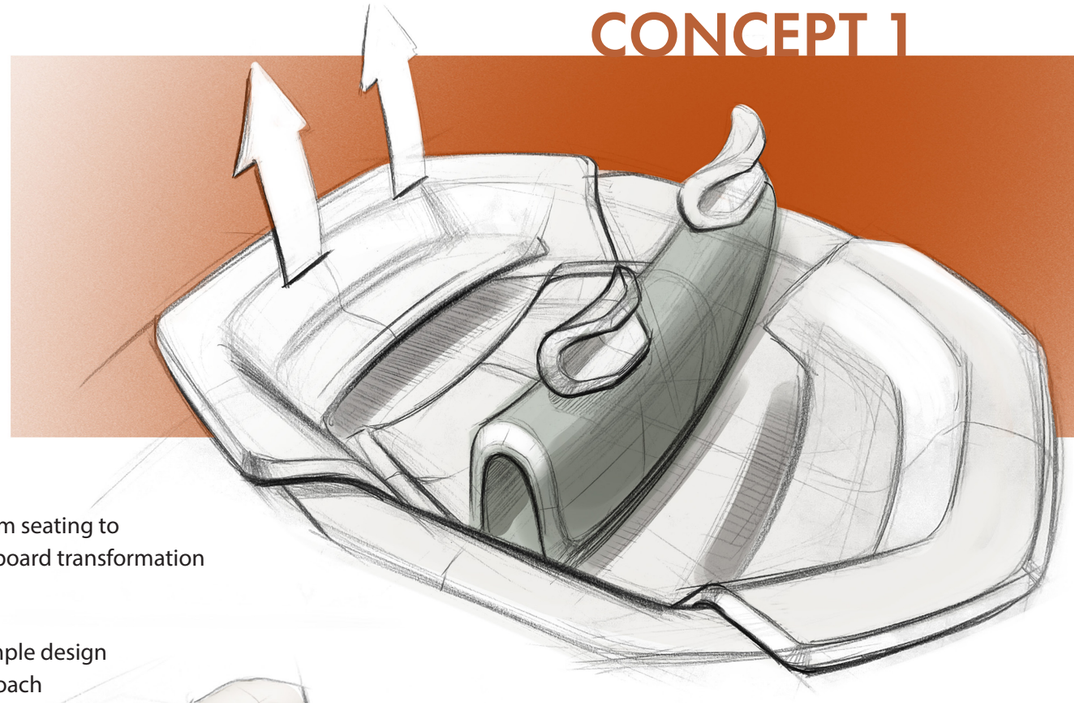
Moving seats





Integration with the seating

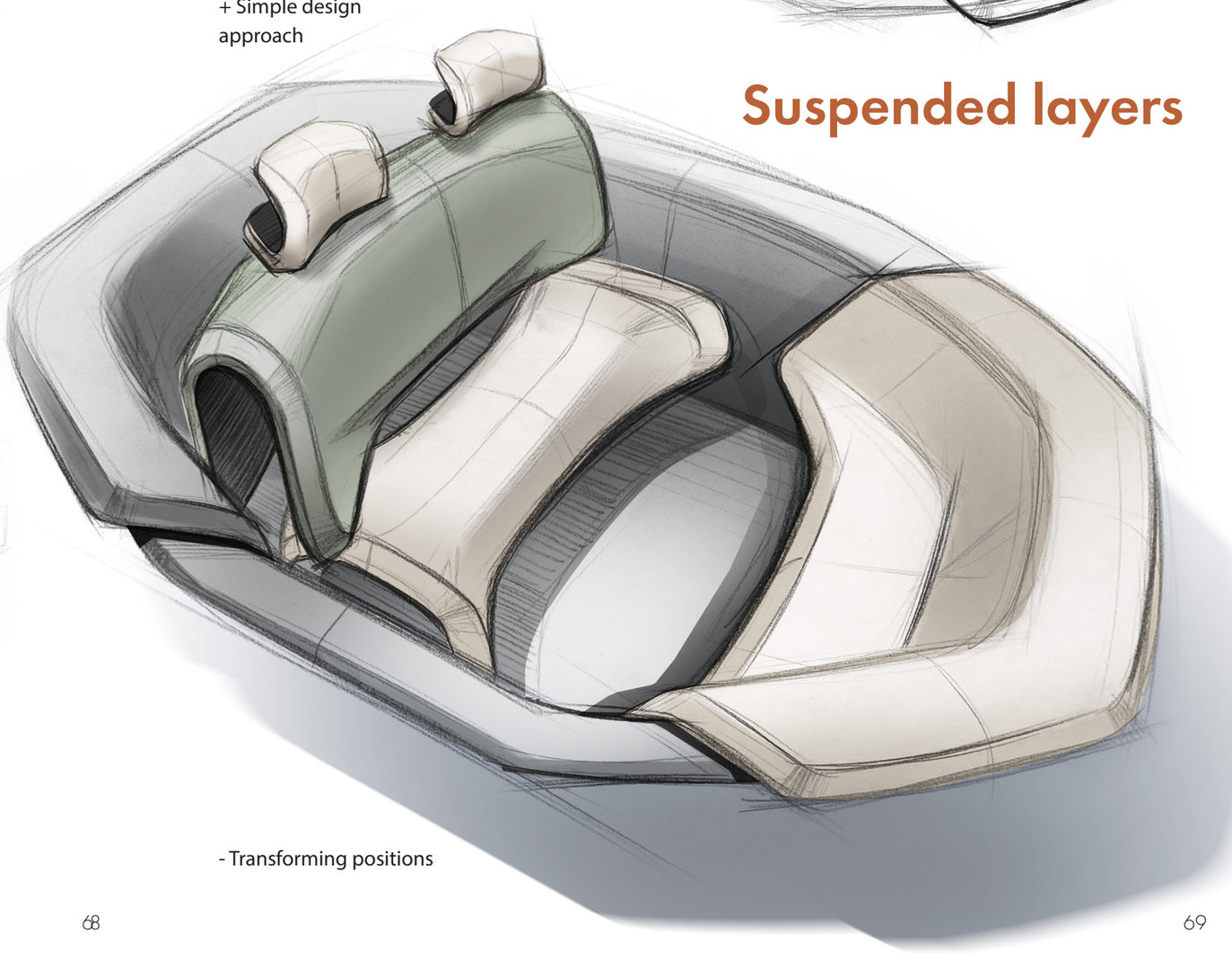
CONCEPT 1



+ From seating to dashboard transformation

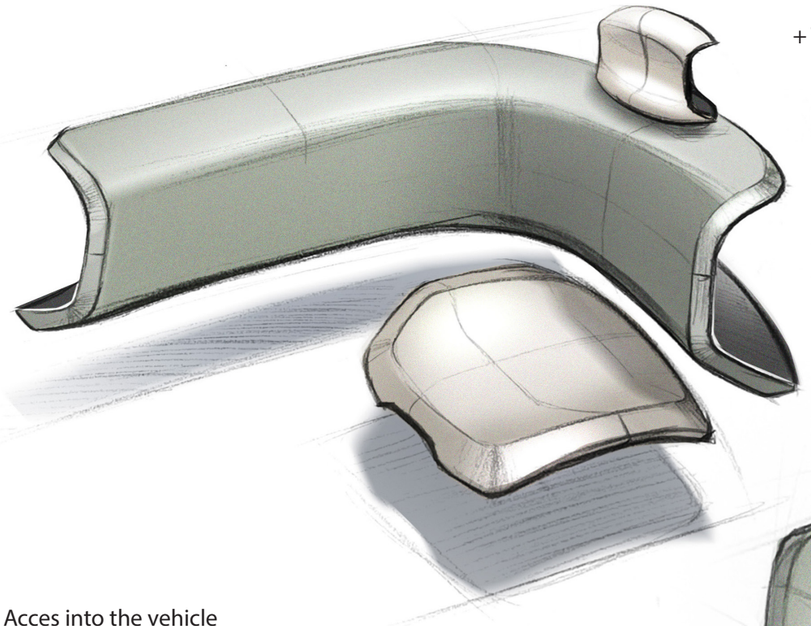
+ Simple design approach

Suspended layers



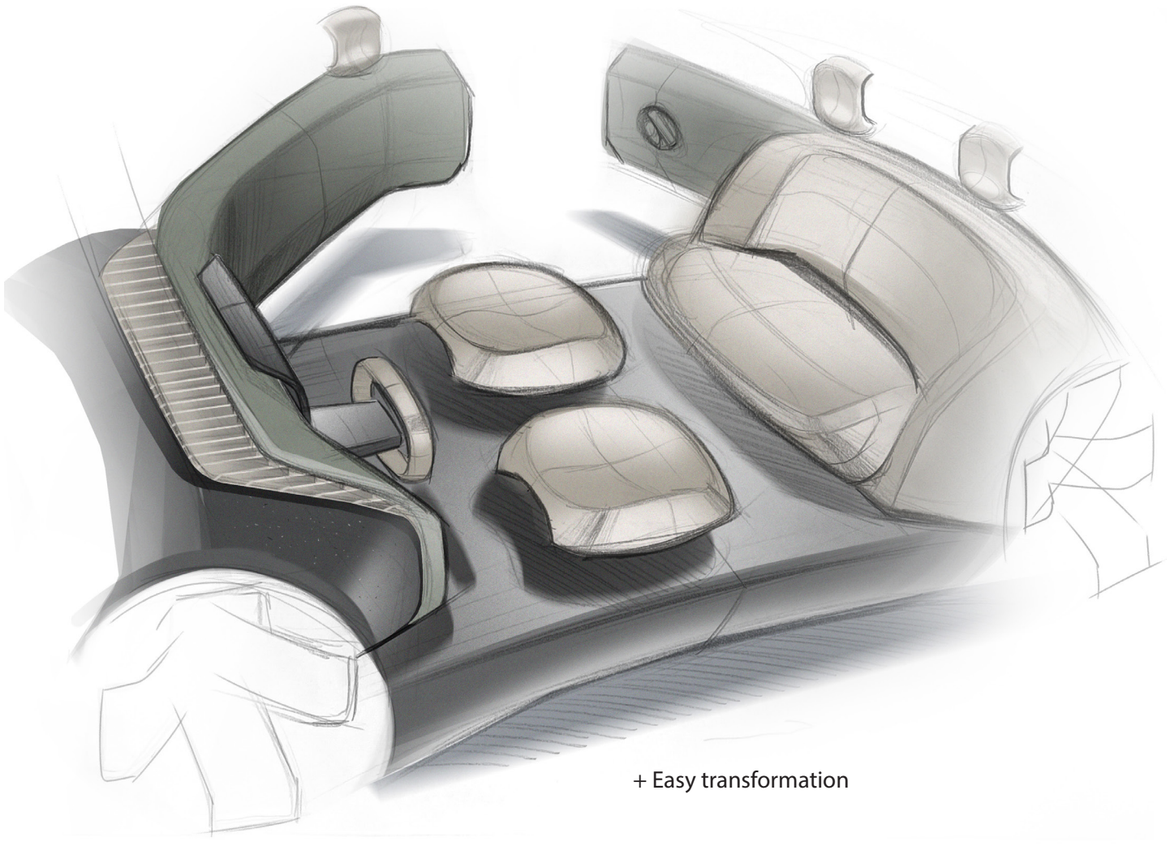
- Transforming positions

CONCEPT 2



+ Transforming backrest

- Acces into the vehicle

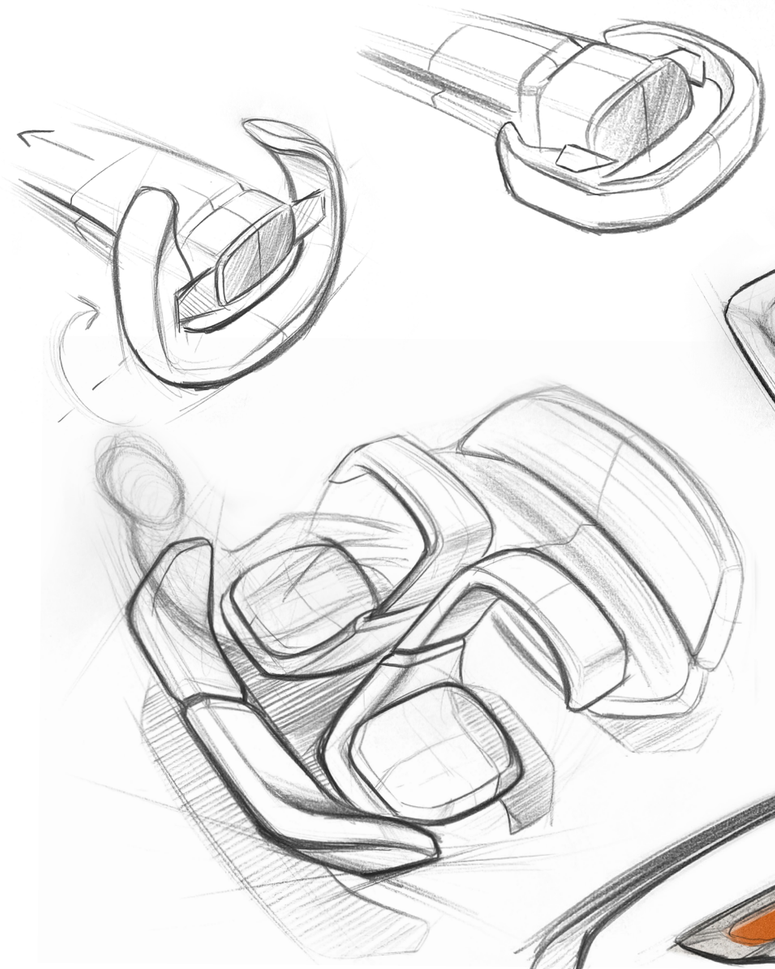


+ Easy transformation

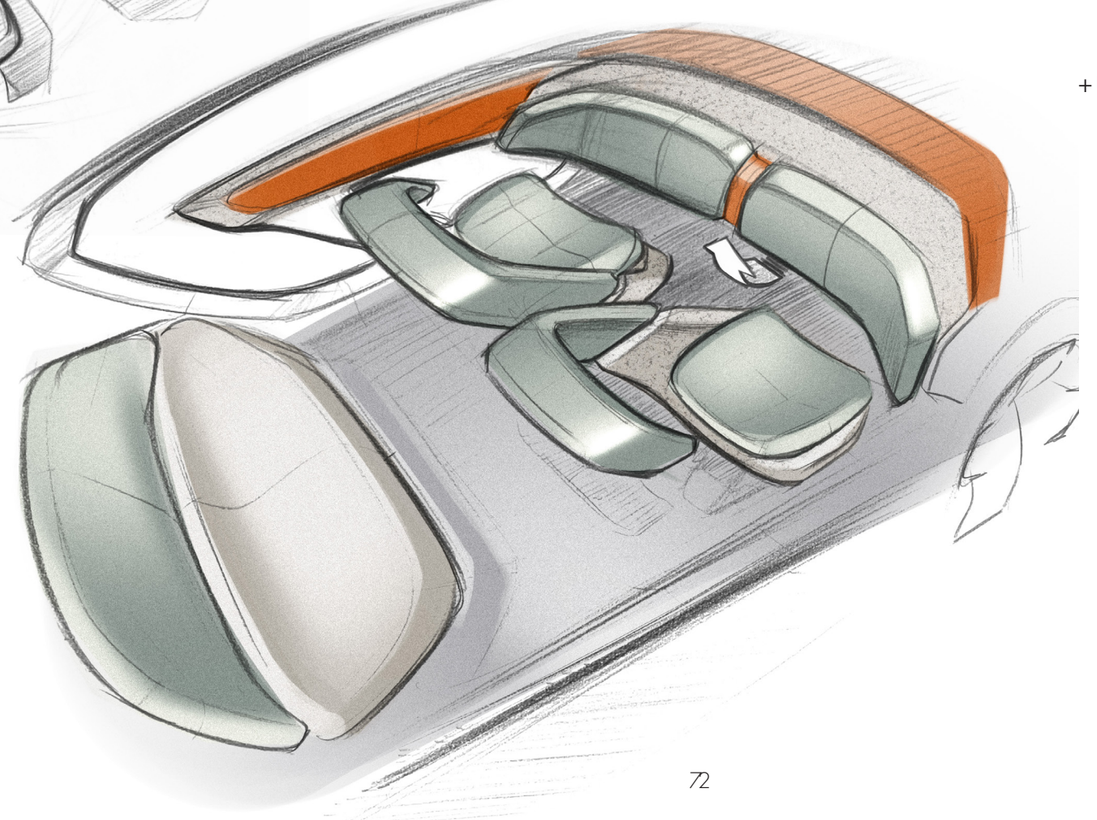
+ Rotating chairs

Converging Conversations

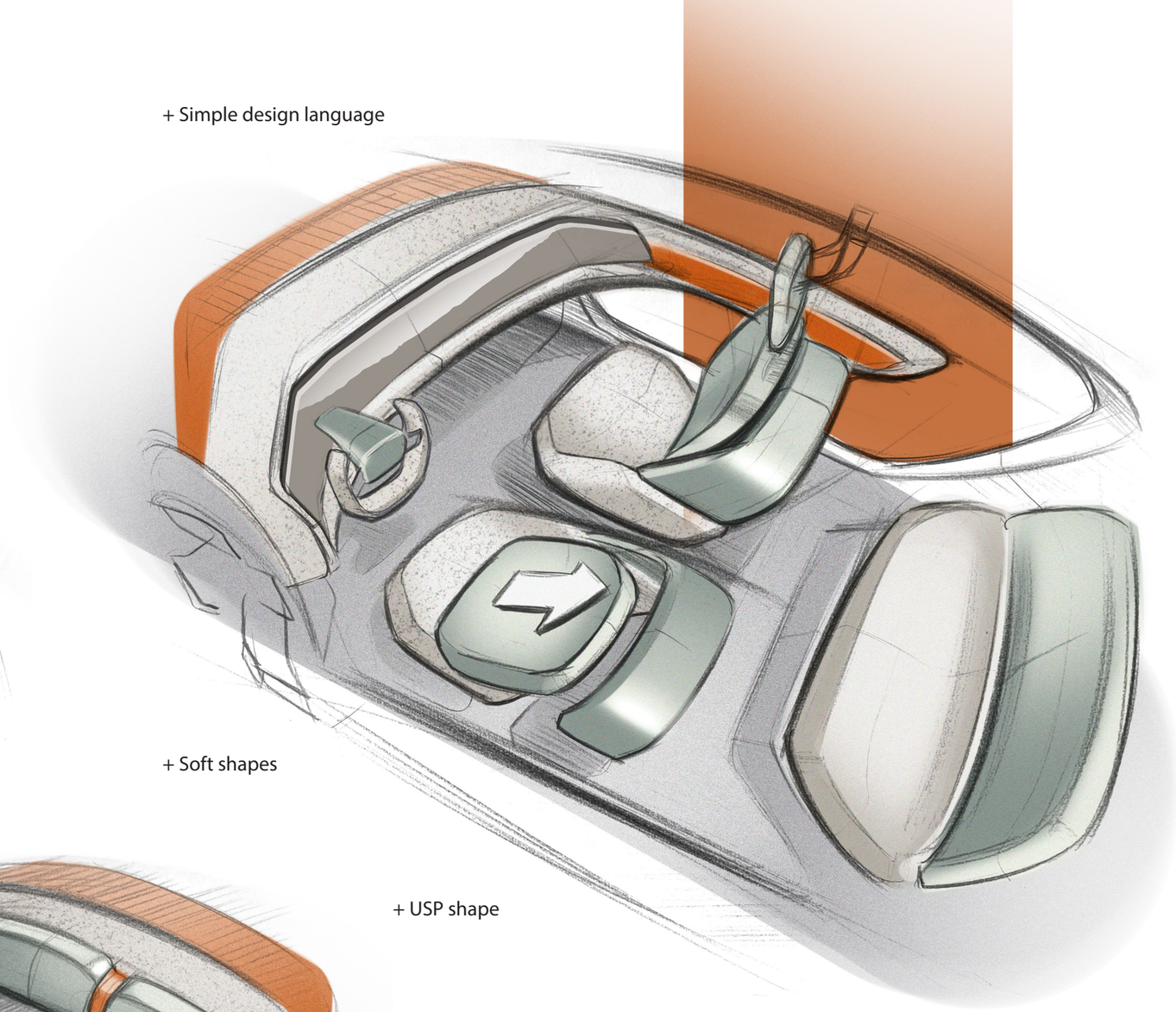
CONCEPT 3



- Challenging way of transitioning between modes



+ Simple design language



+ Soft shapes

+ USP shape

+ Spacious design

Conscious Cocooning

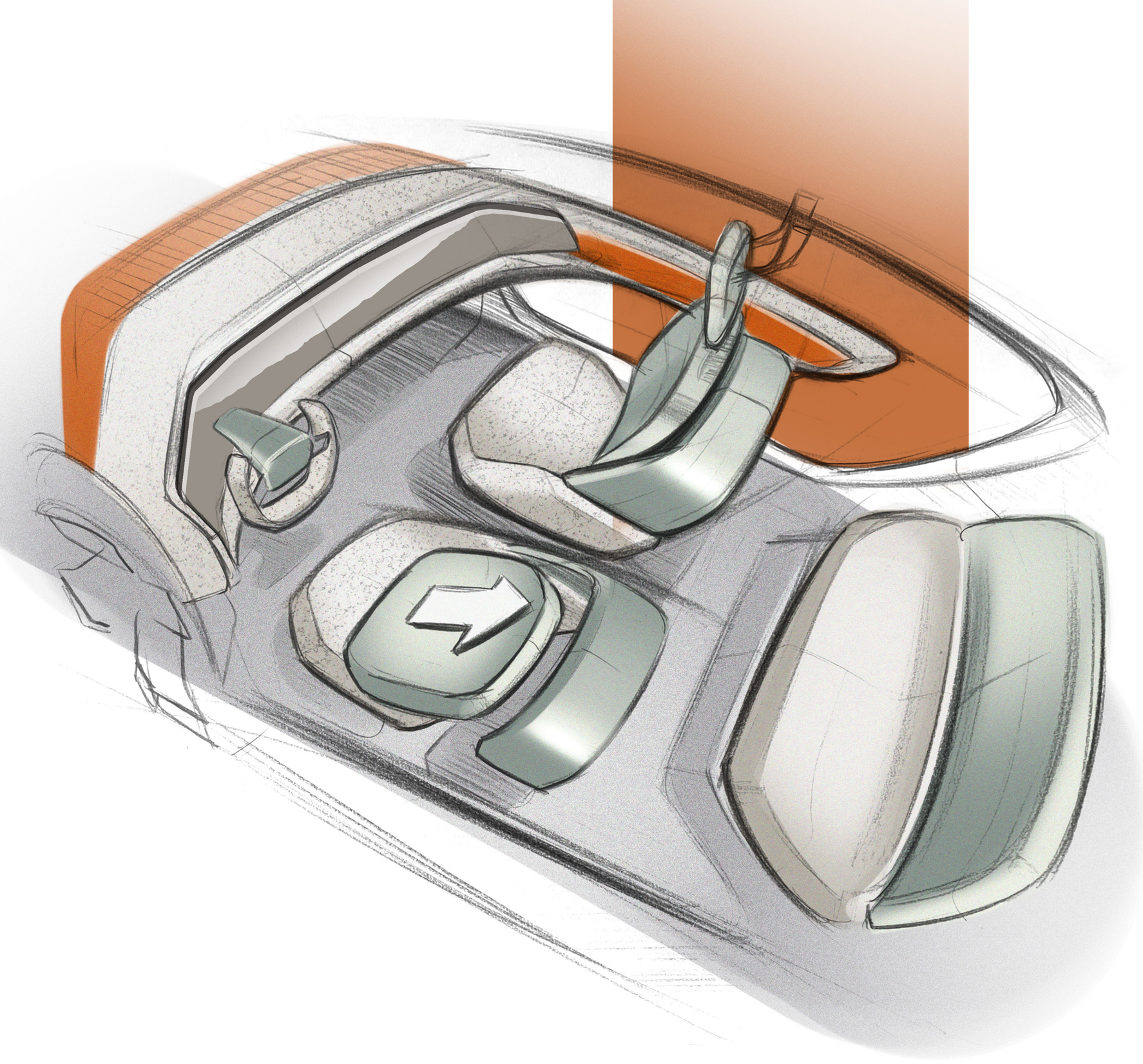
Chapter 8. Design Choice

The three concepts were compared with each other on a few requirements that resulted from previous research.

Which are:

- Multifunctionality
- Light weight
- Architecture that stimulates interaction
- Comfortable for long distances
- Practical to change modes (manual vs. autonomous)
- Easy to access into the vehicle
- Fascinating shapes
- Soft & cosy design language

Which resulted in choosing the third concept :
conscious cocooning.



Context Stimulate

- Chapter 9 Shape definition
  - ◊ 9.1 3D modelling
  - ◊ 9.2 Clay modelling
  - ◊ 9.3 Package
  - ◊ 9.4 User-test location of the HMI

Chapter 9. Shape definition

When the designer has made their design choice it is important to stimulate the concept by estimating and defining the concept.

9.1 3D modelling

Blender is a 3d software is used in the industry by interior designers to quickly put sketches into a 3d model. The 3d modelling is not only useful for seeing the right proportions and fitting the package, but also for making the user-test in the following steps easier for the participants to experience. When you get the ability to sit in and move around a vehicle, you come more close to reality. In the next chapter this will be further explained.

9.2 Clay modelling

