Flowing Oasis

A 2027 envisioned smart cabin interior design concept centered around IoT product connectivity

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Acknowledgment

This graduation project marks the conclusion of my master's journey and the fulfillment of my dream to become a professional industrial designer. As I reflect on this milestone, I would like to extend my heartfelt gratitude to all who have supported me throughout this process.

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感谢！

Abstract

With the development of smart technologies, electrification, and autonomous driving, cars are evolving from simple transportation tools into mobile living spaces. The design focus has shifted toward enhancing in-car user experiences (Floridi, 2019). This thesis, in collaboration with Xiaomi EV, explores the potential of integrating IoT connectivity into smart cabin interiors to improve user experience in non-driving related activities (NDRAs) (Kim et al., 2015).

The project's ultimate goal is to create a "Refreshing" user experience within an L3 smart cabin. The forward-thinking concept developed in this project, Flowing Oasis, reimagines the in-car environment and interactions for Xiaomi's future electric vehicles.

The research follows the Double Diamond design framework, covering discovery, definition, development, and delivery phases. During the discovery phase, an in-depth analysis of user needs—particularly opportunities within the current research gap in in-car product customization and connectivity—was conducted, alongside a comprehensive brand analysis. The project then defined a clear mission: to create a modular, IoT-integrated cabin that supports a seamless user experience through product connectivity, addressing users' psychological and emotional needs by fostering a sense of belonging in a mobile context.

Key deliverables included CAD models, 3D visualizations, and VR prototypes, all used to validate the design's feasibility and user-centric value. The results indicate that integrating IoT-enabled features and introducing the Oasis platform—a co-creative business model where users define their in-car products—significantly enhances user satisfaction and aligns with Xiaomi's goal of product premiumization.

Flowing Oasis not only provides users with a sense of belonging but also fosters continuous innovation through the IoT ecosystem, paving the way for future advancements in automotive design.

Abbreviations

IoT	Internet of things	**AR**	Augmented reality
NDRAs	Non-driving related activities	**HUD**	Head-up display
DRAs	Driving related activities	**DC**	Direct current
VR	Virtual reality	**2D**	Two dimensional
IVIS	In-vehicle infotainment systems	**3D**	Three dimensional
EV	Electric vehicle	**OTA**	Over the air
OEM	Original equipment manufacturer	**OS**	Operation system
SAE	Society of automotive engineers	**CEO**	Chief executive officer
NEV	New energy vehicle	**HREC**	Human research ethics committee
AV	Autonomous vehicle	**CMF**	Color, material & finishing
ICE	Internal combustion engine	**AC**	Air conditioner
AI	Artificial intelligence	**CAD**	Computer-aided design
UI	User interface	**SUV**	Sport utility vehicle
UX	User experience	**BES**	Battery energy storage
FAV	Fully autonomous vehicle	**IP**	Instrument panel
HCI	Human–computer interaction	**DIY**	Do it yourself
IoV	Internet of vehicles	**RV**	Recreational vehicle

Contents

Declaration

This master's thesis is written as part of the Integrated Product Design program at the Faculty of Industrial Design Engineering, Delft University of Technology, in the Netherlands.

The content related to the collaborator company, Xiaomi EV, except for the internal interviews in Chapter 5, is independently produced by the author based on academic research and insights from online media platforms.

In Chapter 1 (Introduction), Chapter 2 (The Context), and Chapter 4 (Brand Analysis), Xiaomi-related images are sourced from the official Xiaomi EV website (www.xiaomiev.com), and the website's descriptions and annotations should be regarded as accurate.

This report is intended for academic research purposes only and does not represent Xiaomi EV's future design plans.

Part A : Introduction

This part will introduce the basic background of the project, including the collaborators, the objectives of the assignment, the focus areas and the design methodology employed throughout the project.

1. The Project

1.1 Project Brief

Topic

The introduction of autonomous technology marks the beginning of a transformative era in car design and functionality, freeing drivers from the task of driving and enabling them to engage in activities that would not be possible in manually controlled vehicles (Tang et al., 2020). This shift transforms human mobility into a purely experiential phenomenon (Floridi, 2019), leading to a significant rethinking of car interior design. The focus is increasingly on the interior space and how individuals interact with products, underscoring the need for innovative use and redesign of this space.

Simultaneously, drivers and passengers are increasingly relying on mobile devices or the advanced features of in-vehicle infotainment systems (IVIS) to stay connected (Pfleging & Schmidt, 2015).

This forward-thinking perspective envisions cars evolving into essential mobile spaces that serve not only as modes of transportation but also as integral parts of our lifestyles. The user experience in autonomous vehicle interiors and the innovative features of smart cars are becoming lively topics of research and design direction in the automotive industry.

The collaboration

Xiaomi EV is an electric vehicle brand established in 2021 by the international tech giant Xiaomi, headquartered in Beijing, China with its design team based in Shanghai, China.

As a new entrant in the automotive industry, Xiaomi EV launched its first vehicle, the Xiaomi SU7, in 2024, with plans to introduce more models in the future. Xiaomi EV is currently in the early stages of development, aiming to secure a significant market share and aspiring to become a leading global automotive OEM within the next 20 years (xiaomiev.com, n.d.).

At present, Xiaomi EV is seeking innovative ideas for future products to inspire its design team and explore possibilities for upcoming offerings. This initiative also presents a valuable opportunity to nurture young designers.

This collaborative thesis project with TU Delft is sponsored by Xiaomi EV, with the company's design team, including the team lead of the product design team as the company mentor and the design directors as advisors, will support this collaboration.

Figure 1. The interior design of Xiaomi SU7

1.2 Assignment Goal

"Design a next-generation system strategy and interior design solutions based on the IoT product connectivity concept for Xiaomi's intelligent cabin, aimed at enhancing the in-car user experience."

After thorough discussions among the three parties (the student, supervisory team, and company), an agreement has been reached on the objectives for this thesis project collaboration, as outlined above.

The primary goals are to fulfill the academic requirements of TU Delft and support the student's development while exploring potential opportunities within the industry.

Using Xiaomi EV as a case study, the project also aims to propose innovative concept that create unique value for the brand and inspire the design team.

One of the distinctive features of Xiaomi EV is the potential application of its IoT product connectivity in the smart cabin interiors, which will serve as a core element in the project's development.

It is important to note that although this project focuses on conceptual design exploration, it must be clearly distinguished from a commercial design project. The approach should be rooted in an analysis of industry trends and the essence of research to identify design opportunities, rather than directly adopting the company's existing strategic direction.

Furthermore, the project is not limited to traditional product design; it will be expanded to encompass comprehensive system innovations that include business strategy, brand identity, and user experience.

This approach aims to make the project more robust in its application logic while challenging the student's comfort zone.

1.2 Assignment Goal

Key words

User experience

This project will focus on enhancing the user experience through interactions and product solutions, aiming to introduce innovation in both strategy and design concept. The goal is to deliver an experience that is distinct from traditional car interiors.

IoT product connectivity

The integration of IoT product connectivity will be a key focus of the project, closely tied to the brand case study to reflect its identity. However, it is also essential for the project to analyze the underlying trends and the rationale behind their relevance to the user experience.

Interior design

The essence and scope of this project remain centered on exploring design concepts for smart cabin interiors.

Brand identity

At the same time, emphasizing the brand identity, its uniqueness, and advantages, along with identifying areas for further improvement, will be crucial aspects of the project's content.

1.3 Scope

Timeframe

This project will be positioned within a 3-year future scope. The company hopes the project will be forward-thinking and innovative, offering fresh ideas. However, as a start-up automotive OEM, and given the rapid development of EVs exceeding previous expectations, they prefer the scope not to be too distant or unpredictable.

2027...

Market

As a China-based OEM, although Xiaomi aims to become a leading international automotive OEM within 20 years, the initial years of development will primarily focus on the Chinese market.

China

1.4 Background

Focus on automation level 3

The Society of Automotive Engineers (SAE) has classified autonomous vehicle technology into six levels, ranging from 0 to 5 (SAE International, 2021). This classification system clearly outlines the transition of responsibility from human drivers to automated systems, detailing the specific roles that each plays at different levels.

While the timeline for adopting different levels of autonomous driving is influenced by local policies, technological advancements, and economic growth, Proff et al. (2021) provided estimates suggesting that L3 vehicles were expected to enter the market in 2021, with L4 vehicles projected to debut by 2025.

Despite these introductions, a significant gap remains between the initial entry and widespread adoption. As of today, it is evident that most vehicles still predominantly feature L2 autonomous capabilities.

Looking ahead to 2027, the automotive industry is expected to make significant progress toward the adoption of mature L3 technologies. During this period, Levels 0 to 4 will coexist in the market, and a combination of policy considerations and on-road permits will make L3 the most rational focus for the project.

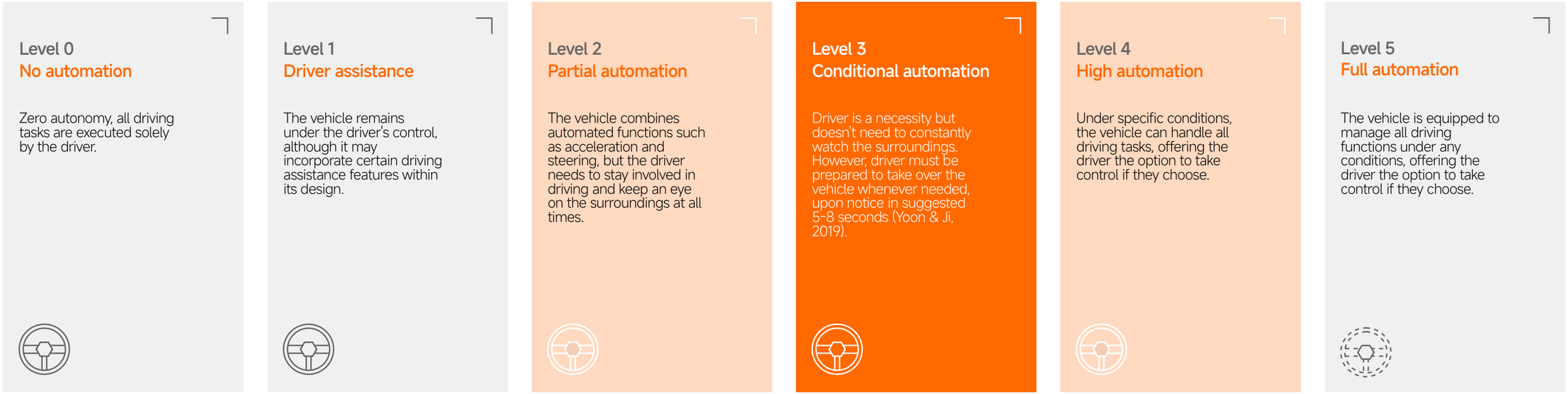


Figure 2. Level of automation (SAE)

1.5 Approach

Double Diamond model

This project will adopt the Double Diamond model as the design methodology, encompassing four phases: Analysis, Vision, Design, and Evaluation.

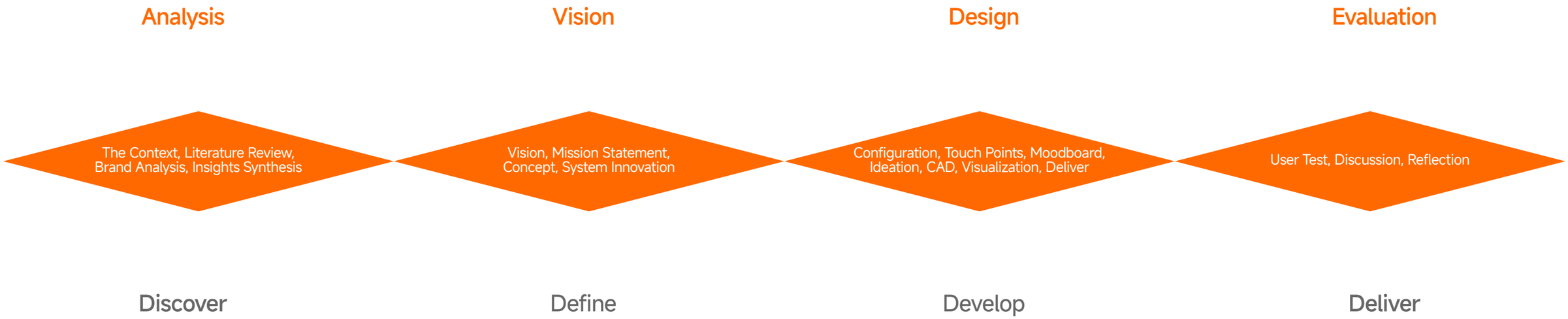


Figure 3. The design approach of the project

Part B : Analysis

In this initial phase of the project, systematic and objective research and analysis are conducted to deepen the understanding of the context, current academic research, and the brand case. This research serves as the foundation and provides guidance for the subsequent concept development.

2. The Context

2.1 The Country

Concentrated in mega-cities

As one of the world's most populous countries and largest economies, China's population distribution is increasingly concentrated in the regional center cities of each province. Mega-cities like Beijing, Shanghai, Guangzhou, and Shenzhen are home to tens of millions of residents (Planning in China, n.d.).

The infrastructure

China has a well-developed network of airports and high-speed rail hubs that connect cities around the clock. Driving in China is primarily for commuting within one's own city of residence. Due to the large population, many people live in apartment buildings and park their cars in communal parking lots within residential compounds. Unlike in many cities in the United States and Europe, open spaces and private parking spots are less common.

Charging stations and battery swap stations for EVs are widespread and easily accessible. According to the National Energy Administration of China, as of July 2024, there were over 10.604 million charging stations across the country, including 3.209 million public charging stations (energy.cctv.com, 2024).

Figure 4. Images and infrastructures of China's mega cities

2.2 The Economy

The accommodation

The tier of cities in China is closely linked to job opportunities and economic status, which also directly correlates with housing prices. As a developing country, China's welfare benefits are not as comprehensive as those in developed nations, and the strained housing supply-demand relationship means that many people still need to rent their accommodations.

In Shanghai, over 40% of the population in 2022 opts to rent, while in Guangzhou, the figure exceeds 50% (China Real Estate Industry Association, n.d.). According to data from one of the biggest real estate information platform in China, Anjuke, the average housing price in downtown Shanghai was approximately 15,000 euros per square meter in 2024 (anjuke.com, n.d.), while the average monthly disposable salary was less than 1,000 euros (Shanghai Municipal Bureau of Statistics, n.d.).

As a result, many people find it impossible to afford home ownership in their lifetime, making renting the default mindset for young people.

The car market

China has been a leader in the global first-hand car market in terms of sales since 2009 (Govorova, 2023), and the Chinese market is now the largest electric vehicle market globally (Dudic, 2024).

Due to a solid supply chain and a mature manufacturing industry, average prices in China, including car sales, are not as high as housing costs.

For instance, the price of a 2024 Tesla Model 3 in the Chinese automotive market is approximately 46% lower than in the Netherlands (tesla.com, n.d.).

Consequently, for young people in large cities, purchasing a car—being much more attainable than buying a house—has gradually become their preferred investment choice.

Figure 5. Images depicting China's accommodation and car market

2.3 The Automotive Industry

Figure 6. Images of CATL headquarter, BYD battery, Zeekr 009, Lynk&Co 01, NIO ET9

Fully committing to the NEV era

Under strong policy intervention and support, China's new energy vehicle (NEV) industry has developed rapidly, forming a crucial part of the country's green energy policy revolution aimed at addressing climate change and environmental issues (Li, 2020).

With recent technological advancements and the rise of major battery companies like BYD and CATL, China has decisively shifted its focus fully toward the development of NEVs. The emergence of companies such as NIO, GEELY, and XPENG is gradually elevating China's automotive industry, demonstrating its potential to compete with traditional high-end brands from Europe and the United States within the domestic market.

Additionally, China's policies strongly encourage the research and development of autonomous vehicles (AVs). For instance, the tech giant based in Beijing, Baidu's Apollo project has already launched L4 driverless road-legal autonomous taxis into the market (robotgo.com, n.d.).

2.4 The Car Culture & Consumerism

Figure 7. The difference of car age between China and the Netherlands

Figure 8. Smart features such as an embedded fridge and zero-gravity seats in the cabins of Chinese EVs

Shifting perceptions

For a long time, cars have been a symbol of status in China, often used to showcase one's social standing. Imported luxury cars were perceived as a means of enhancing social recognition (china.org.cn, 2014).

However, perceptions of EVs and ICE brands are now shifting. Multinational OEMs no longer command a premium in China, and their brand aura has almost entirely faded, a trend that is particularly evident in the electric vehicle industry. At the same time, owners of traditional high-end multinational brands are increasingly switching to high-end Chinese electric vehicle brands, a trend that is almost entirely one-way (Guan & Fang, 2024).

Car ownership duration

The average car age in China is 5.3 years (Statista, 2024), significantly lower than in Europe, specifically 11.4 years in the Netherlands (European Automobile Manufacturers' Association, 2023). This difference can be partly attributed to the higher cost of cars in the Netherlands, as previously mentioned, and the faster product turnover in the Chinese automotive market.

This trend also indicates that the Chinese market is more prone to consumer preference for novelty in automotive products, with a strong interest in smart features (Guan & Fang, 2024). If a brand's vehicle lacks features such as smart driving, AI assistants, or amenities like refrigerators, large screens, or massage seats, or if its price is slightly higher for the same configuration, it will struggle to compete with other players in the market and may face failure or even bankruptcy. Consumers are consistently eager to embrace new technologies and experiences, leading to the emergence of many pseudo-demands.

2.5 The Target User

Target group: young generation

After discussions with the company, we have decided to maintain our focus on the current users of Xiaomi EV in this project, as it was determined that this focus is most relevant to their three-year strategic plan.

Since Xiaomi EV has only recently been launched, there are no authoritative academic or official user profile reports available yet. However, according to a user research report based on a small sample (150 users) released by the Chinese media outlet EV Users Union from NetEase, the average age of Xiaomi EV users is 30.1 years. The user base primarily consists of post-90s young adults working in the IT industry and residing in first-tier cities such as Hangzhou, Beijing, Shanghai, and Guangzhou. The majority (63%) are either unmarried or married without children, with 28% being female young users. Notably, 70% of these users are also Xiaomi smartphone users, and 44% own between 11 to 30 products from Xiaomi's product lineup (EV Users Union-NetEase, 2024).

This user report aligns well with the previously discussed trends in China, where residents of mega cities primarily choose to buy cars rather than houses. In summary:

 # Post-90s generation

 # Mega city residents

 # Without children

 # Loyal Xiaomi users

Figure 9. Image of Xiaomi EV's user target

2.6 Insights of the Chapter

Following the research and understanding of the broader context in this chapter, we have summarized two key insights that will guide the subsequent design process:

1. Exploring the influence of residential and economic context on car concept

When developing a project for the Chinese market, the context of living patterns and economic factors inevitably influences users' lifestyles and underlying needs.

Understanding and addressing the inner needs of users within a context of high urbanization, widespread renting will be crucial in proposing an innovative vision that resonates with young users. This will be a key consideration in the subsequent design process.

2. Possibility of extending car ownership duration through design features

Although the trend of pursuing novel features is hard to change in the social level, we might be able to use innovative strategies to make Xiaomi EV more sustainable while maintaining these smart features, thereby enhancing quality and increasing user loyalty.

For example, by integrating IoT products, it could be possible to continuously update the interior space without needing to replace the entire vehicle, thereby enhancing quality and user loyalty.

3. Literature Review

3.1 The Mobile Space

Research purpose

Subsequently, we conducted extensive research on a wide range of academic literature and business articles, aiming to identify current trends in automotive interior development, their impact on user experience, and potential technological opportunities for future design concepts. Notably, this section seeks to identify research gaps in existing studies, thereby exploring new areas that can create value.

Transportation to mobile space

As Tang et al. (2020) stated, "Automation will free drivers from the task of driving, enabling them to engage in activities that would not be possible in manually controlled vehicles, thus transforming human mobility into a purely experiential phenomenon" (Floridi, 2019). Consequently, cars will gradually evolve from traditional tools for moving from point A to point B into mobile spaces that host experiences and activities—essentially becoming a "Room on Wheels."

OEM's strategy

The latest trends among automotive OEMs highlight a strategic shift toward viewing cars as extensions of personal living spaces. For example, NIO considers its vehicles a "Second Living Room" in its design philosophy (nio.com, n.d.), while Li-Auto describes its cars as a "Mobile Home" (lixiang.com, n.d.).

Figure 10. The transformation from transportation to mobile space

Figure 11. Images of mobile space strategy from NIO and Li-Auto

3.2 NDRAs

Find meaningful in-car experience

Meaningful experiences play a central role in the future of mobility (Riener et al., 2022), making it essential to identify the potential for exceptional user experiences and to understand the underlying human needs.

Focus on NDRAs

The activities within the car directly determine the user experience inside the vehicle, along with the corresponding interior design and functionality. A significant amount of research has focused on understanding how user behavior within vehicles changes across different levels of autonomous driving.

These research categorize vehicle user behaviors into two main types: Driving-Related Activities (DRAs) and Non-Driving-Related Activities (NDRAs).

DRAs are further divided into three specific tasks: the Primary Driving Task, which involves the direct control and navigation of the vehicle; the Secondary Driving Task, which includes supportive functions for the primary task, such as adjusting mirrors or climate controls; and the Tertiary Driving Task, which involves activities not directly related to driving but necessary for the journey, such as choosing music or setting navigation points.

In contrast, NDRAs encompass a broader range of activities, highlighting the flexibility of the vehicle space for purposes beyond traditional driving.

Jeon et al. (2018) provided an extensive list of NDRAs that occupants engage in within vehicles, extending beyond mere driving to include activities such as sleeping, eating, doing office work, monitoring the vehicle's operation, making phone calls, watching TV, and using social networks. Similarly, Kim et al. (2015) identified a wide range of activities that users engage in within AVs, including leisure activities, eating, resting, communicating, grooming, and working, highlighting these as essential experiences users expect in these settings.

In the context of automation L3, both DRAs and NDRAs will coexist within the vehicle. However, due to the greater constraints on driving activities and the complexity of research, it is challenging to consider both simultaneously in this project. Since the assignment focuses on user experience, including not only the driver but also other passengers, and given the rapid development of intelligent EV features in China, where higher levels of autonomy, even driverless vehicles may soon be on the roads, this project will concentrate on the study of NDRAs.

Scenario types

We can categorize NDRAs into the following user scenarios in the automation L3, which will be the mian focus of the later design scope:

 # Drivers and passengers in autonomous driving mode

 # Drivers and passengers in parked mode

 # Other passengers in manual driving mode

3.2 NDRAs

Figure 12. NDRAs examples for automation L3

NDRAs examples for automation L3

Kim et al. (2015) summarized the non-driving related activities (NDRAs) within L3 vehicles into 6 major classes: leisure, eating, working, cleaness, communication and rest. This research indicates that for drivers, leisure, work, and rest were the most frequently mentioned activities, while for passengers, leisure, communication, and work were the top priorities.

It is worth noting that some of these activities, such as sleeping, should be restricted for drivers (Kim et al., 2015). Additionally, drivers remain concerned about unexpected transitions between manual and autonomous driving modes; they typically prefer static activities and require driving information to be presented in a glanceable manner. Some activities might impair the drivers' ability to take control (Yang et al., 2020).

Compared to the 2015 studies, the examples of NDRAs have inevitably evolved. To verify these changes, in the final stage of Part B of this project, we conducted interview sessions with several Xiaomi EV design experts to validate the analysis results (which will be detailed later in Chapter 5). During this session, we discussed additional examples of NDRAs and identified activities that drivers cannot participate in, as illustrated in Figure 12.

3.3 Needs and Wants

1 Personalization & customization

Systems should offer extensive options for users to tailor a personalized experience.

2 Connectivity

Maintaining consistent connectivity between vehicles, personal devices, or infrastructure is crucial.

3 Social

Vehicles should serve as efficient locations and mediums for social interaction.

4 Maintenance

In-vehicle space maintenance is necessary.

5 Accessibility

Systems should accommodate all passengers, regardless of characteristics and abilities.

6 Information

It's important for clear information presentation, especially regarding vehicle state changes or journey transitions.

7 Space

The design should offer space supporting various activities users intend to perform inside the vehicle.

8 User interface

The overall UI should match user preferences and seamlessly integrate with driving tasks.

9 Privacy

Protecting the privacy of personal information from both inside and outside the vehicle is essential.

10 Trust

Passengers need to trust the driving system of AVs.

11 Health

Vehicles should support users' physical and mental health needs and overall well-being.

12 Safety & security

Ensuring passenger safety from both physical and digital threats is a priority.

Figure 13. 12 user needs in FAVs suggested by Lee

User needs in AVs

The aforementioned NDRAs examples directly reveal the activities users engage in within the vehicle, as well as the potential for corresponding product and feature innovations. However, we also explored user needs within the vehicle from a broader perspective to support the subsequent design concepts.

Lee et al. (2020) summarized 12 non-driving user demands within Fully Autonomous Vehicles (FAVs). Although L3 having a completely different spatial layout and driver considerations, the level of intelligence will also differ, looking from a higher level downwards, such a summary still holds significant reference value since this project will also focus on non-driving situation within the vehicle. Following the subsequent interview sessions, we collectively confirmed to ensure these needs are also applicable to L3 scenarios. Additionally, we identified a new demand specific to these scenarios, as illustrated in Figure 14.

13 Efficiency (additional)

Can the intelligent cabin help users complete tasks more efficiently (both driving and non-driving)?

Figure 14. The additional need mentioned from the interview

3.3 Needs and Wants

Define needs and wants

Admittedly, it is hard to address all of the above user needs within this project. The key lies in how to map these needs, from basic to advanced levels, onto the user experience—essentially defining needs and wants. This approach, combined with other research insights, will guide the focus of subsequent design efforts. Therefore, we have aligned these needs with Maslow's hierarchy, resulting in a logically structured pyramid.

As shown in Figure 15, needs such as security, health, trust, and privacy correspond to the basic levels of physiological and safety needs. In contrast, needs such as personalization, space, connectivity, and efficiency correspond to the higher levels of esteem and belonging, which represent wants.

Figure 15. Define needs and wants using the Maslow theory

3.4 The Research Gap

Opportunities in product connectivity

After reviewing a series of related literature on autonomous vehicle interior design, we found that since 2015, most studies have focused on driving-related behaviors, layout, and ergonomics in AVs. Subsequently, there has been a growing body of research on NDRAs, artificial intelligence, robotics, human-machine interaction, and UI/UX.

However, the relationship between user experience and the integration of accessory products, particularly IoT products connectivity, within AVs remains largely unexplored. This represents a highly promising area for development in the current industry.

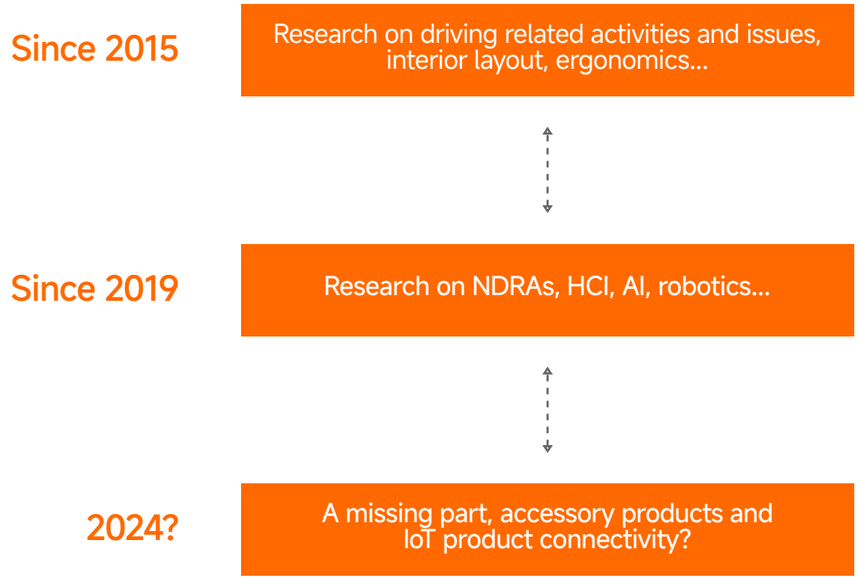


Figure 16. The research trend since 2015

3.5 Connected Vehicles

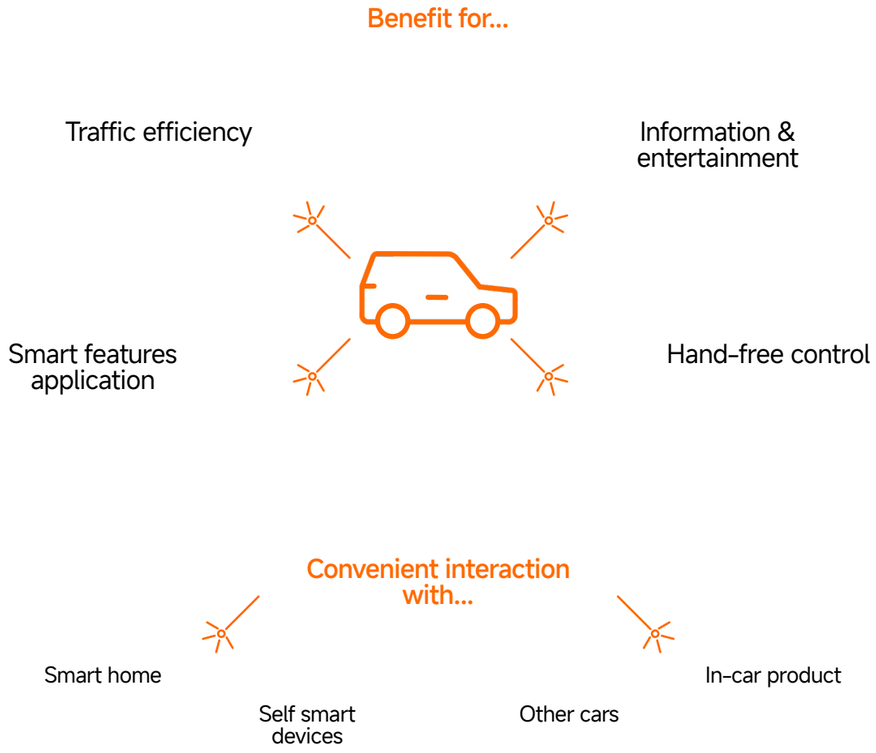


Figure 17. The beneficial features of connected vehicles

Multi-scenarios connected vehicles

Before conducting research on in-car product connectivity, it is essential to understand that vehicle connectivity is also rapidly becoming widespread.

The Internet of Vehicles (IoV) is an application of the IoT within the intelligent transport system, which has prompted significant research (Berdigh & El Yassini, 2017).

The connected car, a vehicle capable of accessing the Internet, communicating with smart devices as well as other cars and road infrastructures, and collecting real-time data from multiple sources, is expected to play a fundamental role in the foreseeable Internet of Things (Coppola & Morisio, 2016) and is beneficial to multiple areas, as shown in Figure 17.

With the recent proliferation of smartphones and similar connected devices, efforts have been made to integrate them with in-car operation system, offering a variety of solutions to do so.

This integration allows data collected by internal car sensors to be combined with information gathered from the web and the surroundings, enabling drivers to enjoy a cleaner, more secure, and more efficient driving experience (Coppola & Morisio, 2016). Vehicles can also be integrated with multi-scenario functions, such as smart-home features, allowing drivers to activate devices like lighting, heating, entertainment systems, or garage doors through the car's central operation screen, all before they even arrive home (xiaomiev.com, n.d.).

In summary, the current connectivity can be categorized into three main functions: remote control of products, remote control of the vehicle, and in-car connection and direct use of IoT products.

Connecting and controlling home products from the car is just the first example. In fact, an increasing number of in-car products can now be directly connected and used within the vehicle, significantly enhancing its functionality and user experience.

3.6 Product Connectivity

Figure 18. Cases of connected in-car products from NIO, Xiaomi and XBox

Connected in-car products

The development of CarIoT and Connected Vehicles will inevitably provide opportunities for product connectivity both inside and outside the car. Connected products, much like the interior components of the vehicle, directly offer users new functionalities and experiences, thereby creating richer opportunities.

Examples such as NIO's smart in-car entertainment AR glasses (nio.com, n.d.), Xiaomi's smart in-car aroma diffuser (xiaomiev.com, n.d.), and the connection of Microsoft's XBox controller to Tesla vehicles (cyberbackpack.com, 2023), among others, illustrate that with the advancement of EV intelligence and related industries, such product cases will be limitless, demonstrating that product connectivity is gradually becoming an important part of the interior space.

3.7 Technology Opportunities

Tech opportunities

The final part of this chapter's research will explore potential technological opportunities in the near future.

Technology will function as the indispensable carrier for novel features and experiences. From literature, production, and conceptual cars within the industry, we can uncover the potential opportunities. Such industrial developments will serve as a necessary support for interactions in the future car (Murali et al., 2021).

Based on the literature review from Murali et al. (2021), the articles from several automotive medias and OEMs, we have summarized the following 15 technological opportunities worth considering, listed below and visualized in Figures 19.

AR-HUD

AR-HUD technology will become more mature and widespread, displaying navigation, road signs, speed, and other information on the windshield. This reduces the frequency of drivers looking down at the dashboard, thereby enhancing driving safety.

Smart voice assistants

Smart voice assistants will become more intelligent and natural, capable of understanding and executing complex voice commands such as setting navigation, adjusting the interior temperature, playing music, and even answering passengers' questions or engaging in simple conversations.

Emotion monitoring

Through the use of cameras and sensors, in-car systems will be able to monitor the emotional state of drivers and passengers and make corresponding adjustments. For example, if the system detects that the driver is fatigued or in a negative mood, the lighting and music in the car will automatically adjust to help the driver maintain a better state (Banks, 2015).

Health monitoring

The vehicle will be equipped with a health monitoring system that uses sensors embedded in the seats and steering wheel to continuously monitor the driver's health indicators, such as heart rate and blood pressure, in real time. If any abnormalities are detected, the system will issue a warning or suggest that the driver take a break (Mobility - Pontosense, n.d.).

Charging and discharging

Vehicles will offer more wireless charging pads or DC interfaces for convenient charging of devices such as smartphones and tablets. Additionally, there will be 12V DC output interfaces for powering medium-sized devices like refrigerators, coffee makers, and projectors.

Smart seats

Smart seats will feature automatic adjustment capabilities, adapting in real-time to the passenger's body shape and posture. Additionally, these seats may include features such as massage, heating, and ventilation to enhance comfort during the ride.

Environmental control

Sensor-based environmental control systems will become more intelligent, capable of monitoring and adjusting the car's air quality, temperature, humidity, and lighting in real-time, ensuring that the interior environment is always in optimal condition.

In-car entertainment system

In-car entertainment systems will become more diverse and interactive, allowing passengers to enjoy a wide range of entertainment content through large screens, virtual reality (VR) devices, and other means, including movies, games, and interactive programs.

Smart chassis platform

With the advancement of autonomous driving technology, the smart cabin will further integrate this technology, offering passengers more freedom and comfort. Cabin designs will become more flexible, with seats that can rotate or adjust, allowing passengers to better engage in work or leisure activities during autonomous driving mode.