Where some companies only use milling machines to showcase the 3d models and then go back into 3d modelling to adjust these mistakes again, Changan still uses the traditional ways of Clay Modelling to redesign and adjust certain aspects of the design, which they later scan into 3d again.

By having this extra step of designing and evaluating the design, there are not only more people that give feedback and a vision on the design. It also helps the designer to rethink and evaluate their designs in a different way. This experience makes you more aware as a designer of certain proportions and thickness and the feeling a design evokes in 3d. As shown in figure 43 and figure 44 it is visable to see the 3d modelling (left side of the images) and the redesign done in clay (right side of the image).

figure 43 Shape reflection through clay modelling

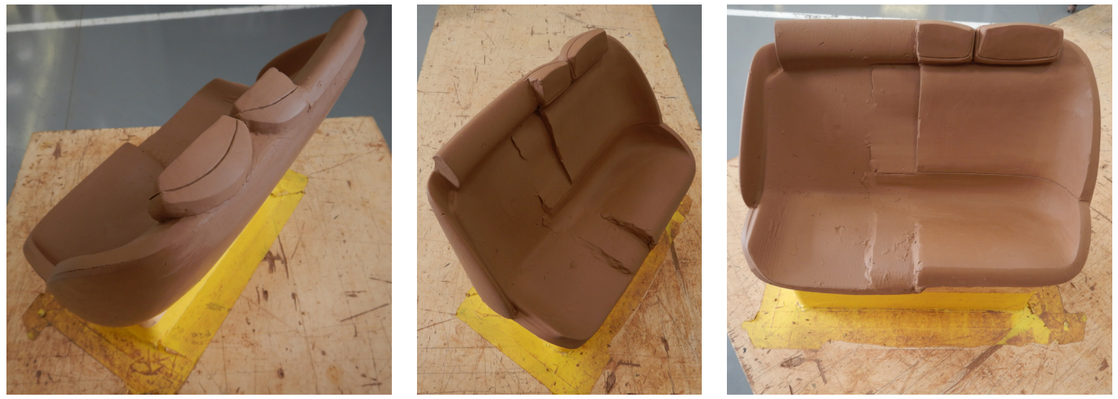


figure 44 Shape reflection through clay modelling 2

Which gives the advantage of experiencing the model in 3d already before implementing user tests. Adding this extra design loop will prevent the designer from walking into obvious design mistakes that can only be seen while looking at the model as a physical form of 3d.

9.3 Package

For the concept design is chosen for an European 5-seater. This choice is based on the aim of making a design process that would fit the European Market.

By making this decision it becomes challenging to come up with a design that enables the user to switch the driving direction. To make this possible with this current concept design, the chairs will move to the dashboard and towards each other in the autonomous mode. This will be further explained in the 'Final Design Chapter' of this thesis. The aim with this concept is to push the limits in a sense of design freedom with a package that is based on current vehicle packages.

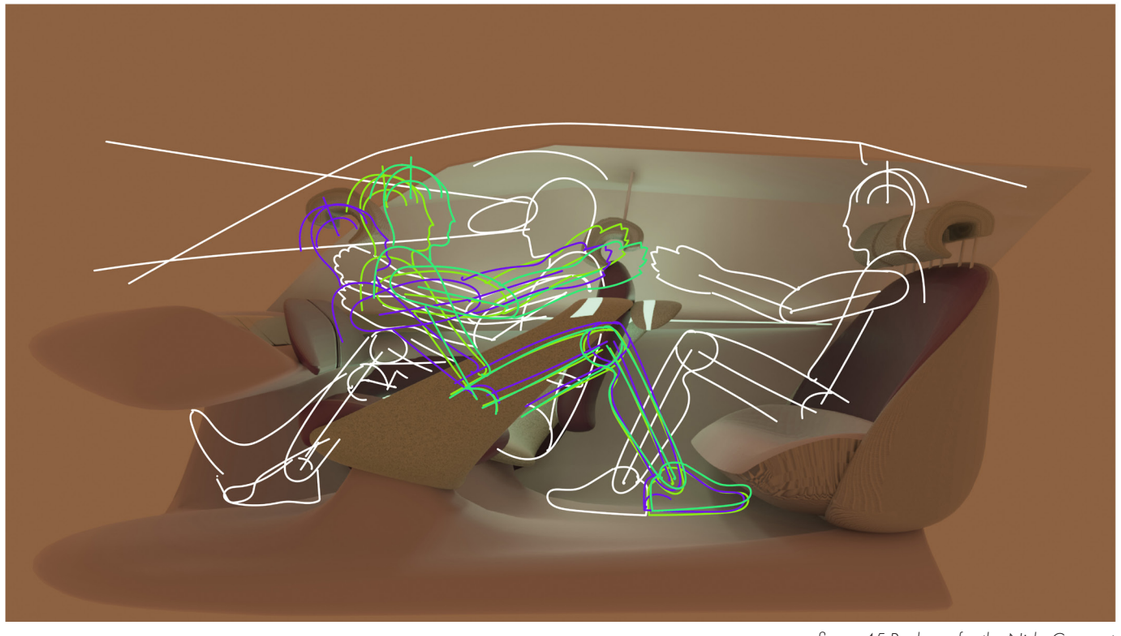


figure 45 Package for the Nido Concept

9.3 User test 1. Location of the HMI