3.7 Technology Opportunities

3D-printed interior components

It is worth noting that 3D printed materials generally have lower strength compared to injection-molded materials, but there are still broad opportunities for their application in certain interior products, making interior design more flexible and customizable. Automakers will be able to quickly produce personalized interior parts based on customer demands, shortening production cycles and reducing costs (tnform.com, 2023).

Panoramic sunroof with smart tinting

Future vehicles may feature panoramic glass sunroofs combined with smart tinting technology, allowing passengers to adjust the transparency of the sunroof as needed. This not only enhances the sense of openness within the car but also effectively controls light and privacy. Electrochromic technology will be applied to windows and rearview mirrors, enabling changes in glass transparency by adjusting the electrical current. This helps reduce glare during bright conditions or nighttime driving while providing privacy protection.

OTA software updates

Through Over-the-Air (OTA) software updates, the vehicle's smart cabin system can continuously upgrade, adding new features and improving performance. This means that the vehicle's functionality and user experience can be continually enhanced over time.

Advanced sound system

In-car sound systems will be further enhanced, featuring 360-degree surround sound and noise-canceling technology to provide passengers with a high-fidelity audio experience. Additionally, the smart sound system will be able to automatically adjust the audio based on the car's environment and the passengers' positions.

Surround display screens

More vehicles will be equipped with surround display screens that may cover the entire dashboard and even extend to the interior sides of the doors. Both passengers and drivers will be able to control these screens through touch or gestures to perform various functions (Krijgsman, 2022).

Multimodal interaction

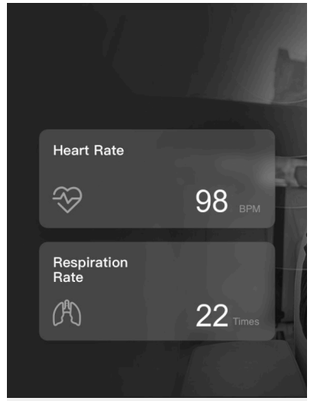
Multimodal interaction systems will combine various input methods such as touch, voice, gesture, and eye-tracking controls, enabling drivers and passengers to control various in-car functions more conveniently and naturally. For example, a driver could adjust the air conditioning temperature with a gesture or select a navigation destination through eye movements.

3.7 Technology Opportunities

AR-HUD

Smart voice assistants

Emotion detection



Health detection

Charging and discharging

Smart seat

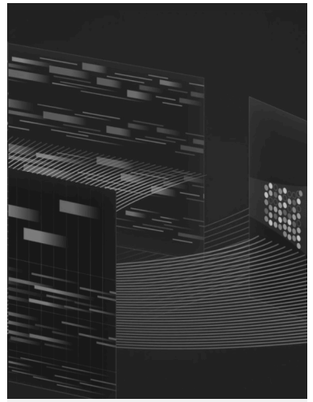
Environmental control

Entertainment system

Smart chassis platform

3D-printed components

Panoramic sunroof



OTA software updates

Surround display

Advanced sound

Multimodal interaction

Figure 19. Visualization of the 15 technology opportunites

3.8 Insights of the Chapter

Now that we have established a foundational understanding of in-car user experiences, behaviors, and needs at the L3 level of autonomous driving. We have also recognized the important trend of in-car product usage and connectivity in influencing interior functionality, as well as the technological opportunities that may support our later design process. The following three key insights can be derived from this chapter after the subsequent interview sessions with several Xiaomi EV design experts.

1. The future trend of connected vehicles will involve more NDRAs

The future trend of connected vehicles will inevitably shift from fixed functions to accommodating more non-driving activities, including the seamless integration of activities and functions from the home and office into the vehicle, see Figure 20.

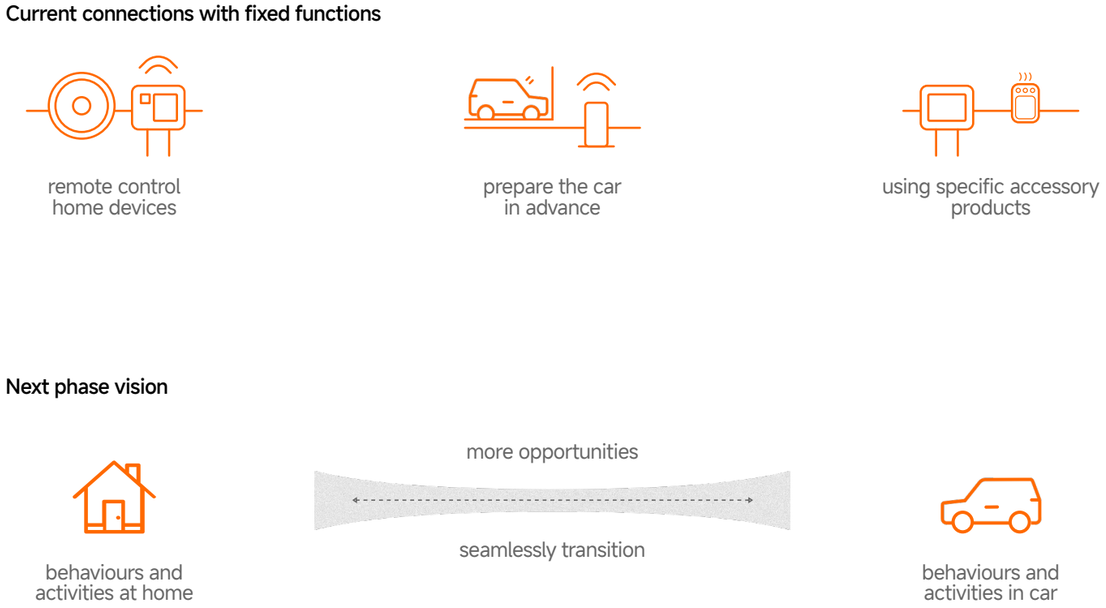


Figure 20. The future trend of activities inside connected vehicles

3.8 Insights of the Chapter

2. Create opportunities for niche activities while meeting the demands of high-frequency activities

Nevertheless, there are fundamental differences between the home and the car. Therefore, as highlighted in the previous research, one of the key aspects of this project will be to consider how to create opportunities for low-frequency or personalized niche demands while still satisfying high-frequency behavioral needs and situations. This is crucial to avoid poor user experiences and investment losses associated with pseudo-demand products.

The high-frequency activities listed by Kim et al. (2015)—leisure, work, rest, and communication—will undoubtedly become the fundamental areas that need to be adequately addressed.

At the same time, this design direction needs to align with users' needs and wants. Different product features and interior design elements should be mapped to their corresponding levels within Maslow's hierarchy of needs.

3. Seizing opportunities in interaction feedback and physical interaction technologies

Based on the assignment goal of this project, which is to enhance user experience from the perspective of interior concept design with a focus on the interaction with physical product design, we will prioritize interaction technologies and physical interaction methods that provide specific feedback on the user's experience with the interior.

Technologies such as emotional monitoring, environmental control, and multimodal interaction will be key references. The remaining technologies will serve as support and inspiration for the overall concept.

4. Brand Analysis

4.1 The Company History

Research purpose

The purpose of the following chapter is to study the Xiaomi brand in order to effectively integrate it as a case study into the project. First, we need to understand what makes Xiaomi unique and identify areas where Xiaomi can improve, thereby creating value for the brand.

The company history

Xiaomi is a young consumer electronics company known initially for its smartphones. As of the first quarter of 2024, it has become one of the top three companies in global smartphone shipments and ranks first in China (About Xiaomi | mi.com, n.d.).

While we won't detail the complete history here, some key milestones in Xiaomi's development are presented in Figure 21, illustrating its significant growth.

Figure 21. The imortant milestones in Xiaomi's history

4.1 The Company History

The trend

Xiaomi announced its entry into the electric vehicle market in 2020 and officially launched its first car, the SU7, in 2024, marking its expansion into multiple fields. The company's history reveals two important development trends.

First, Xiaomi has evolved from its initial focus on smartphones to become a diversified technology company that includes laptops, smart home appliances, and smart vehicles, creating an all-round product ecosystem.

Second, Xiaomi has transitioned from primarily targeting the low-end market with competitive pricing to pursuing a path of product and brand premiumization, which was repeatedly mentioned in the 2023 annual speech press conference delivered by Xiaomi CEO, Jun Lei. Xiaomi has delegated the low-end market to its subsidiary, Redmi, while Xiaomi itself has embarked on a high-end journey, focusing on quality and service. This journey has been marked by collaborations with Leica, co-developing brand concepts with renowned Japanese designer Kenya Hara, and launching flagship products like the Ultra series to compete with tech giants such as Huawei, Apple, and Samsung.

 # Building all-round product ecosystem

#On the way of premiumization

4.2 Brand Value

Evolution of Xiaomi's brand value

Xiaomi has always positioned itself as a budget-friendly brand that makes users feel at home. Initially, its slogan focused on promoting a tech brand rooted in fan culture, named "Just for fans" (About Xiaomi | mi.com, n.d.). At that time, Xiaomi attracted a large fan base called "Mi Fans" with its low prices and high-value products. Unlike typical brand enthusiasts, "Mi Fans" were directly involved in product development. For example, Xiaomi's former smartphone operating system, MIUI, responds to "Mi Fans" feedback on a weekly basis, with updates released every Friday at 5 PM—a strategy that has been in place since Xiaomi's inception (Lee, 2021).

However, as its product range expanded and its audience grew, Xiaomi gradually transformed its brand value into providing excellent user experiences with approachable technology, aiming to enhance people's quality of life. Two new slogans created by the CEO, Jun Lei, are "Always believe that something wonderful is about to happen" and "Making quality technology accessible to everyone" (About Xiaomi | mi.com, n.d.).

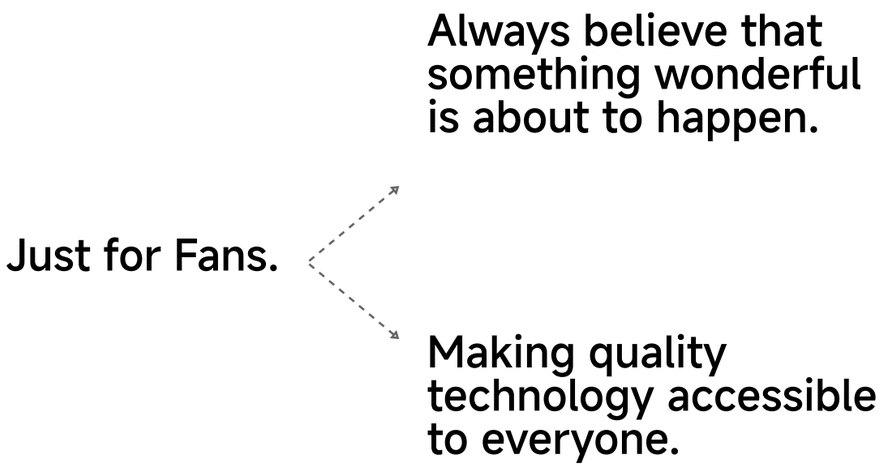


Figure 22. The evolution of Xiaomi' brand value

4.3 The Product

Figure 23. The minimal product semantics of Xiaomi's product

"Alive" design and the "Warm-Tech"

Intentionally or not, all products communicate their unique perspectives through design elements like shape, color, and texture, establishing a non-neutral dialogue with users. How designers utilize color, shape, form, and texture to convey information is part of a linguistic structure known as semantics, making the design process communicate with the user (Demirbilek & Şener, 2003). Unlike the sci-fi semantic approach adopted by many tech companies, Xiaomi consistently emphasizes "Minimal," "Simple," and "Clean" in its design language. This semantic approach is rooted in Kenya Hara's philosophy of "Alive," which he introduced to the brand in 2021. This philosophy suggests that technology is evolving naturally toward a form of life itself (Xiaomi Next 10 Years' Brand Identity, n.d.). Different from the purely high-tech or low-tech definitions, Xiaomi's product DNA can be summarized as "Warm-Tech".

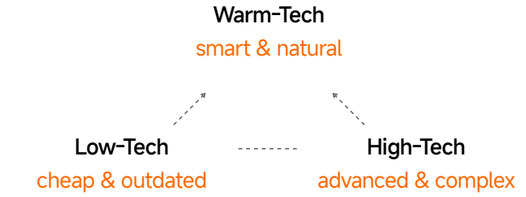


Figure 24. The concept of "Warm-Tech"

4.3 The Product

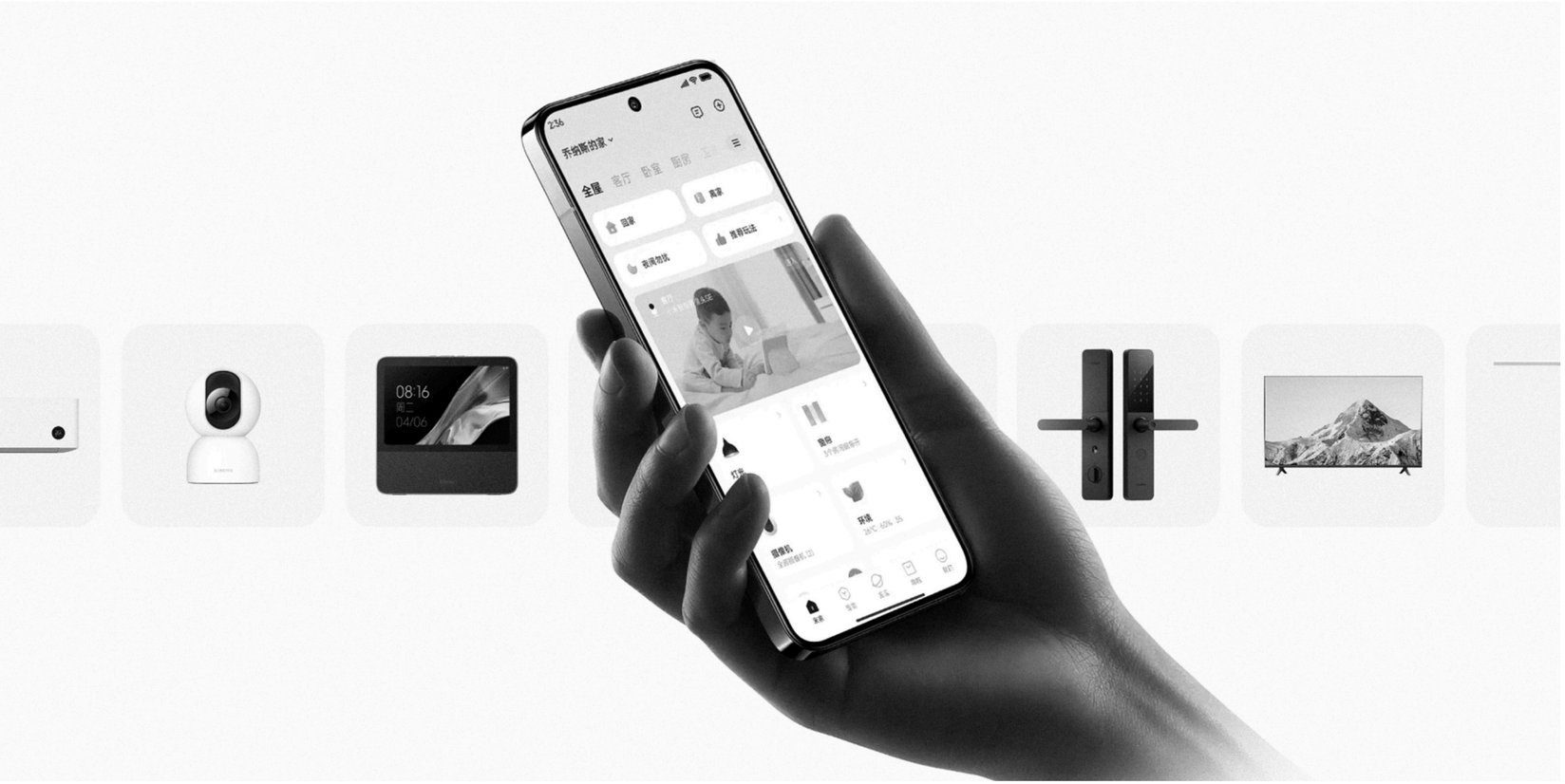


Figure 25. The IoT product ecosystem of Xiaomi

What makes Xiaomi unique

Xiaomi's unique advantage in the EV industry lies in its extensive and dominant IoT product ecosystem in the Chinese market, particularly through its sub-brand Mi Home, which includes numerous existing smart home products and an open-source connection platform for innovation (Xiaomi IoT Documentation and Resource Centre, n.d.). At the 2023 Xiaomi IoT Ecosystem Partner Conference, Xiaomi's President, Weibing Lu, announced that Xiaomi has built the world's largest consumer IoT platform, with a total of 655 million connected devices.

This platform has already been extended into the Xiaomi SU7, with features like the smart aroma diffuser and smart speakers (xiaomiev.com, n.d.).

This integration provides abundant opportunities for the development of Xiaomi EV's accessory products and novel in-car functionalities, further embedding the concept of living space into the car's interior.

4.4 Brand Identity & Image

Brand identity

Xiaomi has always aimed to be perceived as a friendly, approachable identity while also striving to be seen as a representation of technological pioneering (About Xiaomi | mi.com, n.d.). Indeed, Xiaomi has achieved significant success, market sales, and widespread attention in the fields of smartphones, smart home appliances, and smart devices, supported by its technological prowess and innovative products (Kim, 2018).

Figure 26. Illustration of brand identity and brand image (Jain, 2017)

Brand image

Despite Xiaomi's recent push towards high-end products, with significant improvements in the performance, quality, design, and service of its smart devices, and an increasing market share, the brand still faces polarization in public opinion (He & Sun, 2021).

Factors such as brand history, market competition, public perception, and cultural differences contribute to this polarization, resulting in extreme views of either admiration or criticism towards Xiaomi. In summary, while there are many loyal Xiaomi supporters, known as "Mi Fans," there are also many detractors, leading to a highly polarized image of the brand, with strong likes and concerns.