The first user test will be done to test the location of the integration. Since the future user has the preference for a face-to-face architecture whilst driving in the autonomous mode. (See Chapter 1). It is important to define where the HMI will be integrated in the interior design to steer the user back to the driving mode when this is necessary.

The research question for the designer can be answered differently depending on the concept of the designer. That is why it is important to state the research question of this user test in a general manner.

Where will the HMI be integrated into the interior?

Where the designer has to take into account the research questions that were resolved in the previous step (synthesise). Which are:

- What is the architecture of the design (see Synthesise Chapters)?
- What are the given scenarios that need to be solved by the HMI (Chapter see 1.2.4) and how are these scenarios translated in a physical way (see Chapter 1.2 and synthesise)?

To know where to integrate the HMI into the interior it is important to question:

When will the HMI be most visible in the back?

To research this in a user test it is important to not have too many variables.

1. Use-case
As for a production vehicle all use-cases of the HMI should be tested. For this size of this thesis project only one use-case will be tested to showcase how a user test could be implemented in this step of the design process.

The chosen use case of this user test was mediator"s use case 10 which tries to make a smooth transition between full disengagement to going back to the drivers position and letting the driver engage with the road again.

In the specific scenario of this concept it will be focussed on:

Where will a driver (that is facing the passengers in the back of the car) notice the HMI in the interior to know that it is time to move their positioning back to the front of the car to prepare for driving the vehicle again.

2. Shape
As shape can influence the visibility of the design the possible places that are considered to implement the HMI are filled by a plain LED in the user test with the same shape and thickness in different locations. In this way it is made sure that only one variable can influence the test results.

3. Location
The location will be the tested variable in these user tests. Where the chosen locations are:

- The side door
- The left chair (driver side)
- The right chair (passenger side)
- The top door panel
- The armrest

The test-set up
The specific set up and the user testing questions can be found in appendix C. To perform this user testing as a sprint, renderings of the 3d model are used to re-enact the situation as real as possible in the given timespan.

The Participants
For this test 3 experts in the industry of UX design participated in this qualitative research. Since this research was supposed to gain more insights in finding a right positioning for the visibility of the HMI (and the fact that for this set up renders were used instead of a blender model to make it fit the sprint format), it was more fit to use professionals than customers.

The procedure
The set-up existed out of 9 research questions with guiding renders. See appendix C.

- Q1. What image (HMI location) did you notice first?
- Q2. Can you rank the 5 images on visibility of the HMI location?
- Q3. What viewpoint would most likely align with the direction you would prefer to look at from the driver's position? Could you elaborate on your choice?
- Q4. What viewpoint would most likely align with the direction you would prefer to look at from the back passenger's position? Could you elaborate on your choice?
- Q5. Is the HMI more visible in the front or the back in your opinion?
- Q6. Do you think there is an influence on the perception of the HMI as soon as the other passenger changes their seating positions? Could you elaborate on this?
- Q7. Do you think this seating position evokes more engagement between passengers compared to current cars? Why?
- Q8. Do you think there is a big difference on the HMI visibility if you compare day setting with the night setting on a scale from 1-7?
- Q9. How much do you think you would notice the HMI whilst engaging in a conversation during daylight on a scale from 1-7?

By choosing professionals to interview, the average interview took 30 min. where all questions got elaborate answers and useful insights. To give a clear overview on the findings the main findings of these interviews are summarised in the results.

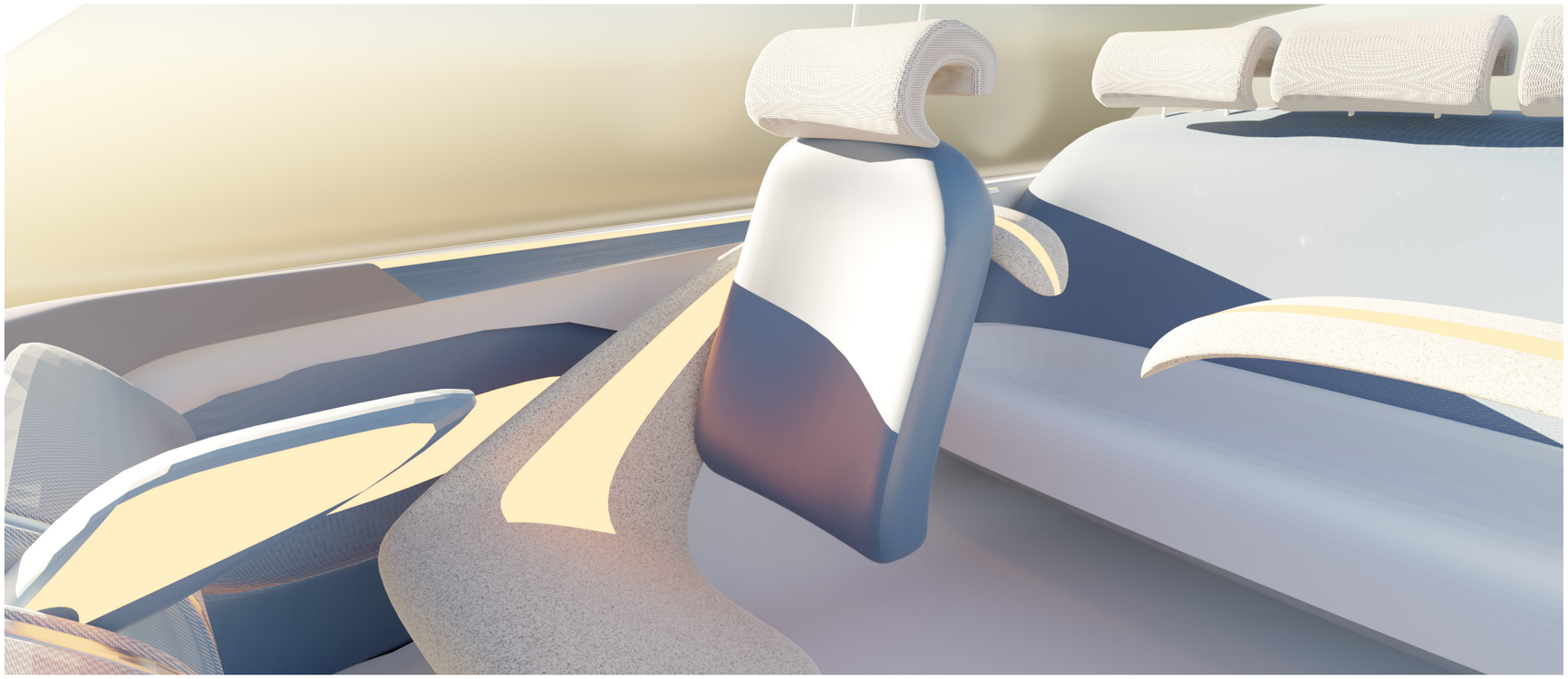


figure 46 The 5 tested HMI locations

Results
The results for this specific whereas followed.

- The HMI was most visible from the front passengers' perspective.
- The front passenger side HMI was most preferred. Followed up by the driver side HMI.
- The top door panels were suggested to keep included based on the current way of implementing ambient light location into a vehicle.
- A preferred testing location for future research that was mentioned 3 times was implementing the HMI on the roof of the interior.

Discussion
It was very helpful to choose a group of experts to interview for these user-tests. Since the test was set up as a sprint the 'prototype of testing' had to be created in a short time span. This had the following influence on the results:

- The participants had to use more imagination to envision the renders as a real life situation.
- Without a roof in the blender model the lighting stroke on top of the door panels (Q1) wasn't visible, whereas I was told by the participants it is already implemented in the industry since it is one of the most fit locations.
- *Q7.* was in the end a question that was off topic for this kind of research. It seemed to be a question that could not be answered with the given prototype and set-up of this user test. That is why this question is moved to the other research test that will be found in the next chapter (Evaluate) of this report.

Conclusion
Although the set up for this test was minimal it still gave the following results with some help from participants that have experience with designing HMI for the automotive industry.

For this design it is important that the HMI is located in a visible location. Since it also needs to serve in a context of providing safety rather than entertainment it would be advised to implement the HMI in multiple locations. This will be advised in the given scenario with a design where the driver also has the possibility to go in the opposite direction whilst driving.

The recommended locations would be, **the tables that are located in the front seats** and **the top door panels.** For further research it would be recommended to **include the roof in the possible locations** for implementation to know if this will improve the safety and might be able to **replace** one of the other advised locations.

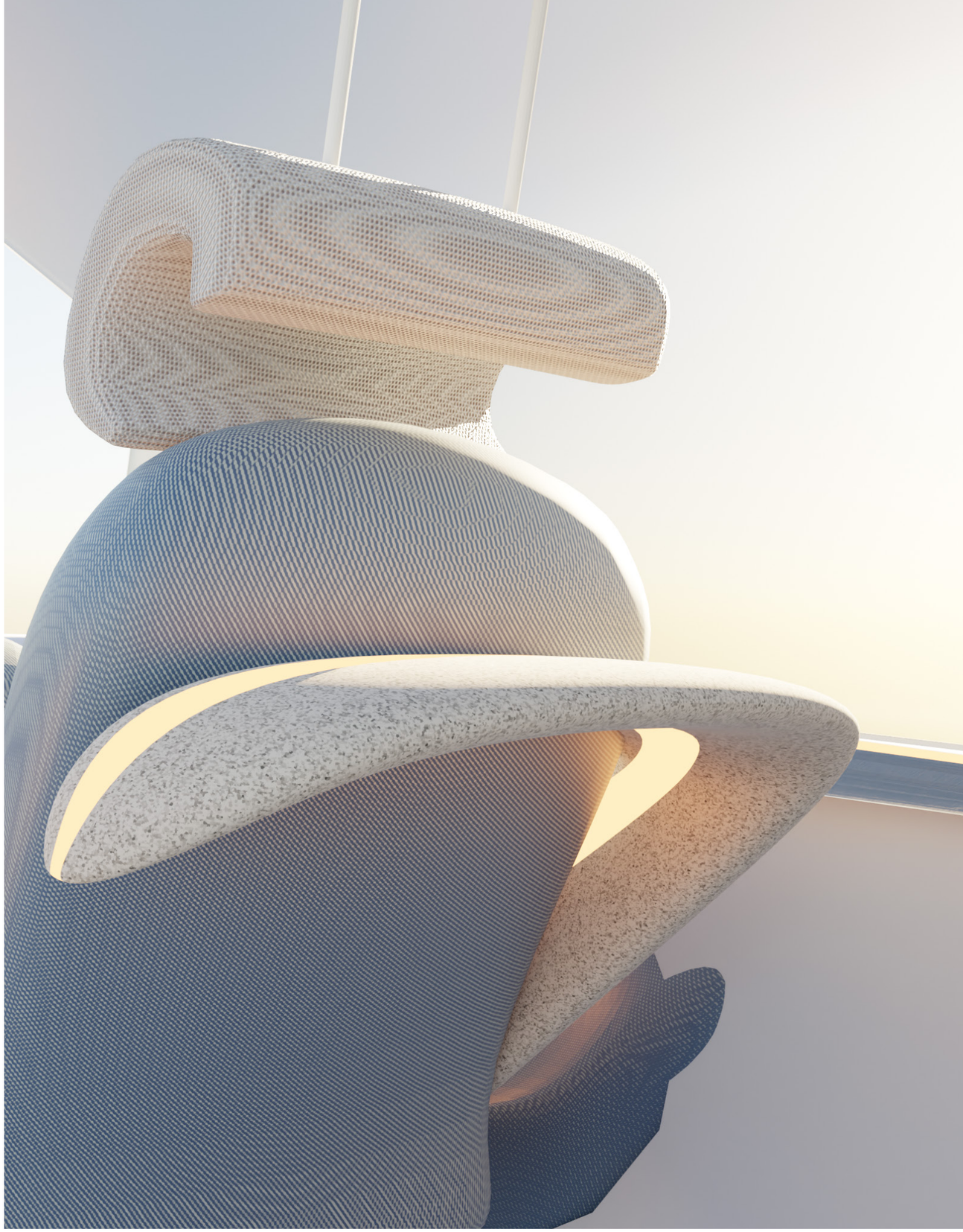


figure 47 Table and top door pannel door of the Nido Concept

Context Evaluate

- Chapter 10 User-test Intended Emotions
  - ◊ 10.1 Introduction
  - ◊ 10.2 Why is VR fit to test the intended emotion?
  - ◊ 10.3 Why is the PrEmo method fit?
  - ◊ Final Design

Chapter 10. User test intended emotions

10.1 Introduction

In chapter 4 the method "Rich Experiences" was introduced into the interior design process to solve certain emotional triggers that might be caused by autonomous driving. To analyse the intended outcome of creating a "Rich experience" the concept of this project will be tested in VR. When testing an emotion based on the physical properties of an interior design it is important to look at the user experience that exists between the user and the concept.