This polarization in Xiaomi's image stems from various factors. Based on literature and the comments surrounding Xiaomi's products on various social media platforms, we can summarize the following reasons.

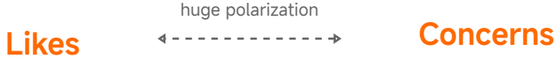


Figure 27. Highly polarized brand image

On one hand, Xiaomi's products are praised for their cost-effectiveness and user-friendliness (Kim, 2018). The innovative technology behind these products has also received positive feedback from users, such as the initial MIUI operating system based on Android (Sun & Fah, 2020). As a young and dynamic company, Xiaomi's product launches and promotional slogans are energetic, with a strong emphasis on customer feedback, which they continually use to optimize and upgrade their offerings (Lee, 2021). Additionally, many consumers appreciate the ability to build an IoT ecosystem with Xiaomi products in their homes or offices, allowing for seamless control of all appliances through their smartphones (EV Users Union-NetEase, 2024). Finally, Xiaomi's CEO, Jun Lei, has significant personal influence and popularity, boasting around 50 million followers across various social media platforms, making him one of the most prominent business figures with a substantial online presence.

On the other hand, the concerns surrounding Xiaomi can be attributed to several critical factors. Early iterations of Xiaomi products, particularly smartphones and home devices, were frequently associated with inconsistent quality, contributing to a perception of the brand as offering lower-tier products.

Furthermore, Xiaomi has been criticized for its perceived lack of innovation, primarily due to its initial reliance on external technologies and the absence of a distinctive design language, an issue that the company's CEO has acknowledged in several public statements (He & Sun, 2021). Additionally, Xiaomi's occasionally assertive marketing tactics, such as generating hype or making direct comparisons with competitors, have alienated some segments of consumers. Finally, as a prominent representative of a Chinese brand, Xiaomi continues to contend with international biases linked to the "Made in China" label, which is often unfairly associated with inferior quality (ITI Manufacturing, 2023).

Despite these challenges, Xiaomi has established itself as one of the most widely discussed technology companies. For instance, during the launch of the Xiaomi SU7, the Chinese automotive media platform Yiche.com reported that the product generated over 30 trending topics across various social media platforms in China. On the popular video-sharing platform Bilibili, it peaked at 17 million views, while on TikTok, it ranked as the most popular product during that time, amassing over 100 million views (Yiche.com, 2024).

4.4 Brand Identity & Image

Reason for likes

- Affordable
- Approachable
- Interesting technology
- Dynamic atmosphere
- Value the user feedback
- Always improving
- Convenient connectivity
- All-round ecosystem
- CEO's influence

Figure 28. Inventory of reasons for likes to Xiaomi

Reason for concerns

- Perceived variance in product quality
- Product image associated with lower-tier quality
- Opportunities for enhanced product differentiation
- Marketing efforts perceived as extensive
- Frequently juxtaposed with competitors
- Preconceptions associated with "Made in China"

Figure 29. Inventory of reasons for concerns to Xiaomi

4.4 Brand Identity & Image

What can be improved

Despite Xiaomi's ongoing efforts to enhance its in-house development capabilities, improve product quality and service levels, and establish its own product DNA, brand reputation is the result of long-term factors, reflecting the overall perception built over time (Veloutsou & Moutinho, 2009). As a result, it tends to persist longer than the actual facts.

In the context of the brand funnel, current consumers are often concentrated in the consideration stage or directly in the loyalty stage due to the public's polarized perceptions of the brand. Therefore, it is crucial to continuously enhance Xiaomi's image and recognition, attracting more users from the consideration stage to the preference stage.

In the macro level, this also represents a process of improving the overall image of "Made in China" products.

Figure 30. The brand funnel of Xiaomi

4.5 Insights of the Chapter

In the brand analysis of Xiaomi, we can clearly derive the following two insights:

1. Leverage the unique advantage in IoT product connectivity within the in-car space

Building on the previous chapter's research on NDRAs and product connectivity, we should continue to integrate Xiaomi's unique advantage in its IoT product ecosystem into the in-car environment. By aligning this integration with users' psychological and behavioral needs, as well as technological opportunities, we can optimize its application logic. This will also serve as a core element in highlighting Xiaomi's identity as the case study for this project.

2. Enhancing the brand Image and recognition through design concepts

Addressing each of the existing reasons for the negative perceptions ("concerns") individually is not feasible for this project. However, creating design concepts that resonate with consumers on a higher emotional and experiential level, guiding them to perceive Xiaomi's products and services as more premium offerings, is where this project can add significant value.

5. Insights Synthesis

5.1 The Internal Interview

The interview purpose

Now that we have completed the basic research and analysis phase, it is time to review and organize the findings to identify key insights.

First, to ensure the preliminary research findings align with the company's expectations, four interviews were conducted with senior automotive design experts from the Xiaomi EV design team, see Figure 31. Additionally, as previously mentioned, we validated and supplemented certain ideas from the analysis that lacked clear academic support, which have been presented earlier in the report.

During these interviews, we also discussed the direction for further design development, including refining and deepening the initial project goals.

The interview set-up

The interviews were conducted through online video calls, with each session lasting approximately 40 minutes. All human research activities for this project received approval from the TU Delft Human Research Ethics Committee (HREC), including methods for data collection, storage, and processing (see Appendix B for the specific documents). These interviews did not involve the collection of any personally identifiable information or personal privacy details. Before beginning the interviews, we had each participant sign an informed consent form (an anonymized version of the consent form can be found in Appendix C).

The four participants were senior employees from the Xiaomi EV design team: a product design expert, an exterior design expert, an interior design expert, and a strategic design expert.

Figure 31. The overview of participants

5.1 The Internal Interview

The interview process

1. Project introduction & interview purpose (3min)

Goal: A brief introduction to the project's topic, scope and current progress; also, inform the participants about the purpose of this interview.

2. Ice-breaking (3min)

Goal: Use some basic questions about in-car products to get the overviews of the participant, and to stimulate thinking.

- Do you regularly drive a car with smart features? (e.g., cars with intelligent driving, smart connectivity, built-in AI models)

- How often do you drive, and what is the purpose of your driving? (e.g., daily commuting)

- What in-car products do you have that can enrich in-car activities (whether pre-installed or optional accessories: such as physical AI assistants, in-car refrigerators, etc.)? How often do you use them? How is your experience using them?

3. Review and validate the research on NDRAs and user needs (6min)

Goal: Have participants immerse themselves in the project's research process, discuss and evaluate the insights we obtained, and provide expert opinions and feedback on the NDRAs and needs analysis, as well as revise or supplement these findings in alignment with the scope of this study.

- According to literature research, Kim and others summarized user non-driving activities in L3 autonomous vehicles. Please immerse yourself in the scenario, and based on your knowledge and experience, discuss and express your agreement, doubts, or additional insights regarding these activities. (Show the analysis of Kim's research to the participant.)

- According to literature research, Lee and others summarized the 12 core needs of users in fully autonomous vehicles (L5). Based on the characteristics of L3 vehicles, I have extended, adjusted, and supplemented each need. Please immerse yourself in the scenario, and based on your knowledge and experience, discuss and express your agreement, doubts, or suggest additional needs. (Show the analysis of Lee's research to the participant.)

4. Review and provide insights on connectivity (3min)

Goal: Have participants provide expert opinions and feedback on the development and trends of smart connectivity of the cars, as well as revise or supplement these findings in alignment with the scope of this study.

- Based on research, the current smart connectivity features of cars are still in a specialized functionality stage (e.g., remote control of the car via smartphone, car control of smart home devices, AI assistants controlling the car, cars recognizing regions and automatically initiating "home mode", etc.), with distinct barriers between different scenarios. In your opinion, what is the next step in the development and trends of smart connectivity of cars and other scenarios like home and office? (Show the analysis of the research of connectivity to the participant.)

5. Review and evaluate the insights on brand analysis (5min)

Goal: Explain to the participants the brand analysis process and results, with the goal of enhancing Xiaomi's user recognition and brand image. Have participants, from an expert perspective, review whether these align with the company's goals and suggest what metrics and key elements should be considered to enhance brand recognition, providing tone references for the subsequent design vision.

- When it comes to enhancing brand image, what keywords or key metrics come to mind for you (e.g., luxury, creativity, progression, stability)?

6. Free discussion and questions (15min)

Goal: Provide the participant with an opportunity to add and share any additional insights or thoughts on the topic.

5.1 The Internal Interview

The results

After the interviews, the supplements and validations to the literature research have already been presented earlier in the text, so they will not be elaborated upon again here.

The participants highlighted the importance of "Creativity," "Culture," "Quality," and "Emotional Values" as key indicators for enhancing brand image. Given that this project is a design exploration, "Quality" may be relatively difficult to validate in the subsequent design output, but the other three keywords will serve as crucial guiding elements for the design vision.

Keywords for enchancing brand image

 # Creativity

 # Culture

 # Emotional values

The "Refreshing" experience

Furthermore, after conducting research and analysis, we have gained a deeper understanding and more specific requirements regarding the assignment goal of enhancing user experience. In this project, we aim to propose a "Refreshing" user experience.

"Refreshing" aligns with Xiaomi's Alive design philosophy, incorporating emotional features, and seeks to create a concept that not only makes users feel refreshed within the car but also revitalizes Xiaomi's image in the industry, thereby inspiring the design team.

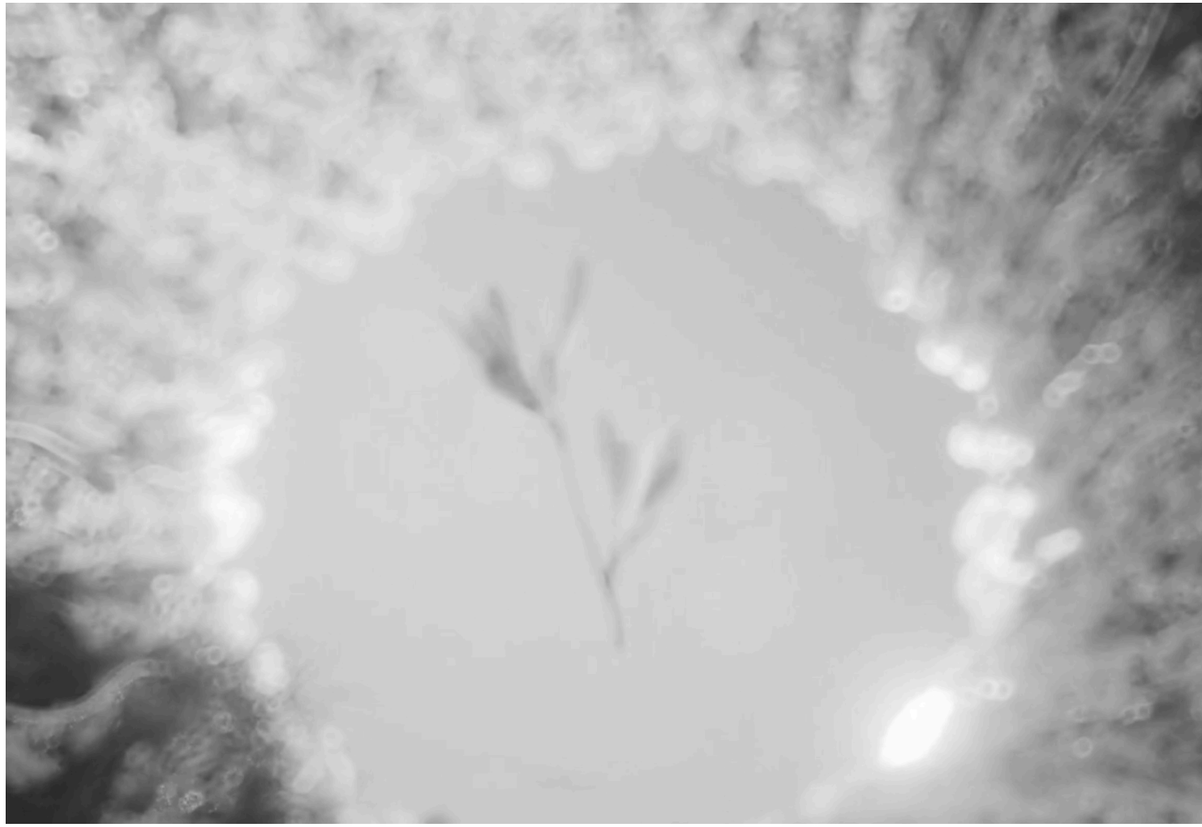


Figure 32. Image of "Refreshing"

5.2 Conclusions

The conlusions

Now, we can synthesize the insights from the entire analysis part. It is worth noting that the nature of this project is conceptual exploration in design, rather than a strict problem-solving or step-by-step research-driven project. Therefore, the research conducted during the analysis phase does not necessarily correspond directly or causally to the subsequent design vision. However, it provides solid support and broadens the perspective, ensuring that the vision is neither too subjective nor too biased.

Consequently, we have identified three key conclusions.

1. Integrating product potential with interior design considerations

During the interior design phase, while considering the form, CMF, and interaction within the mobile space, the potential for a new product should also be explored to better align with the NDRAs and identified needs.

IoT product connectivity will serve as a key emphasis in design considerations under connectivity needs, highlighting the brand's identity and strengths.

2. Possibility of leveraging co-Idea for tailored NDRAs and user needs

Since it is difficult to meet all NDRAs within a single mobile space, we should prioritize fulfilling the needs of high-frequency activities while also exploring opportunities for unique activities.

How can we then utilize product connectivity to cater to niche demands? One promising approach is to engage users in a collaborative process, creating a co-idea platform that aligns with specific product and functional needs.

In the book Convivial Toolbox, it is noted that everyone has creative potential and can be guided by professional designers to participate in the ideation process. Designers are gradually shifting from being the "Creators of Ideas" to becoming "Translators of Ideas," guiding people in uncovering their own concepts (Sanders & Stappers, 2013). This is the essence of the co-idea process.

In our project, encouraging users to co-ideate the NDRAs that could take place within their vehicle during or after the car purchasing process, and then tailoring product connectivity to these unique activities, may present a novel approach. This approach could distinguish itself from existing business models and generate new value.

3. Create for "Wants"

To further support Xiaomi's premiumization and enhance its brand image, we need to focus on design innovations that emphasize creativity, culture, and emotional values. In terms of user needs and wants, this project will concentrate on addressing higher-level psychological demands, such as esteem and belonging. The subsequent design vision will follow this direction, prioritizing the creation for wants.

5.2 Conclusions

1

Design for mobile space

Systematically consider aspects of Form, CMF, Interaction, Connectivity.

Product connectivity as the key

Product connectivity will serve as a key emphasis in design considerations under connectivity needs, highlighting the brand's identity and advantages.

2

Find meangingful experience

With a priority on meeting the needs of high-frequency activities, then consider creating opportunities for unique activities.

Opportunities for co-idea model

It's essential to avoid creating fake-demand products that fail in the market for the majority of users. On the other end of mass production, perhaps personalizing based on the users' own desired experiences and functionalities through co-idea could be a promising concept.

3

Enhance brand image

On the way to premiumlization, enhance brand recognition and image.

Create for "Wants"

Aiming the design priorities towards mid to high-level needs.

belonging, esteem
...

Figure 33. The illustration of three conclusions from the analysis

Part C : Vision

Now, it's time to look towards the future by immersing ourselves in the in-car scenario from a designer's perspective, and thinking about how to create a refreshing and innovative experience.

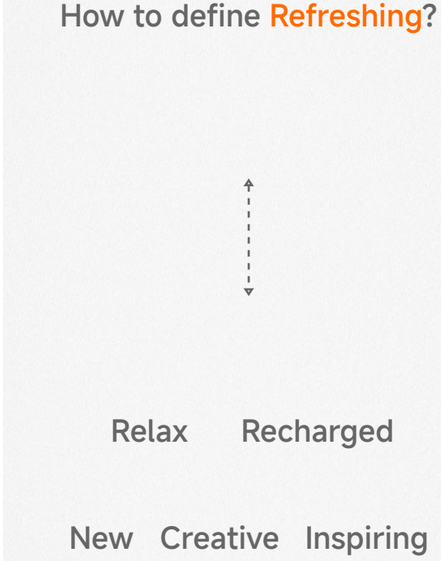
6. Vision

6.1 Define

How to define "Refreshing"?

A refreshing in-car user experience must be built on a meaningful foundation. "Refreshing" does not imply creativity that is detached from reality or disconnected from the user's needs and context. Instead, it involves creating a highly positive emotional experience. To achieve this, we need to identify the emotions within the mobility context that we can tap into and leverage.

According to dictionary definitions, "Refreshing" emphasizes its emotional value, offering a sense of feeling less tired—essentially recharged and relaxed. Additionally, "Refreshing" also relates to the inspirational aspect of encountering something new, leading to feelings of being inspired and creatively stimulated.



The mobility context

To create such experience, we first need to understand the emotional values within the mobility context of this project as the entry point.

Based on our previous analysis, we can narrow our focus to the specific scenario of commuting between the office and home in first-tier cities in China, with the car serving as the medium of mobility, the mobile carrier transporting in the physical words.

In this context, several factors can influence emotions. Research shows that the majority of young people in first-tier cities primarily settle through renting, which often means that the property, furniture, and layout are fixed and belong to the landlord or the rental platform. This leaves renters with limited opportunities to create a personalized, cozy atmosphere that feels uniquely theirs. Additionally, the instability of renting is further exacerbated by the frequent need to move, contributing to a sense of impermanence and lack of control over their living environment.

On the other hand, the office environment introduces its own set of emotional stressors, including the burden of heavy workloads and the intense pressure of workplace competition. Additionally, in the high-pressure environment of a large city, factors such as job changes, layoffs, and transfers contribute to a sense of instability and uncertainty in one's professional career, as illustrated in Figure 33.