10.2 Why is VR fit to test the intended emotions?

The interaction

To experience a negative or positive emotion in a concept car there has to be an interaction. Where having a full scale model of the concept presented to people in VR will make them able to interact with the concept in the following way:
Entering the vehicle
Sitting in different positions in the vehicle
Changing the seating position
Switching the different modes in the vehicle (Autonomous- and driving mode).
Seeing different parts of the interior form up close.

The immersion

By using VR you isolate the user from the real world and let them be completely immersed into the designed concept. This method causes the user to better imagine how it feels to be inside the vehicle and experience the visual senses of the interior. Which in the case of testing human emotions will be a useful method (Rebelo, 2012).

Imagination

By using VR it will higher the users capacity to image a nonexistent concept. In this way it lowers the barrier to point out certain emotions the user feels.

Limitations

To prevent motion sickness the experiment has to be under the condition that the exposure of VR has a short duration.
The VR models do not move, while a real car does.
The VR set that is used for this user test doesn"t include feeling the objects in the interior.

10.3 Why is the PrEmo method fit?

This is a tool that is designed by Desmet to designate the emotions evoked by products. By using a non-verbal instrument it makes it easier for participants to express what they are feeling. This results from to unique qualities:

- **Cross-culturally use:** The participant does not have to verbalise their emotions.
- **Distinct emotions:** The emotions that come out of the testing are more distinct compared to verbal emotions.

The tool measures a total of 12 emotions (6 positive- and 6 negative emotions). To make the measurement more specific participants can rate the feeling on intensity from 0 (I do not feel this) until 4 (I do feel this strongly). (appendix D)

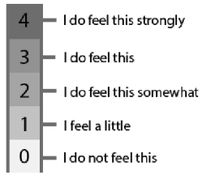


figure 48 PrEmo rating of Desmet

To get the result of these unique qualities the verbal explanation of the certain emotions will be left out during the test. After testing, the non-verbal image results that are used during the testing (see appendix E) will be linked with the verbal text to further evaluate the provoked emotion of the concept design (Desmet, 2003).

10.3 User test

Test setup

A car interior can evoke a lot of emotions. From the first time you enter the vehicle to sitting in the vehicle. The emotions that are aimed to measure in this research are related to the switch from manual to autonomous driving.

To make the two situations clear to measure separately they will be tested in two static states, instead of a transition within the VR test. By this way the questionnaire will be split up in two parts.

- First test setup: **Driving mode**
- Second test setup: **Autonomous state**

The extended visual overview of these set-ups can be found in Appendix F.

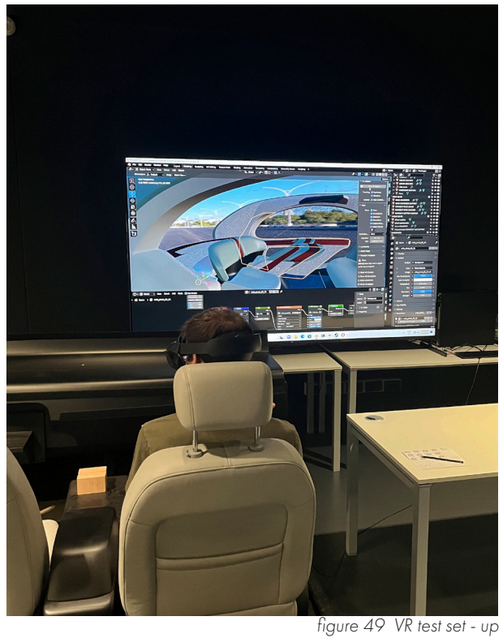


figure 49 VR test set - up

Participants

All participants will be professionals within the different design departments of Changan Europe. Where there will be 16 participants. The ages differentiate between 22-53 years old.

The procedure

The participants are asked to designate the emotions they feel by comparing two different driving modes within the vehicle. For the performance of this test the PrEmo tool (see appendix E) (Desmet, 2003) and Virtual Reality in Blender were used.
First the participants were asked to look at the **Manual Driven model** in the **VR environment**.

1.) During this first set up they were asked to answer the following questions:

- *What physical aspects do you like the most in this concept design?*
- *What physical aspect do you like the least in this concept design?*

2.) After this they were asked to fill in the first **PrEmo sheet** to write down their feelings whilst sitting in a **manual driven mode**.

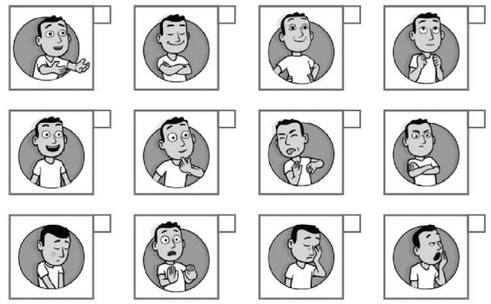


figure 50 PrEmo Emotion sheet

3.) For the second part the participants were asked to look at the **Autonomous Driven model** in the **VR environment**. Whilst answering to the following questions:

- Did you feel any changes in your mood while making this transition?

What do you think influenced your emotional state of mind?

4.) As a last step they were asked to fill in the second **PrEmo sheet** about the **autonomously driven mode**, which is identical to the previous PrEmo sheet.

By letting the user go through these steps we will get a good overview of

- *What kind of emotions are evoked during the transition from manual to autonomous driven?*
- *What was the cause of this switch in emotions?*

Results

Methods for analysing

To give a good overview of the differences in Emotion comparing the manual driven state with the autonomous driven state both results of the PrEmo tests are shown in a Radar Chart. In this way it is easier for the user to understand where the differences are located.

To explain why the participants felt these emotions the interview results are grouped in topics. The interviews and PrEmo results can be found in Appendix G, H and I.

The Radar Charts

In the manual-driven VR set-up the main emotions were Fascination (3.0625), Satisfaction (2.75) and Joy (2.67). In the autonomous-driven VR set-up the main emotions were Satisfaction (3.375), Fascination (3) and Joy (2.75). Although the emotion fear in both VR set-ups was below 1, there was a noticeable increase going from 0.1875 (manual driven) to 0.625 (autonomously driven).

When participants were asked... how their mood changed in this transition and what they thought influenced their state of mind, ... these were the following responses:

Manual Driven Chart

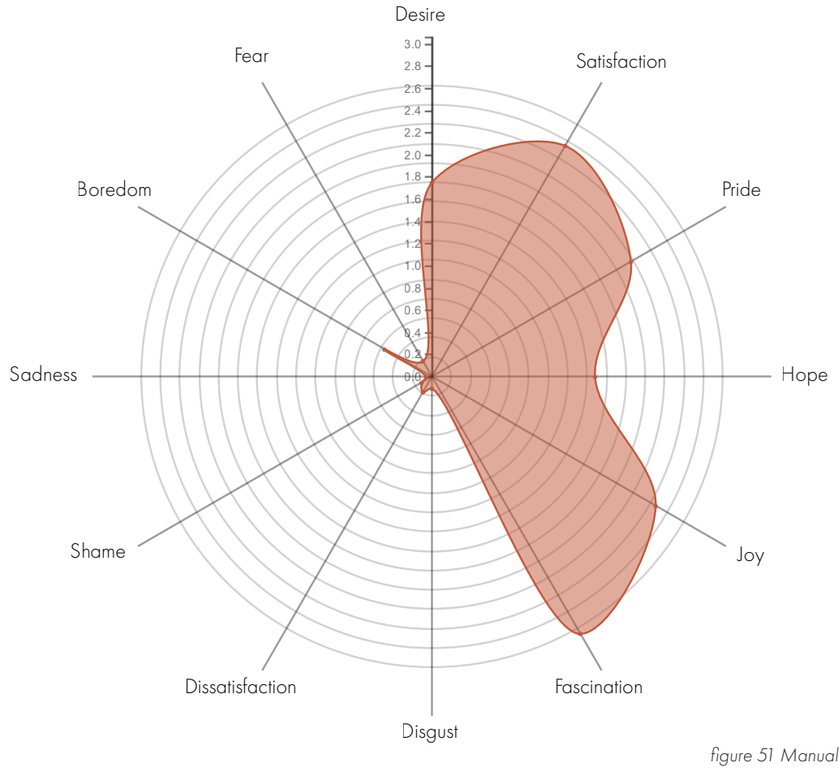
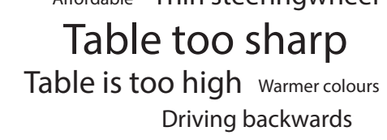


figure 51 Manual driven VR set-up

- A **comfortable feeling** (mentioned 10 times) created by the backseat (mentioned 5 times) and the front seats (mentioned 3 times).
- The fact that the vehicle appears **more spacious** (mentioned 8 times) where 4 participants gave the table as a possible influence. 2 participants had the feeling it was caused by the lack of a tunnel in the middle of the vehicle.
- 6 participants felt that the whole car felt more **open** after this transition.
- 6 participants mentioned the space to be more **interactive and provoking social interactions**. Where 3 of the 6 participants this was caused by the table of the concept.
- 4 participants mentioned that the **ambience** was easier to experience while transitioning to other modes.

There were two influences in the design that were mentioned to be the cause of the fear whilst switching to autonomous driving:

- *The table in the back is too sharp (mentioned 5 times).*
- *Sitting in the opposite direction whilst driving (mentioned 2 times).*
-



The second topic was in total mentioned 4 times where half of the participants mentioned they feared this driving backwards, the other two participants mentioned it was a preference to sit in this position. That it felt like sitting in the train in the opposite direction.

Other influences and topics discussed in the interviews that were mentioned less than 4 are evaluated more detailed in Appendix I.

Autonomous Driven Chart

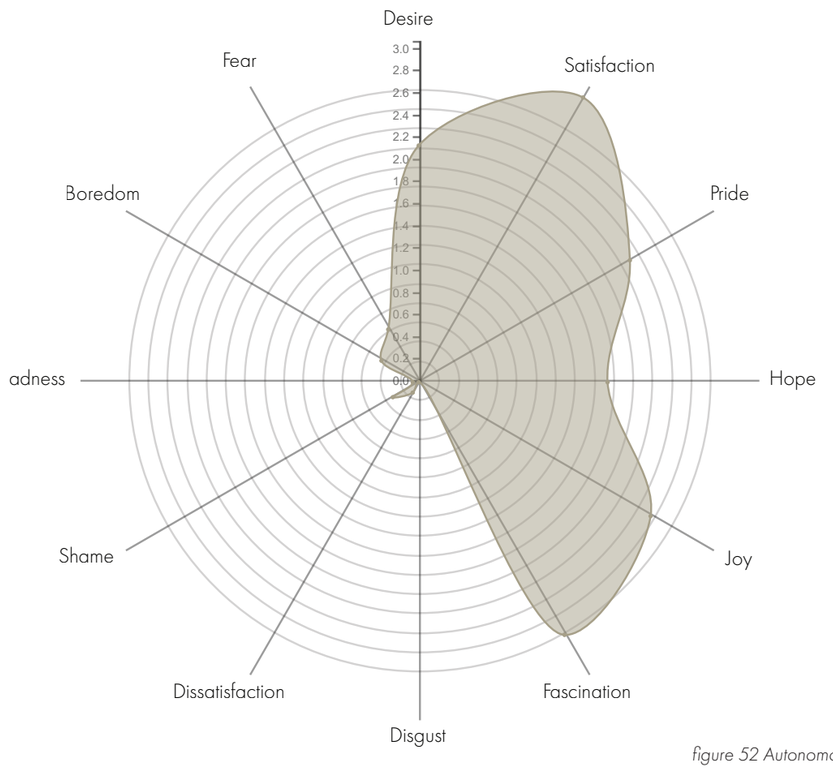


figure 52 Autonomous driven VR set-up

Discussion
For this research the method PrEmo was chosen to measure the emotions of the participants in two different VR concepts (manual driven concept and the autonomous concept).

- The set-up

For the testing set-up the structure of the physical model was used in the blender VR set-up. The reason for making this decision is that people could see more of the interior since one of the sides is open. During the testing it was found that sitting in the Open position felt less safe than sitting on the left position with the side beams and roof included.T

his was noticed by two of the 15 participants. One of them stated: "Now that I am sitting on the left side it feels more comfortable and protective".

Where the results of the level of fear might have been lower when all participants would have taken place on the side near the beams and roof structure. Since the outcome of the fear was still below 1 it can be seen as a minor influence.

With the current set up it was easier to point out certain distinct emotions although it was more difficult to notice which mode the participant preferred. To get more insights about this the following research questions can be included for further research:

- Which mode (manual driven or autonomous) do you prefer?
- What kind of activities would you engage in whilst sitting in this autonomous mode?

To further test a concept on the provoked emotions while driving autonomously the test should be taken into a moving vehicle. Although 4 of the 16 participants already mentioned thinking about this element while doing the tests, it might change a lot of outcomes in the testing results. For testing the design of the concept it will not be a great influence. When you look at the overall seating architecture of this concept it is predicted to have way more influence on the overall emotional state. For this it is suggested to do further research in a moving test-set up.

- The method PrEmo

The method PrEmo is stated to be cross-culturally and make it able to find distinct emotions. Changan is a very multicultural company. The participants of these tests included 4 asian participants and 12 participants with different backgrounds. One thing that stood out during the testing is that a lot of participants were confused about the emotional shame which they associated with being shy. From the asian participants in particular the question "Does this symbol mean shy?" was mentioned by 3 of the four participants. In total this was questioned 4 times out of the 16 participants.

To make further conclusions about this outcome it is suggested to do another research with a bigger sample size.

One other outcome was the amount of participants that asked if the verbal description of the emotion could also be included. The non-verbal symbols helped make it harder for participants to give the intended outcomes, since some participants have different interpretations of the meaning non-verbal symbols.

Conclusion
This user-test was used to validate if the intended emotion "Fascination" by adding a "Rich Experience" to the concept was provoked in both the manual driven state and the autonomous driven state. In both states Fascination was one of the top three main emotions that was present, together with Satisfaction and Joy.

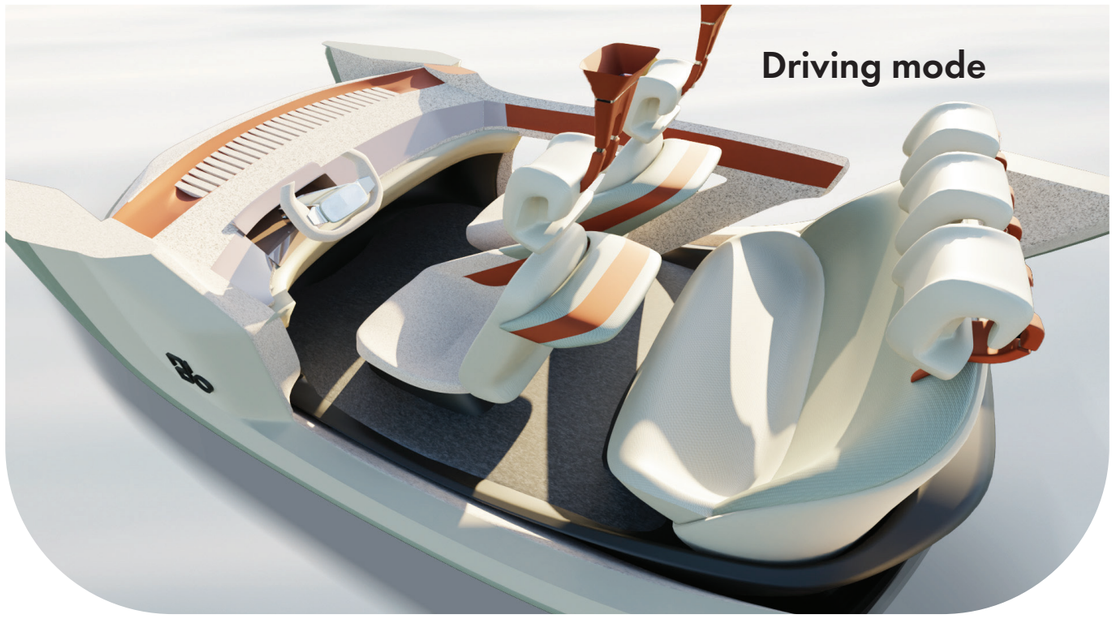
Although the emotion fear had a slight increase going from the manual driven to the autonomously driven state this number scored only a 0.6/4. In the open questions this was further explained that some participants did not prefer to drive backwards, while other participants feared the sharp edge of the table whilst they were sitting in the back.

It can be concluded that this method is also **fit** for implementation in the **automotive industry** for two different reasons:

- Testing the intended emotion "Fascination" in a concept to **ensure the emotion** "Fear" caused by autonomous driving won't be one of the main emotions (See Chapter 4 Rich experiences).
- Making sure the concept **meets the customers emotional needs**, since customers nowadays make decisions based on emotional consumption (Guo, 2023).

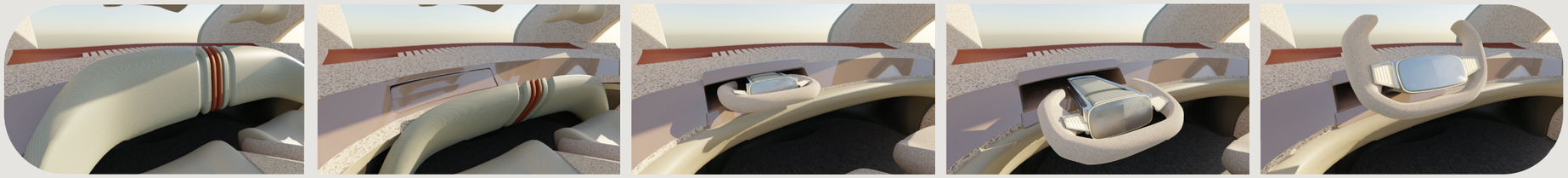
Chapter 11.
Final Design

After evaluating the results of the user test the Nido concept went through one last Blender adjustment loop. Where the steering wheel was made thicker, the table of the backseat softer. It is also important to showcase the seating position when people sit into the vehicle and the different transitions of the vehicle. To showcase this chapter includes final renders of the concept.



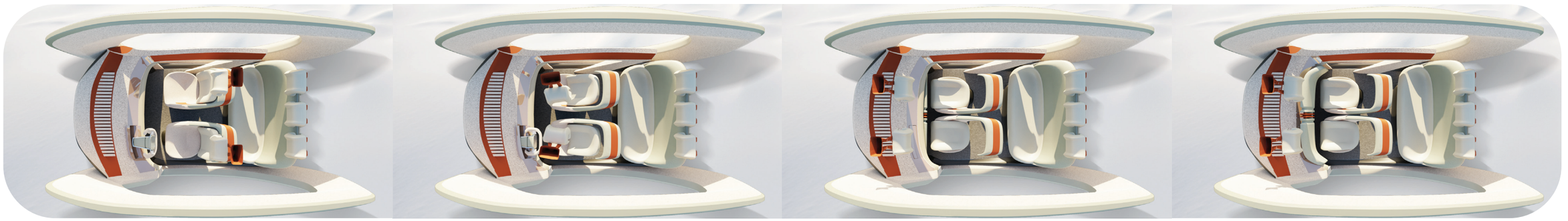
Conscious Cocooning

Autonomous towards manual transition



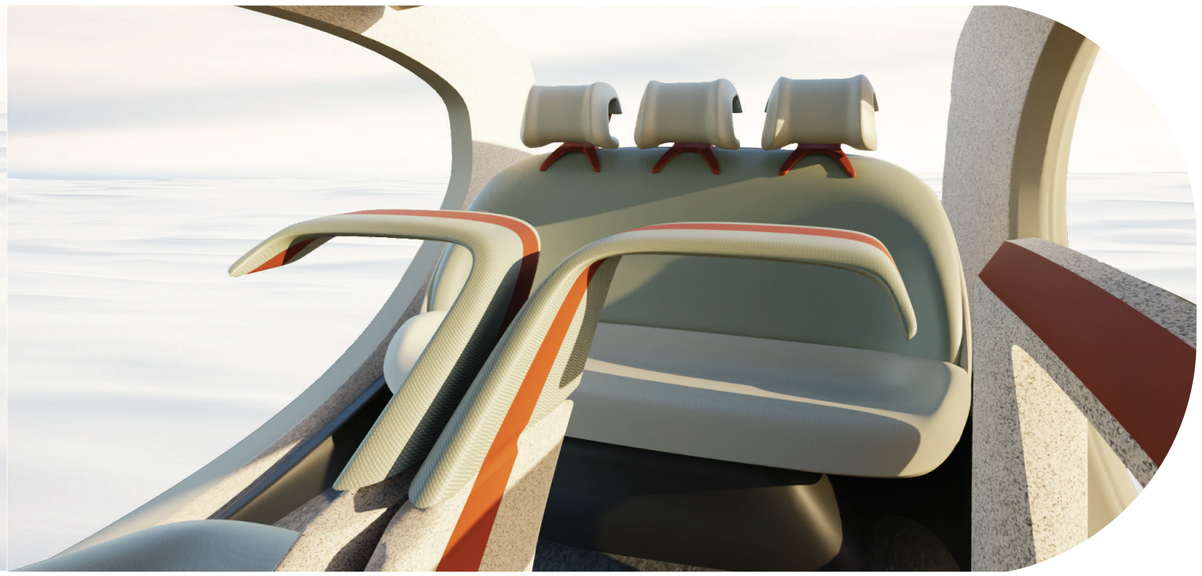
Steering wheel appearing

Moving headrests attached to the roof

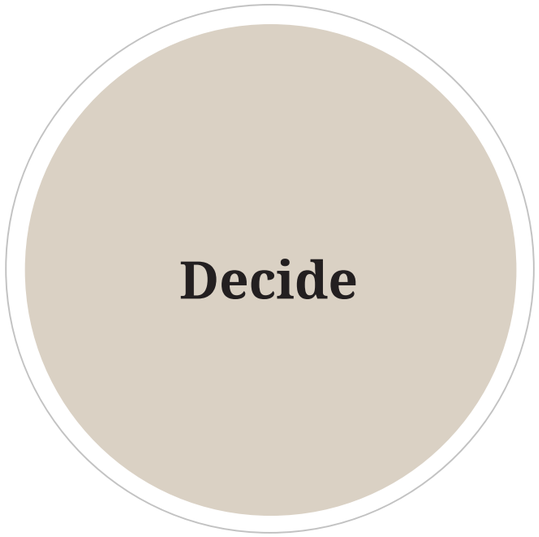


The chairs that move towards the dashboard in the autonomous mode for extra leg space

The view from the backrest



The view from the drivers perspective



Context Decide

Chapter 12 Evaluation of the design process

During this thesis project there were a few problems that needed to be solved.