The emotion

To summarize the emotional factors present in the two scenarios described above, we can observe that people, whether at home or in the office, often experience a sense of instability and anxiety, accompanied by a feeling of chaos due to the lack of orderly control over their circumstances. In a single word, they are in a negative state of flux, as illustrated in Figure 34.

6.1 Define

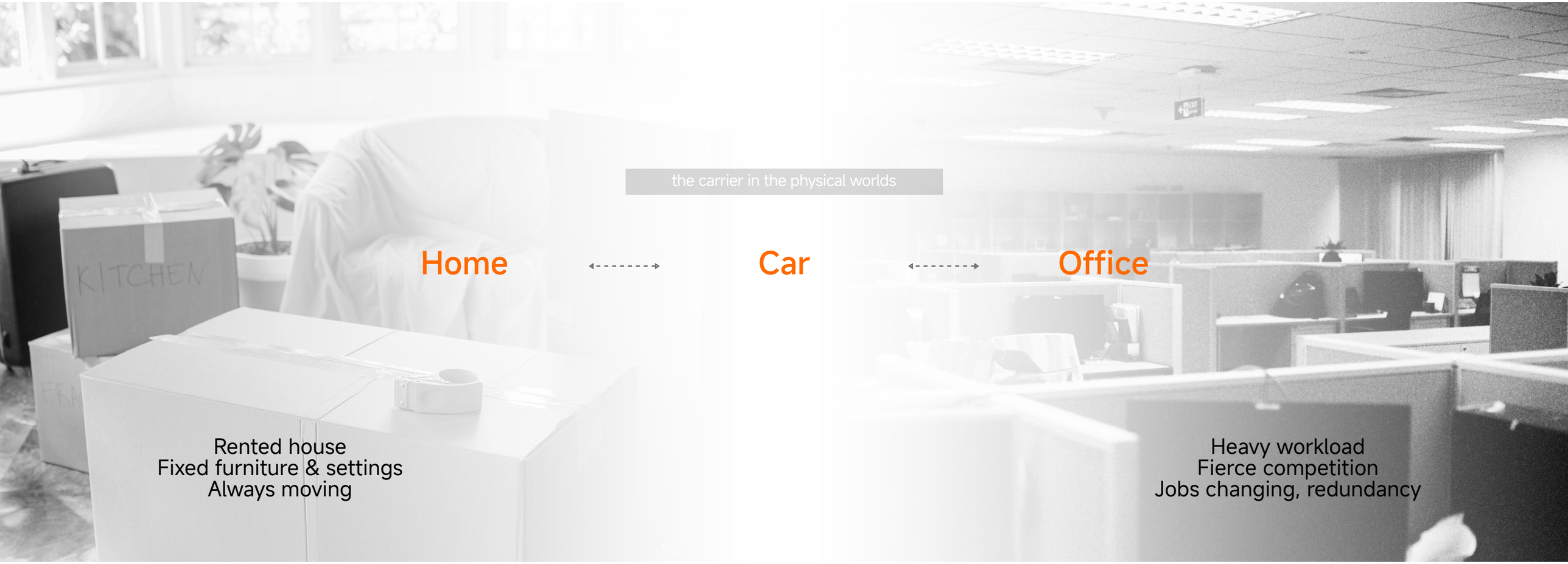


Figure 34. The illustration of the mobility context

6.1 Define

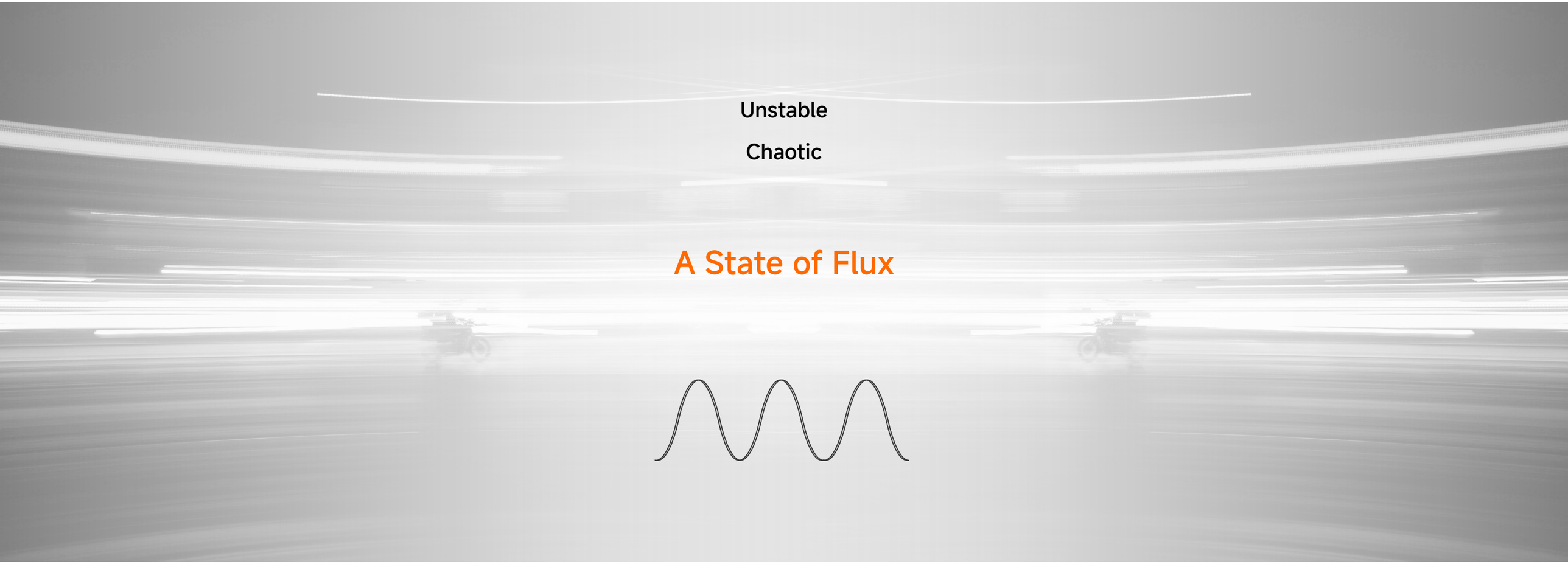


Figure 35. The illustration of the emotional state of flux in the mobility context

6.1 Define

The solutions

Creating a refreshing experience requires alleviating the negative emotions associated with this state of flux.

Firstly, the goal is to make the user feel stable—transforming the car into a mobile space that feels welcoming and belonged, a place that truly supports the user, allowing them to fully relax and find solace.

Secondly, it's essential to help the user feel not chaotic—turning the car into a space where they have the freedom to lead a orderly life and experience a sense of control.

These solutions can be summarized as creating a sense of belonging.

A key aspect of a sense of belonging is the feeling of affinity toward a particular place. In this context, we elevate the concept of the car to become the user's home on the move, serving as a sanctuary for the mind. The car, therefore, not only acts as a physical vehicle providing transportation and living space in the real world but also becomes a mobile carrier offering a sense of belonging in the mental and emotional realm, especially in the state of flux.

Figure 36. The illustrations of solutions to alleviate negative emotions

6.1 Define

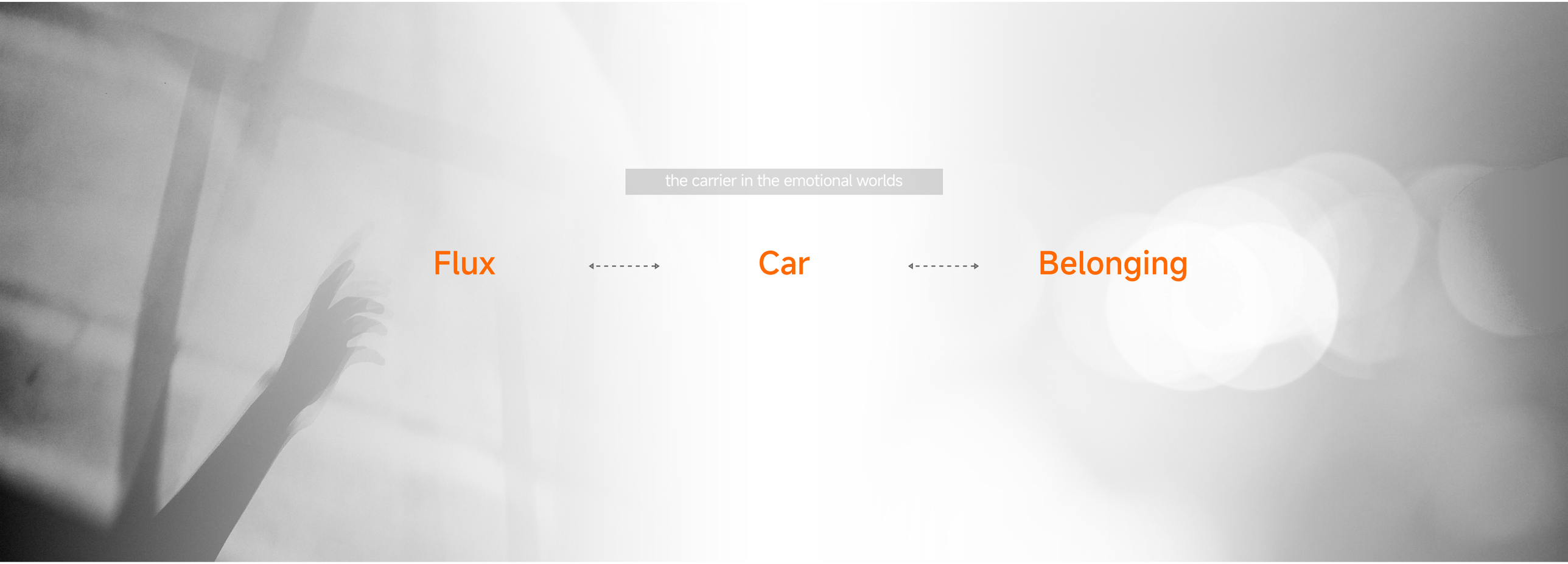


Figure 37. The illustration of the car as a carrier of creating a sense of belonging in the state of flux

6.2 Mission Statement

"I envisioned the car interior as a sanctuary, offering a sense of belonging amidst the flux of physical and emotional worlds."

Thus, we have formulated the mission statement for the design vision of this project, as described above. We now have our primary guideline to pursue and have addressed the foremost consideration in creating a "Refreshing" experience. The creation of a sense of belonging, as a pursuit of higher emotional needs, aligns with our previous conclusion to "Create for Wants."

However, as previously mentioned, crafting a "Refreshing" experience also requires making the user feel inspired and infused with creativity. This aspect will be integrated with the earlier analysis insights and will continue to be reflected in the subsequent specific design concepts. With this foundation in place, we are now ready to present the design concepts.

心流绿洲

FLOWING OASIS

Figure 38. The mood image of "Flowing Oasis" concept

6.3 Concept

Introduction

Flowing Oasis is a car interior design concept centered around a co-idea in-car product ecosystem, offering users a sense of home and belonging amidst the flux of daily life.

The name "Flowing Oasis" embodies two key concepts. "Flowing" signifies the mobility and fluidity represented by cars, while "Oasis" serves as a metaphor for a sanctuary in the desert, symbolizing a refuge and sense of belonging in a state of flux within the mind. This concept will permeate the brand identity, user experience, and business strategy, creating a cohesive system of innovation that forms a closed loop.

Given that the focus of this project remains on the design of a tangible product (automotive interior) and considering the nature of this master's program in Integrated Product Design, the user experience aspect of the system will be developed into concrete design outputs. Meanwhile, the business strategy and brand value innovation will remain at the conceptual vision proposal stage, serving to inspire further thinking and innovation for the company.

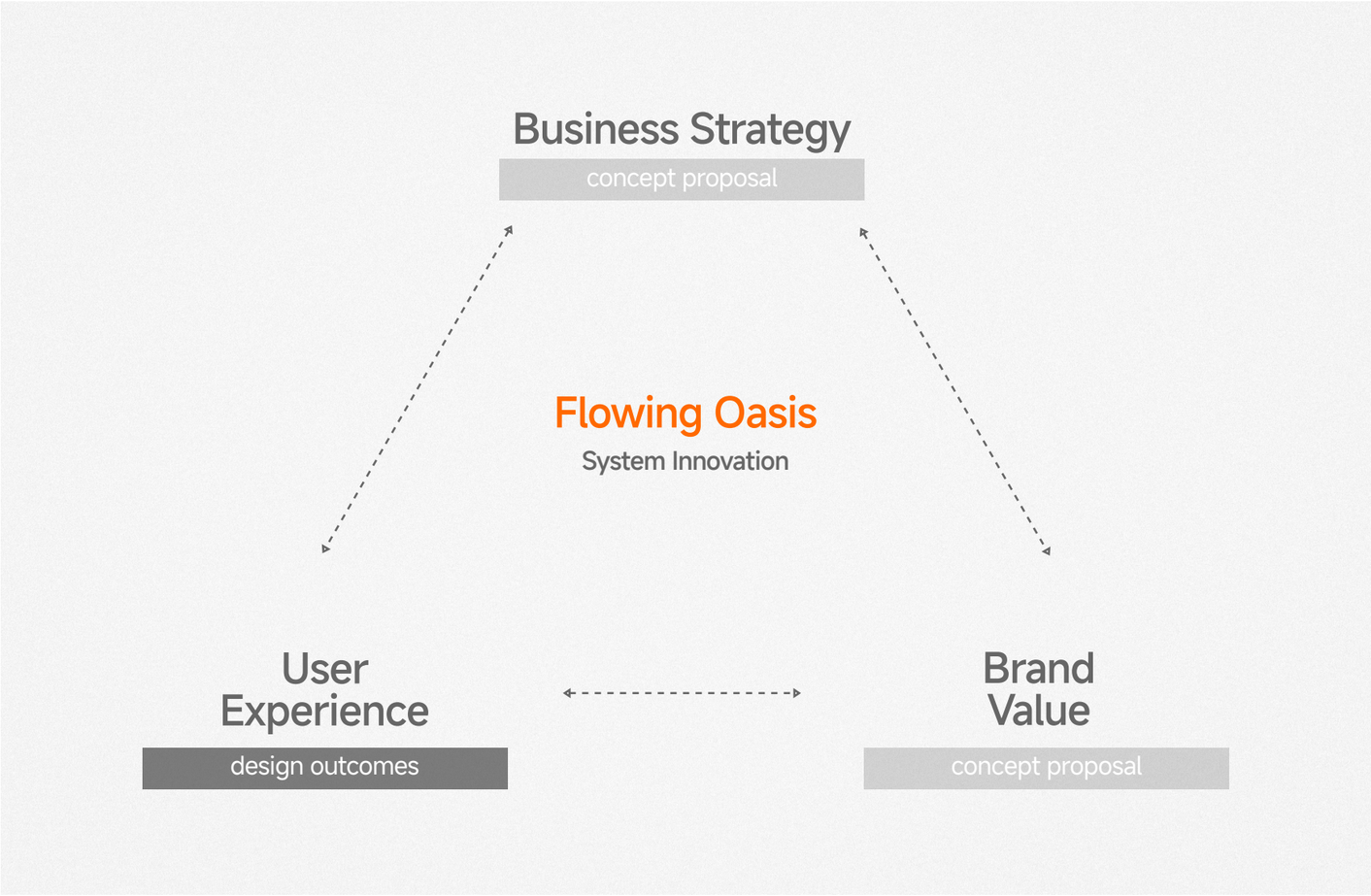


Figure 39. The illustration of the system innovation structure

6.4 System Innovation

Buniess strategy

Co-idea creation

This concept aims to propose a co-creation business platform for an IoT in-car product ecosystem, called the Oasis Platform. Users can participate in co-creative services organized by Xiaomi both before and after purchasing a vehicle, customizing in-car products based on their unique needs, habits, and preferences.

Under this business model, the traditional push economy—where manufacturers release products for users to choose from—is transformed into a co-idea model, allowing users to actively participate in the creation process.

For products within the Oasis platform, Xiaomi can continue its current strategy by expanding and launching official in-car connected products tailored to common high-frequency needs (e.g., leisure, work, rest). Additionally, it can introduce products integrated into car components. Xiaomi can also offer modifications to traditional home products to ensure they are ergonomically and safely usable inside the car.

Furthermore, the Oasis platform will be open-source to third-party developers, allowing users to integrate third-party products and functionalities into the vehicle via connectors designed by external manufacturers. Additionally, users will have the option to create DIY solutions, 3D printing connectors either online or at Xiaomi's offline stores, enabling them to link external products into the car ecosystem seamlessly.

Finally, it is worth mentioning that the co-idea creation process is a business service designed to offer customization for users. Xiaomi's vast IoT ecosystem, along with its robust supply chain and manufacturing capabilities, provides the foundation to support such a service. Although this form of customization is more simplified and cannot be compared to the bespoke services offered by high-end brands like tailored suits or Rolls-Royce customization, it represents a significant step toward premiumization in the consumer electronics indsutry. Offering customization at this scale is a strategic move by Xiaomi to elevate its brand towards a more premium positioning.