1. What will change whilst designing an L4AD interior design process?
2. Where should these changes take place?
3. What methods can be implemented to solve these gaps?
4. Do the chosen methods give the aimed result?
5.

As the initial research question stated:

How can Changan shape its interior design process to enable the transitioning roles of the user in a level 4 Autonomous vehicle?

12.1 A strategic design approach

To solve the first question of **"What will change whilst designing an L4AD interior design process?** It is important to set a scope. This thesis was set in a timeframe of 20 weeks. Which means that it is important to make choices in the focus points of the project.

So why choose an interior design process and not an UX/UI design process?
The autonomous system and the HMI of the vehicle will play a big role in autonomous driving. Looking back at this it might have been more feasible to focus on the UX/UI design aspects given the time frame of this project. To translate this into physical aspects of the interior has been more challenging.

Bringing in this extra challenge also opened a lot of doors. It created a bridge between the UX/UI department and the interior design department with a more user focussed approach which shows clear points of action when and where in the process there is a need to interact with other departments in the automotive industry.

In the end this thesis project can be considered more a strategic design project than an interior design project. Where the end result has led to a physical prototype with a design concept. The knowledge and strategy behind the concept is more extended than the detailing of the final result.

12.2 User-centred design

One of the main conclusions of Chapter 1 was the need for a more user-centred design. With these findings it was important to implement not only methods that could provide these certain needs (Rich experiences & Wabi Sabi), but also provide methods (PrEmo & VR user testing) that could Evaluate the aimed results of these methods.

The challenges that took place where:

- Introducing a used method (Rich experiences) into a new environment (Automotive industry).

Although this was a method I was already familiar with, it wasn't a method that was already implemented into the process of an interior designer or known in the car industry.

- Including a method (PrEmo) into an user test that requires a bit more explanation than usual questionnaires or interviews about a concept.

The method PrEmo is known for being cross-culturally. Which was one of the considerations to choose this method in the first place. Changan as a company is very international with a lot of people from different continents. During these tests I found out that only having non-verbal images to express certain emotions can be confusing and might be perceived differently in other cultures.

Adding changes to an existing process
To find out **"Where should these changes take place?"** With a more user-centred design it is important that there are some changes in the current design process.

The design process needs to be ...

- **Viable:** Future proof, designed for a user in 2040.
- **Desirable:** Taking in account the user's emotion whilst making the transition.
- **Feasible:** Be explained on a level that is easy to understand so the designer has enough time to transition from the current design process to a new design process for L4AD.

12.3 Implementation of the methods

Taking into account the triangle of Viability, Desirability and Feasibility of this design process. It is important to reflect on: **"What methods can be implemented to solve these gaps?"**

For considering the Feasibility of the proposed interior design process it is important to state that a method can not be implemented by a designer for the first time without a given guidance and introduction of the method.

As this thesis aims to do so, it will still be recommended in the future to organise workshops with an expert on these topics to fully trust the right implementation of the methods in this design process.

Some steps of this process are already filled in for the designer by creating this design process.

- To showcase the methods by creating a physical model, I have tried to lower the barrier of understanding how to implement these methods.

- To make the interior design process future proof the methods Brand Identity Prism and Vip are used for analysing.

- To make the interior design process desirable Vip, Rich experiences and Wabi Sabi are used. Next to the existing methods of using 3D modelling (Blender), Clay Modelling and VR. The extra step that is added for Evaluating the aimed Rich Experience is a User Test that makes use of the method PrEmo.

11.4 General reflection

To validate certain choices in this design process it was important to include a user test that confirmed the aimed results. In the case of adding a rich experience to the design the method did indeed give the aimed result of creating a fascinating emotion. It however doesn't imply that another designer will get the same results. To further explore and develop this interior design process it is also important to test:

- Are the steps in the process easy to understand for other designers?
- Do other designers that implement these steps get the same intended results?
- Are the methods in the process easy to understand for other designers?
- Which steps in the design process will be done by a design strategist and which are in reality implemented by the interior designer?
- Are there still unforeseen gaps in the interior design process when it gets implemented in the automotive industry?

Chapter 13 Future recommendations for Changan Europe

Since this project was only 20 weeks it can be seen as the base of a future interior design process. Before it gets implemented in the industry there are a few points that need to be solved first:

- Organise workshops with an expert on these topics to fully trust the right implementation of the methods in this design process. Most of the times these workshops in the automotive industry will be followed by a strategy designer who then translates the information to the interior designer.
- Test the interior design process in the automotive industry to see if there are any unforeseen gaps into the process that need to be implemented.

Chapter 14 Future recommendations for the TU Delft

Where TU Delft was very insightful with pushing new aspects of knowledge in the form of using methods, theory and a way of looking at a greater picture into the automotive industry it also set some boundaries.

Since the TU Delft doesn't offer a specific track for Automotive Design, it can be harder for a student to specialise and graduate at a company that is more focussed on the visual aspects of a design than the research. Given the timeframe I was challenging to please both worlds (The TU Delft and the Automotive industry).

This challenge was very present whilst finding and beginning my thesis project. It became more understandable where in the industry this master overlapped and was appreciated within the company.

Which is the beginning of the process at the Strategic Design Department these processes and methods are way more known than in the department of an interior designer. Which made it a great possibility for me during this internship to push this knowledge also to other departments within the company.

By using a physical prototype to test the interior design process it became a clear example of a way to bring the knowledge to other departments and also create more interaction and feedback between the departments.

If the possibility was there I would have liked to follow a track at the TU Delft that was fully focussed on automotive design (as they already have with the medical design track), so this transitioning gap would have been smaller.

Chapter 15 Personal reflection

In the previous years at the TU Delft I was only used to making use of a design process rather than inventing one myself. Considering this, my first approach was to use an existing one and see which methods I needed along the way to add in the existing process and reflect on it. Which would mean designing a concept and vision and later on writing a proposal in the reflection.

This was approach I started with when I moved to Italy. Where I realised after a few weeks through one of my first feedback sessions that this would not be the right approach.

This was a turning point to step out of my comfort zone and explore other ways to find solutions for a new approach. The next challenge was finding a way to satisfy both the university and the company. Which later on was more a problem of getting my story straight to make both parties see the potential of this thesis project.

Changan offered me a lot of help and possibilities in doing my graduation internship which made me able to reach the fullest potential by also making a physical prototype that showcases this design process and making use of their skills, knowledge and equipment.

By this help and the guidance from my supervisors I have made a lot of growth by becoming better at sketching, blender, understanding of the interior and seeing how a design process works in the automotive industry.

In the end Clay modelling not only gave me more understanding of thicknesses and proportions in the design. It also confronted me with influential design mistakes that I made very early on in the process. If I would not have had this step in my design process, the feasibility of my design would have resulted much lower than it does now.

In this way I could also get a glimpse of how people would perceive certain aspects of my design that have to represent the intended story of my design.

Is the couch soft enough? Does it provoke a cosy and inducing feeling? How do certain pieces of the couch fit into each other?

For my personal development and understanding of interior design these weeks have been very useful and insightful. It also has helped me a lot in getting a better end result in developing the concept design.

My supervisors of the TU Delft have also added a lot of value to this project by pushing me out of my comfort zone and asking the right questions behind the interior design process. Where I first wanted to improve my skills in the aesthetical aspects of the design, I later found the strength of coming up with a good story that is based on research and methods, and can later be implemented into the design process.

There is always a risk in choosing a certain design method and finding out if it fits the environment for which you are designing.

There were different methods that were out of my comfort zone. Especially VIP (Vision in Product) Design. This was a reason for me to try avoiding this method. I have been lucky to have had three different feedback loops with my supervisors before implementing this method in my final design process.

Which makes it an arguable topic of introducing such methods to designers that have never used this method before.

Another challenge I walked across in the end of my project is creating a clear storyline of the design process. To make it fit the automotive industry, the aim was to also walk through every step of the process myself. In this way people get a better visual understanding of methods, design choices, and the implementation of the research.

These implemented steps made it sometimes confusing for my supervisors to follow the overall interior design process proposal.

Next to this I had to shorten the design sketching steps and detailing of the design. Which has led to a more conceptual and less feasible (and possibly viable and desirable) end result of the concept itself. It is important to in this case also look at these steps from an interior design process rather than a concept design.

Overall what really helped me during this graduation internship was the inspiring and lovely environment Changan and the people that work here have offered me these last couple of months. Without the help, enthusiasm and fun during this internship it would not have had the same result.

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Appendix II: Project Brief

DESIGN FOR our future

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IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name: Driessen
initials: D.L.R. given name: Demi
student number: 4653718
street & nc
zipcode & cit
countr
phon
ema

Your master programme (only select the options that apply to you):
IDE master(s): ★ IPD ( ) DfI ( ) SPD
2nd non-IDE master:
individual programme: - - (give date of approval)
honours programme: ( ) Honours Programme Master
specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair: E.Imer D. van Grondelle dept. / section: DA
** mentor: Martijn .C. Haans dept. / section: HICD
2nd mentor: Marcus. Berry
organisation: Changan Europe
city: Turin country: Italy
comments (optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

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Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair E.Imer D. van Grondelle date 14. 04. 2023 signature

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _____ EC
Of which, taking the conditional requirements into account, can be part of the exam programme _____ EC
List of electives obtained before the third semester without approval of the BoE

( ) YES all 1st year master courses passed
( ) NO missing 1st year master courses are:

name date - - signature

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ( ) APPROVED ( ) NOT APPROVED
Procedure: ( ) APPROVED ( ) NOT APPROVED
comments

name date - - signature

Interior design: Transitioning to autonomous driving for Changan Europe — project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 14 - 04 - 2023 — 28 - 08 - 2023 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

This graduation project will be a collaboration between Changan Europe, TU Delft, and myself. Next to these stakeholders, there will be implementations of Mediators research.