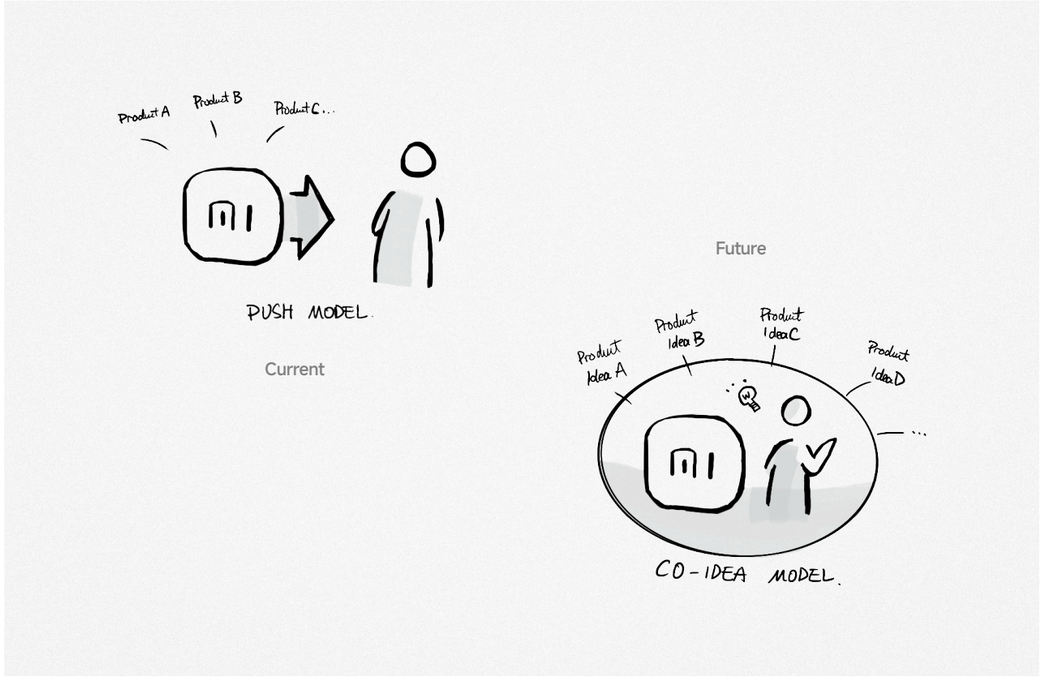


Figure 40. The illustration of co-creation bussiness strategy innovation

6.4 System Innovation

Buniess strategy

Process flow

This strategy cleverly integrates the co-idea service into both the initial car-buying experience and the ongoing customization of new products by users.

Since not all products can seamlessly fit into the car's ergonomic and structural design, the system introduces a modular base product that serves as the foundation for assembling various accessories. This modular base allows for easy integration of different products into the car's interior, ensuring compatibility and functionality. This concept will be further discussed in the following sections. The entire user participation process is illustrated in Figure 41.

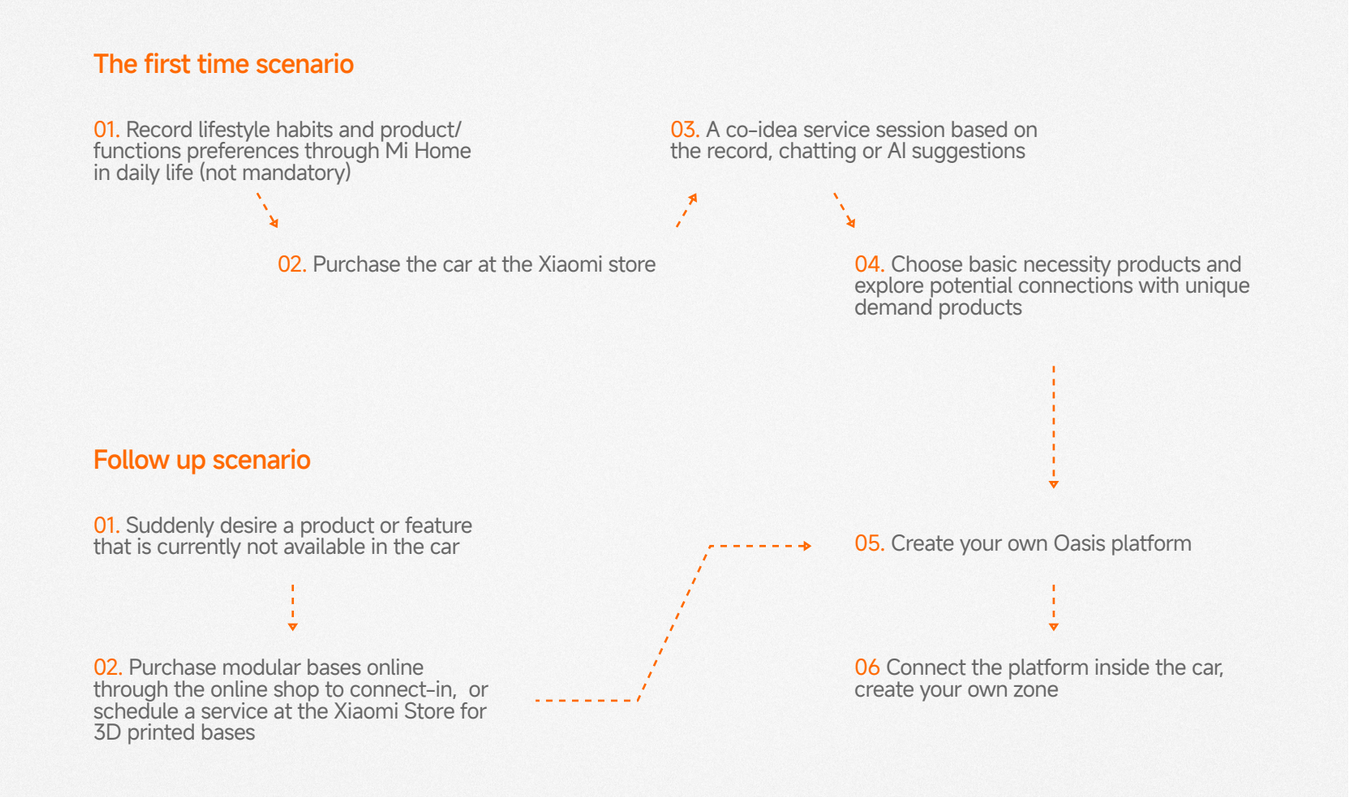


Figure 41. The process flow of user participation in the Oasis platform

6.4 System Innovation

User experience

Integrated modular connection

In the current car interiors, in-car products are often placed chaotically, connected via various cables and interfaces, which not only create safety hazards but also present ergonomic issues. To support the future integration of more functions and behaviors in the car, a more integrated and safer design will significantly enhance the user experience. It will also create a more visually unified and orderly car interior, offering a fresh and modern appeal. Since products come in various shapes and structures, a modular universal connecting base is an ideal solution.

This concept proposes the introduction of small (S), medium (M), and large (L) modular bases with adjustable connectors to accommodate products of different sizes. The S size base will be suited for small products, providing convenience in usage and easy placement. The M size base will support medium-sized products, balancing stability with accessibility for passengers. The L size base will be designed for larger products, with connection points located in areas of the car that offer more space and flexibility.

The modular base concept also considers different connecting methods depending on the product's origin, whether it's from Xiaomi or a third-party developer. The specifics of these connection mechanisms will be further developed and illustrated in the subsequent design phases.

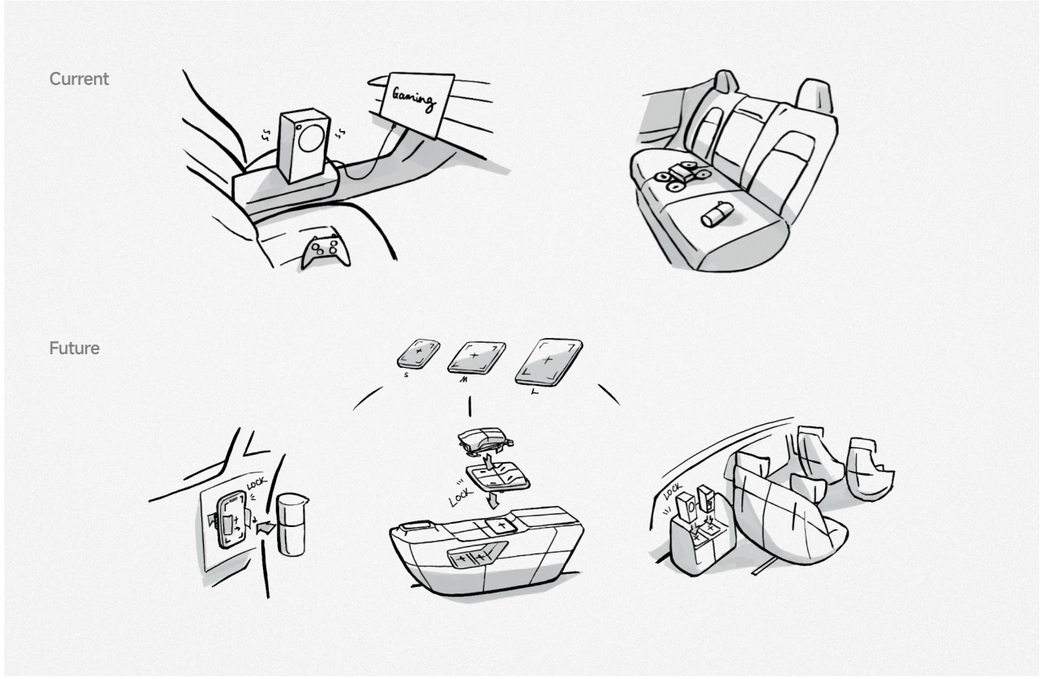


Figure 42. The illustration of the in-car product integration

6.4 System Innovation

Brand value

Emotional perception

With the design concepts of the co-idea business model and the modular base connection, we have developed a relatively mature product design system. However, how can we further elevate Xiaomi's brand value and enhance the storytelling power through design?

The in-car living space and product ecosystem of the Flowing Oasis align with Xiaomi's Alive design philosophy, aiming to create the concept of an "Oasis as a Combination of Life." The car and all connected products are no longer cold, lifeless machines, but smart objects that align with the "Warm-Tech" concept, embodying a sense of life and breath.

In terms of design implementation, the car is able to sense the user and provide emotional feedback tailored to individual preferences. First, through hardware like thermal cameras and software AI from the Mi Home ecosystem, the system can detect the user's preferences, such as the car's AC temperature, seat firmness and position, as well as preferences for connected products like ambient lighting, aroma diffuser intensity and scent, and coffee machine flavor. All these settings are intelligently adjusted without the user needing to speak or operate any controls.

Additionally, the car can monitor both the external and internal environment in real time through various sensing technologies. It tracks external conditions such as the environment and road conditions, and also detects the user's facial expressions and emotions. Based on this information, the car adjusts its functions and settings to emotionally respond to the user in real-time.

All of these sensory interactions are triggered with a sense of ritual when the user places their phone on the charging pad upon entering the car, after having set up their personal Oasis platform. This action ceremonially initiates the personalized, emotionally responsive in-car experience.

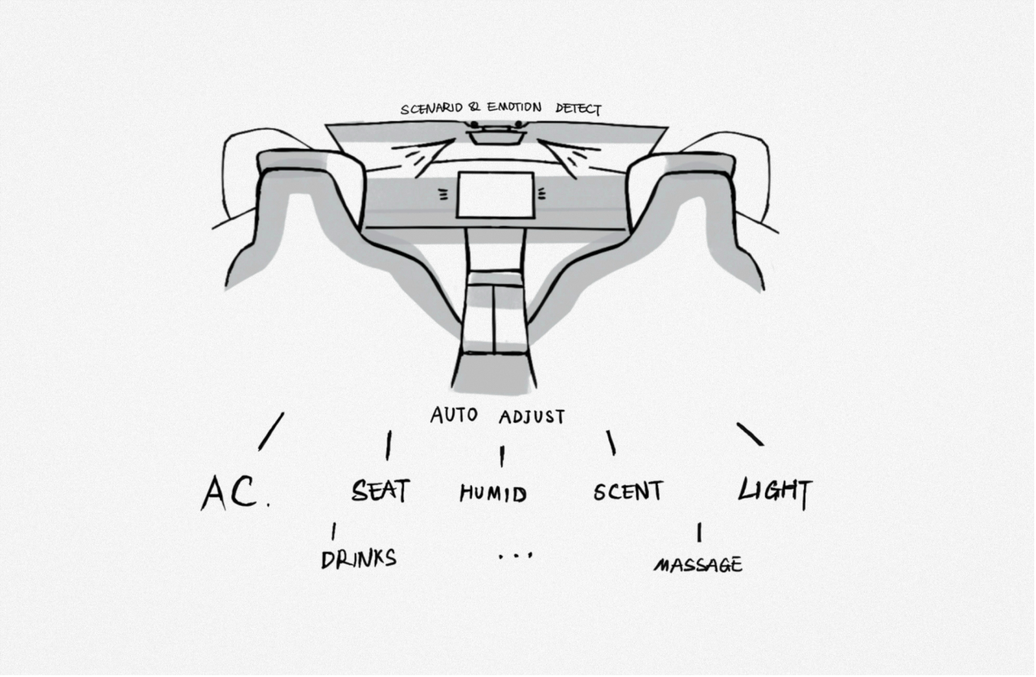


Figure 43. The illustration of the "Alive" emotional perception

Part D : Design

With a clear vision in place, we now move into the most exciting phase: design. From defining the car's configuration, identifying product touch points, and establishing the overall style, to creating ideation sketches, CAD modeling, and 3D visualizations, a novel design will come to life before our eyes.

7. Design

7.1 Configuration

The vehicle type

First, we need to identify the target vehicle model. Considering a three-year timeframe, we will conceptualize based on Xiaomi EV's current platform. This is an electric vehicle architecture featuring an 800V high-voltage battery, a motor exceeding 20,000 RPM, and integrated large-scale die-casting technology (xiaomiev.com, n.d.).

The project aims to propose a vehicle model for Xiaomi that differs from the SU7 (a coupe sedan), serving as a concept for the company's model innovation. At the same time, this vehicle needs to provide ample interior space to meet users' in-car needs. Additionally, the model should further emphasize a sense of premium, aligning with the previously stated goals of continued high-end positioning, upgrading brand image.

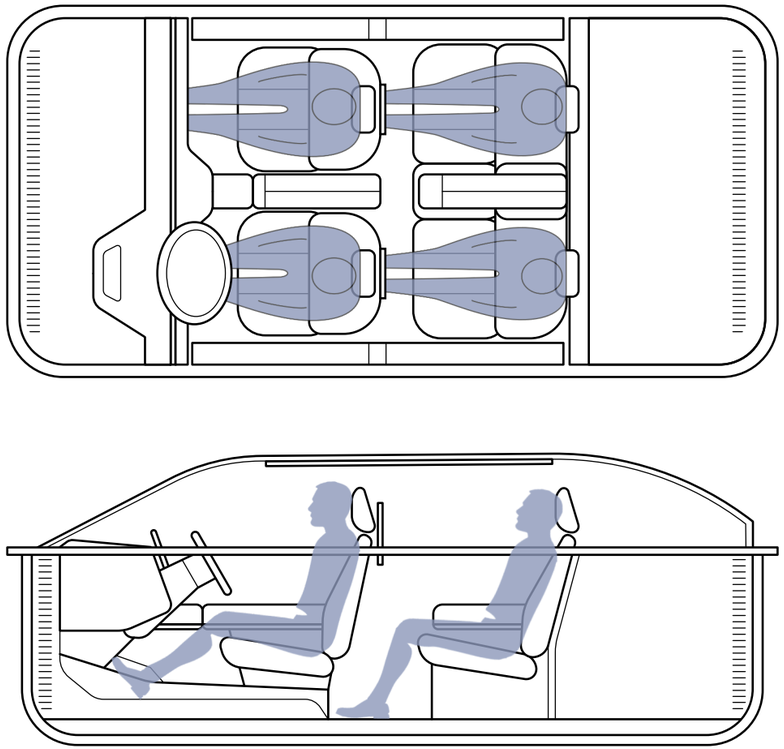
Therefore, a four-seater touring wagon would be a suitable choice. Such a vehicle would be able to accommodate urban commuting as well as the multi-scenario demands typically associated with SUVs, while also featuring an open trunk space. However, the interior design concept proposed here can also be adapted for other vehicle types if necessary.

The package

EVs, transitioning from traditional mechanical to electrical drivetrains, feature electric motors that independently control the torque and speed of each wheel using a single-speed transmission system. Furthermore, EVs utilize Battery Energy Storage (BES) systems instead of traditional internal combustion engines. Typically positioned lower in the vehicle chassis, these systems allow for a cleaner layout, flatter platform and more flexible interior design options, contributing to a lower centre of gravity (Sahoo et al., 2021).

Since this is a pure interior design concept, we are unable to conduct a comprehensive package analysis or determine the full dimensions for a complete vehicle, including the exterior. Therefore, we will use a so-called "Box" to represent the interior space. The package and dimensions for this project are defined based on an extended wheelbase that is slightly longer than the approximately 3000mm wheelbase of the SU7.

This approach will influence the parameters used in the subsequent CAD model. The specific package and dimensions of the "Box" are illustrated in Figure 44.



length: 4060
width: 1956
height: 1540
wheel base: 3100

Figure 44. The package and dimensions of the interior sapce (mm)

7.2 Product Touch Points

Potential interaction touch points

Building on the package configuration, we can conduct an analytical summary of the interaction touch points for in-car connected products within the vehicles, which can be broadly categorized into eleven areas (A to K), as shown in Figure 45.

A. Central and right areas of the IP

Targeting interaction with passengers in the front passenger seat, particularly in left-hand drive vehicles.

B. Central display area

Primarily aimed at front-seat passengers, facilitates both software and hardware interaction through the central touchscreen.

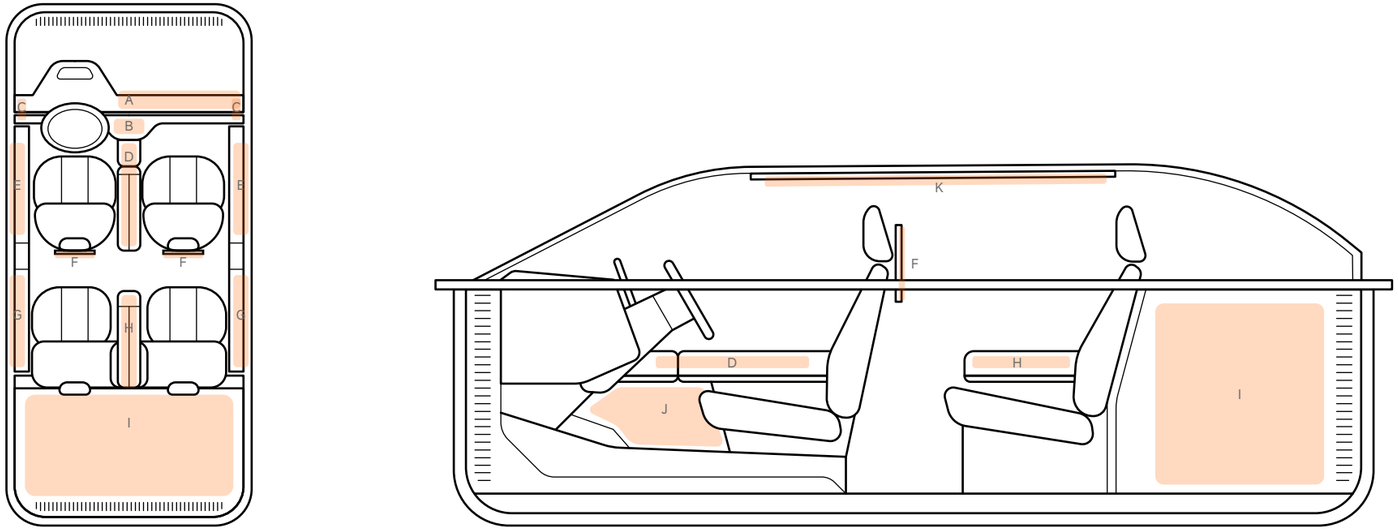


Figure 45. The potential touch points for product interaction in the car interior

7.2 Product Touch Points

C. Corners on either side of the IP

Targeting front-seat passengers, facilitate interaction with components of both the adjacent front doors and the IP area.

D. Front console

Serving both front and rear passengers, offers the richest opportunities for physical interaction, storage space, and hardware expansion, significantly influencing the layout and packaging design of the front area.

E. Front doors' side plates

Which also serve front-seat passengers, offer potential beyond traditional components like door switches, window controls, and seat adjustments for diverse product and feature expansions.

F. Behind the front seats

Targeting rear-seat passengers, holds potential for a variety of product and feature expansions.

G. Rear doors' side plates

Like the front, serve rear-seat passengers and offer potential beyond traditional components for diverse product and feature expansions.

H. Rear console

Mainly for rear-seat passengers, can be a fixed console or a folding design, offering rich opportunities for physical interaction and hardware expansion, crucially affecting the layout and packaging design of the rear area.

I. Back trunk space

Targeting rear-seat passengers, holds potential for a variety of acitivities, product and feature expansions.

J. Under the front console

Mainly for front-seat passengers, offers ample and flexible storage space with potential for diverse product and feature expansions.

K. Ceiling

Serving both front and rear passengers, especially in conjunction with the sunroof system, holds potential for diverse product and feature expansions.

It should be emphasized that this analysis is based only on references from the package layouts, and subsequent ideation processes in the project will have flexible opportunities to move beyond these categories. In addition to the touch points above, major components such as rear seats, which include folding or sliding features that create new spaces, offer the potential for more diverse product touch points.

7.3 Moodboard

Visual style

We are now entering the styling exploration phase, where we will refine the overall design language of Flowing Oasis before moving into the ideation stage. To create a sense of home, Flowing Oasis will adopt a cozy, comfortable, minimalist, and modern visual style inspired by home interiors. The semantics of the interior components and products will align with the overall visual language, aiming to be understated yet refined, avoiding excessive flamboyance while still maintaining a sophisticated attention to detail.

The form

As mentioned earlier, one key characteristic of a sense of belonging is making people feel less tired, thus relaxation and comfort are essential requirements for the product form. Rounded edges, soft shapes, and simple yet orderly designs will be the key design principles for Flowing Oasis.

The colour

Flowing Oasis will adopt a minimalist, low-saturation color palette, including shades such as gray, metallic tones, brown, wood, and white, ensuring that the design does not create visual clutter or dominate the visual focus. Additionally, the use of green in select, refined details will evoke the imagery of oasis plants, while subtly introducing a refreshing feel. This thoughtful touch will serve as the finishing element that enhances the overall design.

The material and texture

Flowing Oasis will thoughtfully pair materials based on the characteristics of each component, such as softness, firmness, durability, and skin-friendliness.
A home-inspired design cannot be achieved without incorporating a mix of knitted fabrics, metal, and wood. To introduce a fresher texture, Flowing Oasis will replace traditional leather seats with 3D knitted fabrics, enhancing the overall tactile experience.

In terms of component details, more textured elements will be added, such as metal ring patterns, canvas textures, and fabric stitching, to enhance the overall tactile quality and visual richness.

The atmosphere

A warm and cozy atmosphere will be a key factor in creating a sense of belonging, and the use of warm-toned lighting that simulates a home environment will be extensively applied throughout the interior space.

The analysis above contains a certain level of abstraction and subjectivity. To better convey these concepts, we referenced a wide range of home products, architecture, and interior design to create a mood board that encompasses visual style, form, colour, materials, textures, and atmosphere. This mood board, presented in Figure 46, is intended to directly communicate the results of the analysis and help solidify the design style before moving into the ideation sketch phase.

7.3 Moodboard

Figure 46. Moodboard of the Flowing Oasis concept

7.4 Ideation

Ideation sketch

With all the preliminary elements in place, we now move into the ideation sketch phase. During this process, numerous sketches are created and iterated upon. In addition to form design, this phase also clarifies specific product interaction methods and functions, showcasing several examples of how IoT products connect within the vehicle, as well as the modular base's form logic.

The sketching process is divided into early sketches and final sketches. The early sketches contain a broad exploration of immature ideas and selections, with an overview of the iteration process presented in Figure 47 and 50. The final sketches, on the other hand, focus on the core design outcomes following the selection process, represented as key sketches, as shown in Figures 51 and 52.

Four main design objects

Since the interior is essentially a collection of various products, this concept divides the design into four major modules for creative exploration.

After discussions and considering the workload and the focus on NDRAs and IoT product connectivity, the decision was made not to address the IP and steering wheel area in this concept. Instead, the emphasis will be on in-depth design for the following areas: seat design, front and rear console design, side plate design on the rear doors, and the back trunk.

Seat design

For seat design, traditional elements are innovated based on the style and material choices derived from the mood board. At the same time, essential design details such as seat adjustment buttons, seatbelt buckles, and headrests are integrated into the overall concept.

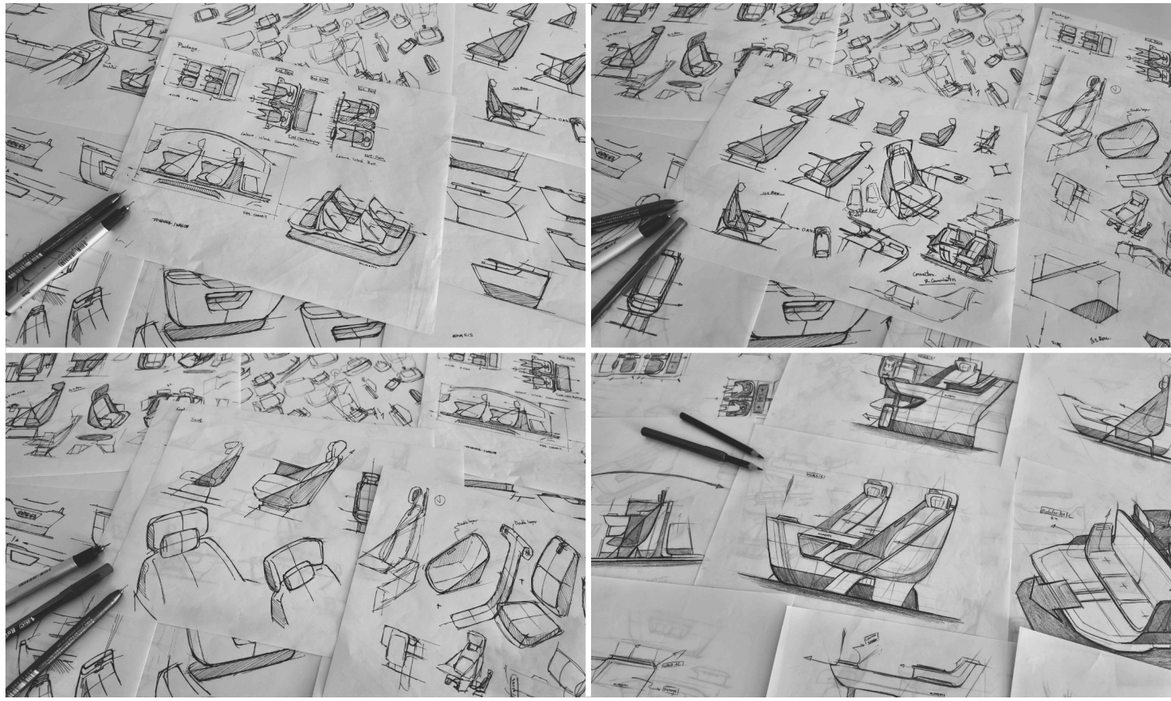


Figure 47. The early sketches of the ideation iteration (package, seats)

7.4 Ideation

Console design

In the front and rear console designs, the original Flowing Oasis theme—based on the visual elements of a plant oasis—is consistently incorporated. This includes the "Oasis Cave" inspiration reflected in the hollow design of the console and the "Flowing Island" idea, expressed through the undulating surfaces that rise at varying heights. Additionally, the consoles contain multiple interaction points for connected products.

Figure 48 and Figure 49. Visual elemetns reference of "Oasis Cave " and "Flowing Islands"

Side plate design

The side plate design is informed by common activities identified in the NDRAs, such as work, leisure, and rest. This results in features like a foldable table, a cup holder for coffee, and interaction points for connected products.

Back trunk design

In the back trunk design, the primary concept is to create a versatile space where large L-size products, such as a coffee machine or gaming console, can be efficiently stored. This area is envisioned as a prime location for product placement, enabling users to access and use these devices directly from the trunk while in park mode, enhancing the overall user experience.

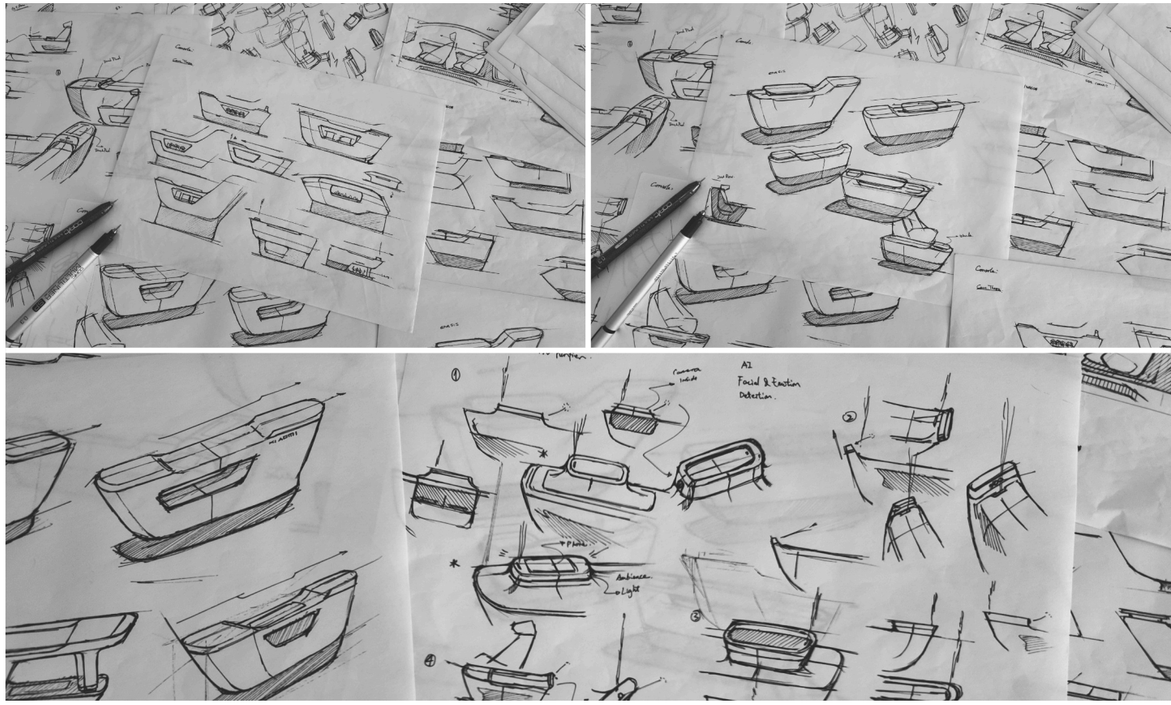
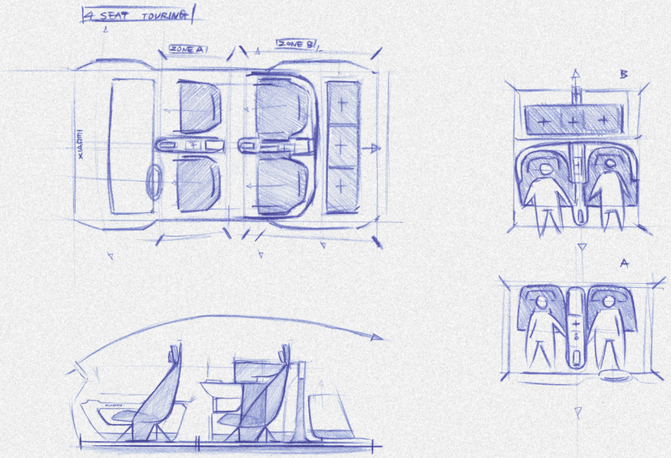
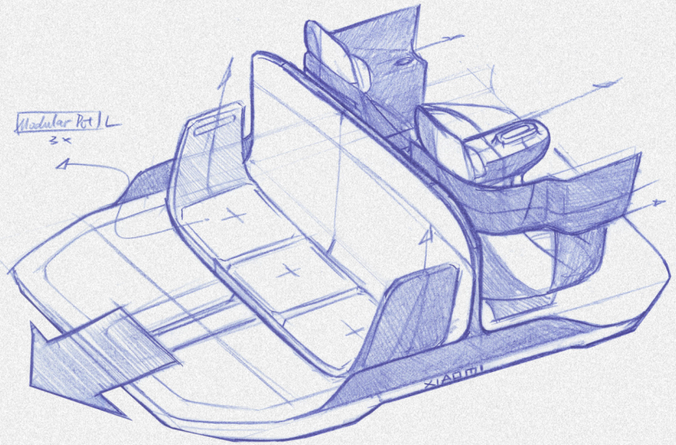
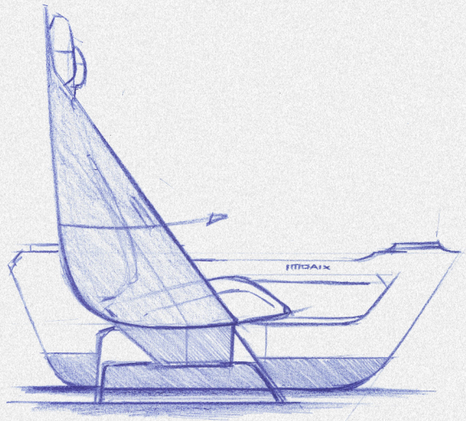


Figure 50. The early sketches of the ideation iteration (consoles)