The main stakeholder of this project will be the Chinese car company Changan. A Chinese state-owned manufacturer that also sells under the names Shenlan (EV), Oushan (mid-level SUVs and MPVs), Kaicheng (Commercial vehicles, light trucks and MPVs) and recently launched in 2021 Avatr (Premium EV). Whereas Changan focuses on premium SUVs and passenger cars.

Changan is currently one of the top 4 best-selling car brands in Asia. Yang Jie (sales and marketing Changan) said in an interview in 2017 that the aim is to enter the European market will be around 2028 (Rendell, 2017).

In mandarin 'Chang' means 'Lasting' and 'An' means 'Safety' (Changan, 2023). Changan has always adhered to three principles: safety, emotion, and efficient experience (A&D, 2022). Besides this, they are also expanding their knowledge of smart technologies and sustainability. In 2025 they try to have 35% of their cars electric and exceed this to 60% by 2030. (Astana Motors, 2023).

Autonomous driving level 4 or 5 (Mediator)
"Automated transport technology is developing rapidly for all transport modes, with huge safety potential." (Mediator, 2023) This transition to fully automated driving can bring in new risks (mode confusion, over-reliance, reduced situational awareness, and misuse). This changes the relationship between the driver and the interior design.

TU Delft
For the TU Delft, it will be valuable that the process and methodology have the same priority as the final deliverables. Furthermore, this project has to contain critical thinking, argumentation, and reflection. With the result of an aesthetically pleasing, user-focused, and meaningful design process.

Possible limitations
- Making a physical clay model.
- Focus too much on aesthetics due to the time span of the project.

Opportunities
- Digital & Physical designing (Improve skills in Blender, Digital Sketching, Clay Modeling, and possibly other software programs they use at Changan Europe).
- Changan Europe is open to being inspired, where I could personally design the brief for this project.

space available for images / figures on next page

Personal Project Brief - IDE Master Graduation

TUDelft

introduction (continued): space for images

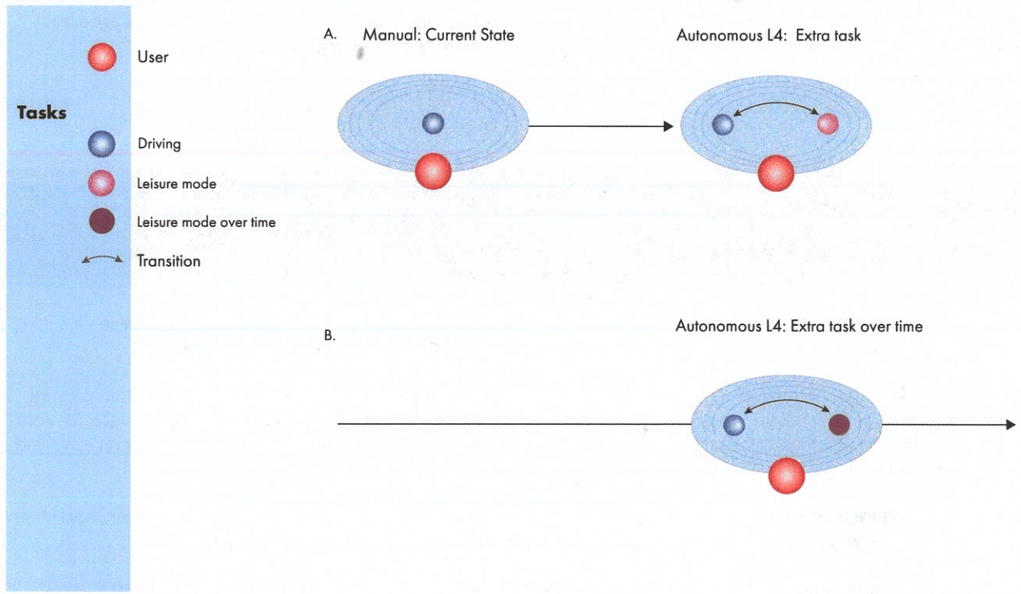


image / figure 1: Transition roles of the user A: transition form manual to autonomous, B: autonomous over time

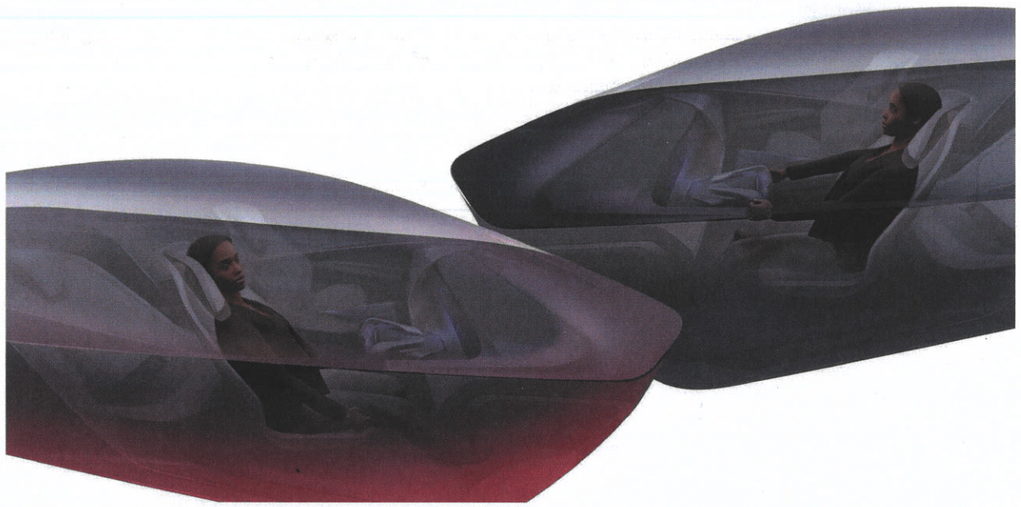


image / figure 2: Transitioning from autonomous to manual driving

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

How can Changan Europe shape its interior design process to enable the transitioning roles (see figure 1) of the user in an autonomous level 4 vehicle?

Scope
This interior design will be focused on
... the European market.
... autonomous driving level 4.
... the method design for emotion
- to change Europe's current perspective on Chinese brands entering the market.
- to improve the user experience.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

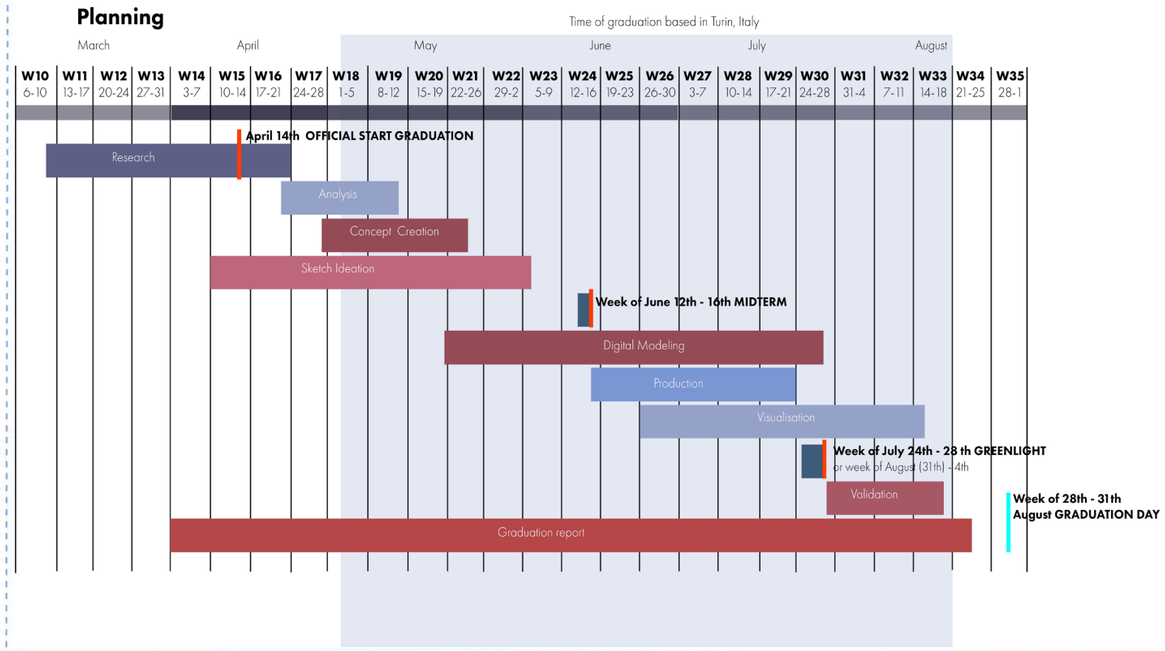
This project focuses on developing a design process for Changan Europe whilst designing an interior design for level 4 autonomous driving. The project focuses on how Changan Europe can enable the integration of level 4 autonomous HMI and the state of driving autonomously (leisure state) in their interiors. Two factors that influence the transitioning role of the user. The process will be user-centered and will make use of the design method "Design for Emotion"

The aim of this project is to deliver a design process combined with an interior design vision.
The project will first focus on creating this design process. After this establishment, a 3d model/clay model will be used to validate the design process and create a vision by putting the theoretical part of this process into practice.
- How can Design for Emotion make the user feel better understood (improve the interaction) by the interior design?
- How sustainable is electric autonomous driving and will it lead to a more sustainable future?
- What does the interior have to communicate to the user during Autonomous Level 4 driving (Human Machine Interaction)?
- What are the design limits and opportunities for designing an Autonomous Level 4 vehicle?

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 14 - 04 - 2023 28 - 8 - 2023 end date



Initial planning

The creative process of this project will be both analogue and digital, to explore the form, function, and overall experience.

An important part of this project will be the research into other factors, developments, and new technologies that influence the future of autonomous level 4 interior design.

To link this research to the sketching phase and implement the important findings in the process the 'VIP method' and 'Design for Emotion' will be used. This will be a valuable bridge to set a base for further designs in the direction of autonomous driving level 4. During the design phases sketching, Photoshop and CAD modelling will be used.

If possible there will be a Physical model or 3D software model to additionally validate proportions, scale and concept principles.

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

My main goal with this project is to have a result that will also get me hired at Changan Europe as an interior designer/clay modeler.

Furthermore I would like to expand my knowledge in:
- Knowing what it is like to work in the car industry and improve my skills (in blender/3d modeling, clay modeling, sketching, gain knowledge in the working culture of the company) so the transition to working in the industry will be more fluent.
- During one of my master courses I made use of the method 'Design for Emotion', a method that can be suitable to also implement in the car industry. It will help in creating a design that is user-centered and evokes a surprising aesthetic result.
- Gain more knowledge on the current developments in Autonomous Driving which makes it easier to predict further developments and implementations.

My last motivation is that I would like to take a bold approach to further explore how this design can show new opportunities for the sustainability aspect of the car industry.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.