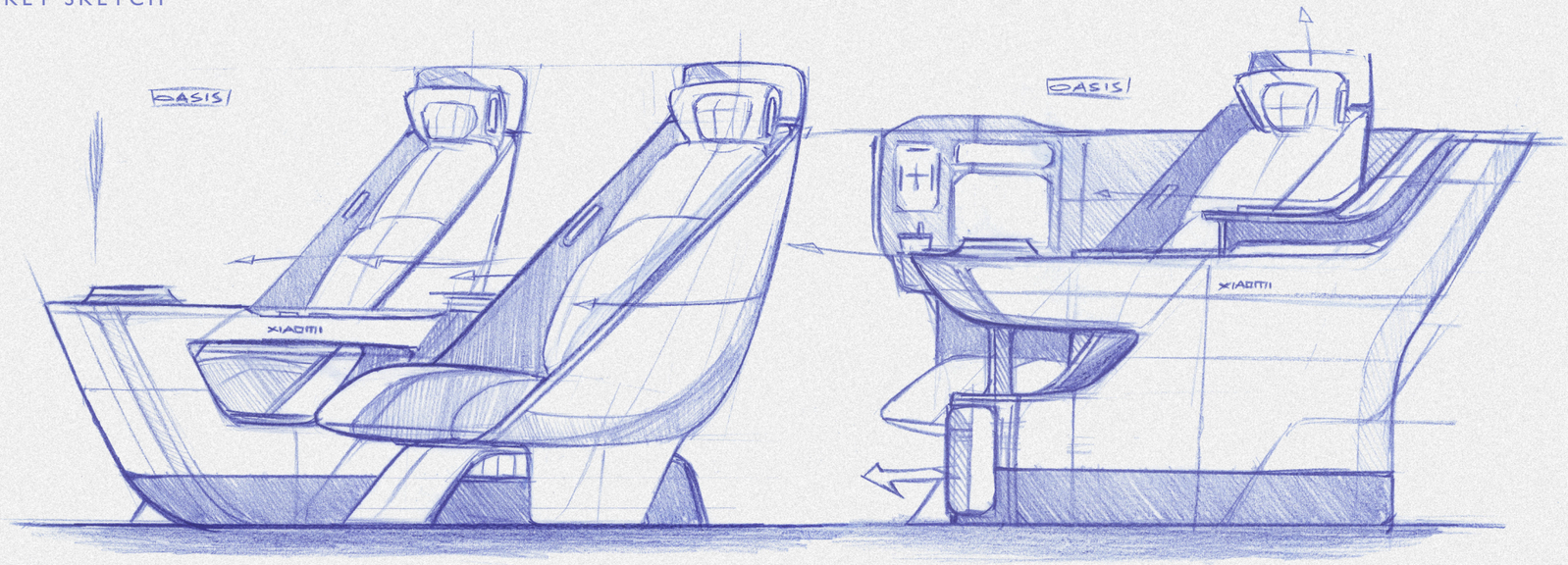






FLOWING OASIS

KEY SKETCH



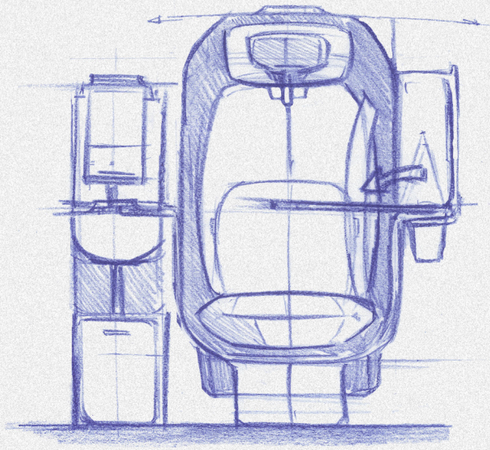


Figure 51. The key sketches of the cabin

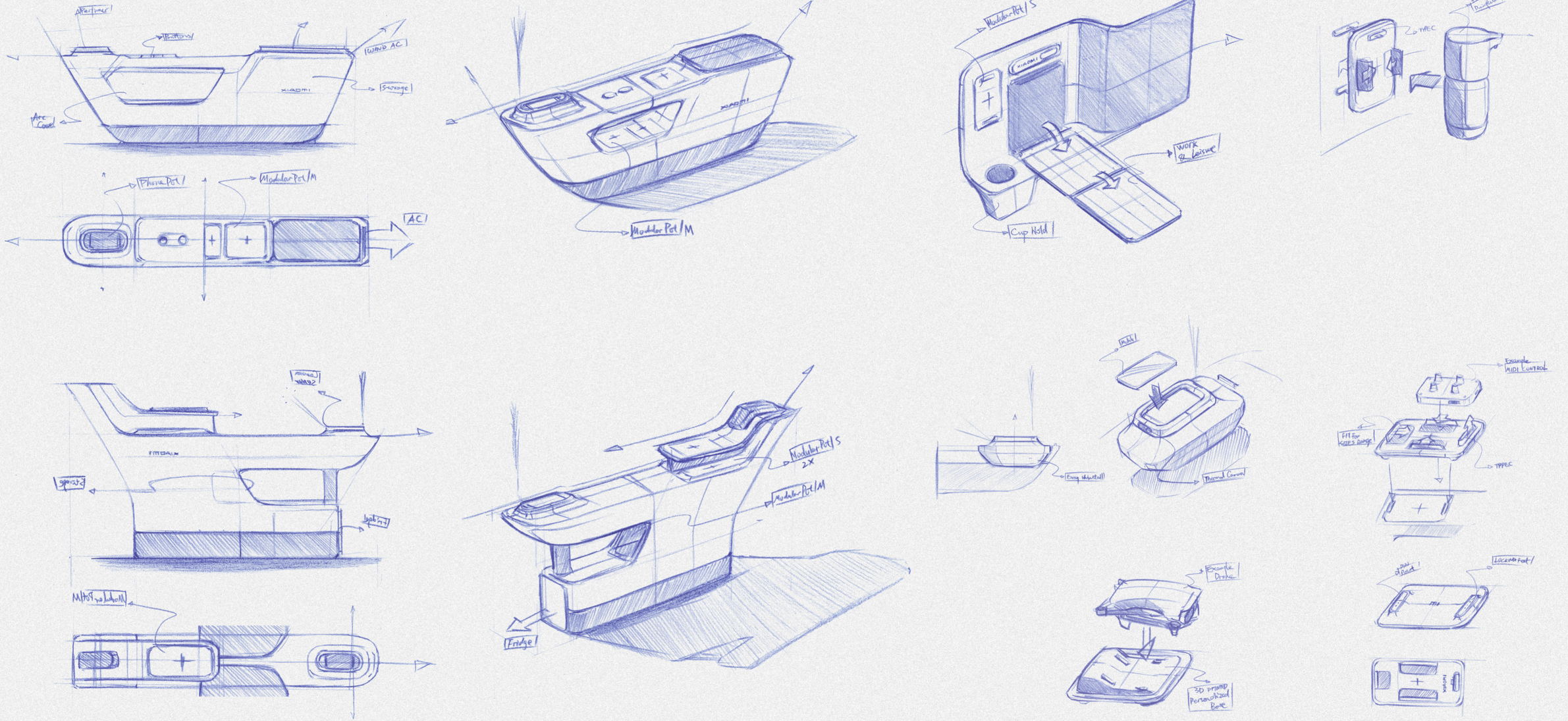


Figure 52. The key sketches of the product details

7.5 Iteration

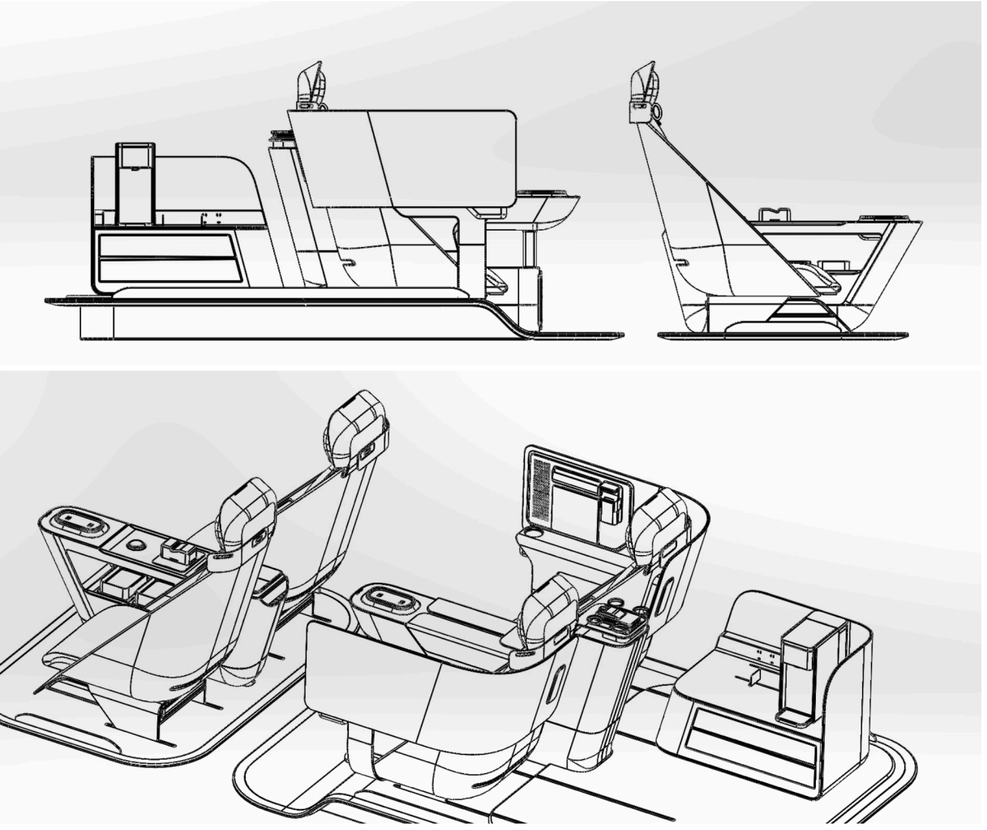


Figure 53. The design iteration process through CAD modeling

CAD modeling

In the CAD modeling phase, the 2D design concepts are transformed into 3D models, where adjustments in dimensions, volume, and visual impact inevitably occur. This phase is also a continuation of the design iteration process, where more precise details are refined, such as defining the volume and design specifics of the modular base (e.g., attachment methods and connection points), which will be presented in the subsequent deliverables.

During this stage, several detailed optimizations were made to the seat design, including adjustments to the headrest shape and width. Additionally, the back trunk area underwent multiple iterations. Ultimately, we opted for an entirely open space in the back trunk, where the rear-right passenger can seamlessly slide back and operate L-size products attached to the trunk's surface base. This design allows users to interact with these devices easily without having to leave the car.

3D Visualization

Once the CAD model was finalized, it was imported into 3D rendering software to create realistic visual outputs, serving as the concept deliverables for this project.

It is worth mentioning that I visualized several connected in-car product concepts. These included a game console and controller, using the XBox as a reference example. However, it is important to note that this project has no affiliation with Microsoft; the use of these examples is solely for conceptual reference.

In this phase, the report will first present the design results and key highlights, with the goal of conveying the core concepts through the visuals alone. Detailed explanations and supplementary notes will be provided in the final section. Now, please hold your breath and get ready to be amazed.

xiaomi

FLOWING OASIS

TU Delft


xiaomi
FLOWING OASIS


xiaomi
FLOWING OASIS


seat design
xiaomi
FLOWING OASIS


front console design
rear console design
xiaomi
xiaomi
FLOWING OASIS


side plate design
xiaomi
FLOWING OASIS


back trunk design
XIAOMI
FLOWING OASIS

Seat design

Knitted material

xiaomi
FLOWING OASIS

Console design

Product case

Aroma diffuser &
Smart plant pots (M)

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Console design

Product case

Gaming controller station (M)

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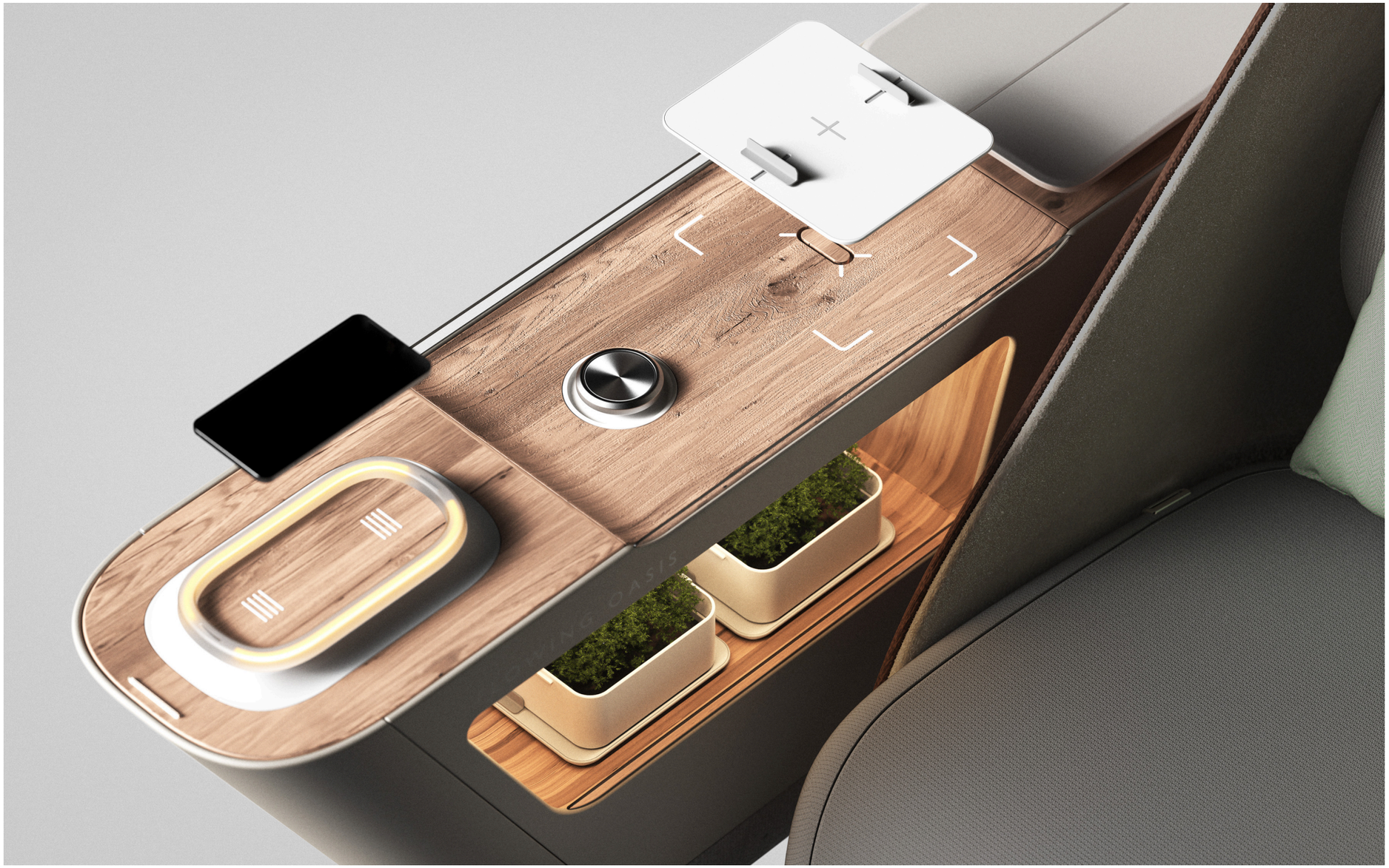
FLOWING OASIS



Console design

Product case

Charging pad &
Connector base (M)

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Console design

Product case

Mini drone station (M)

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Side plate design

Multi-functional integration

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Side plate design

Product case

Ambient light (S) &
Automatic alcohol
sanitizing dispenser (S)

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Back trunk design

Product case

Coffee maker (L) &
XBox (L)

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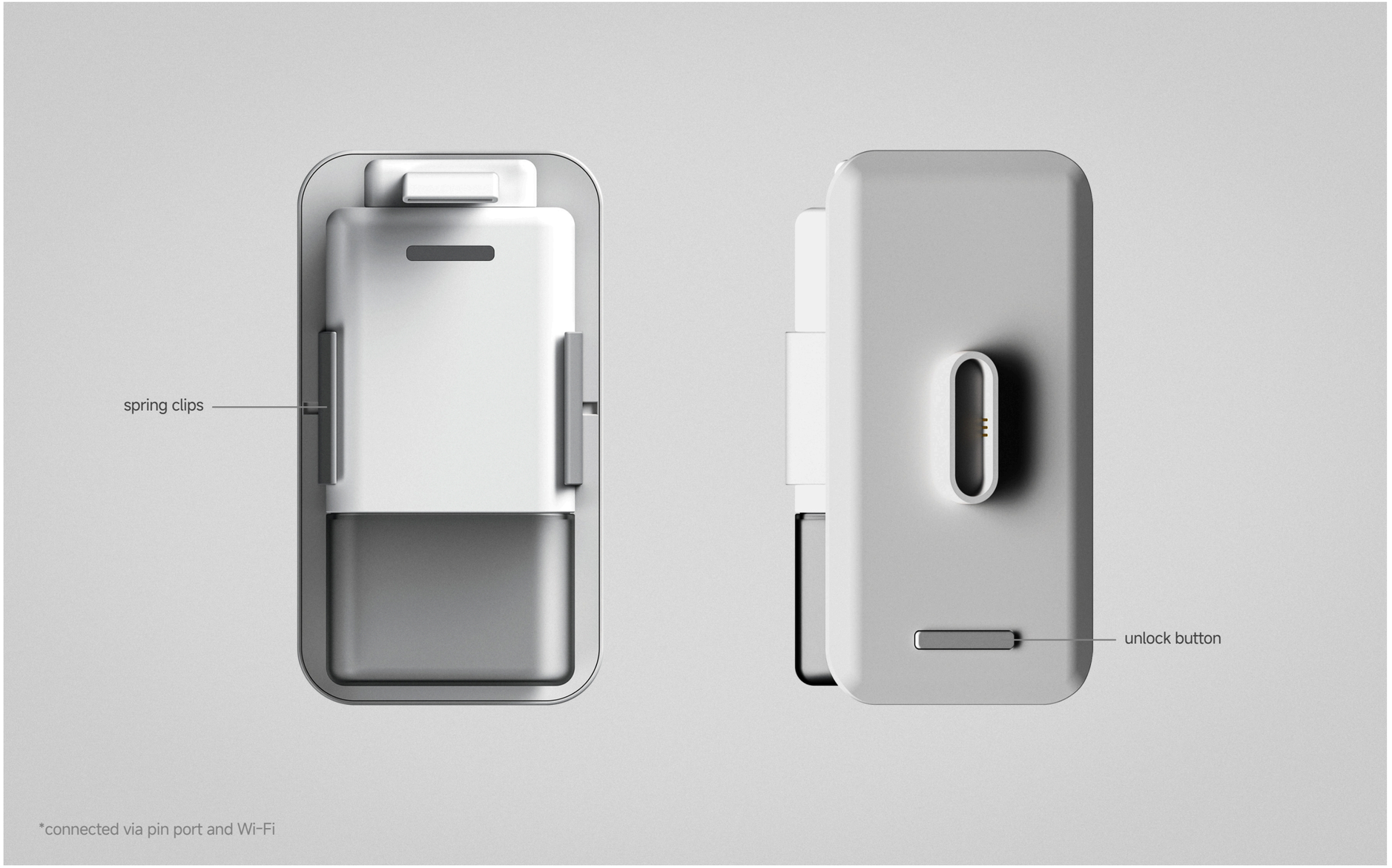
Connecting type A

Assembles effortlessly with spring clips and unlocks with a single button press



*connected via pin port and Wi-Fi

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Connecting type B

Official structural modifications snap-fit with the product base

*connected via USB-C, WIFI and DC power supply

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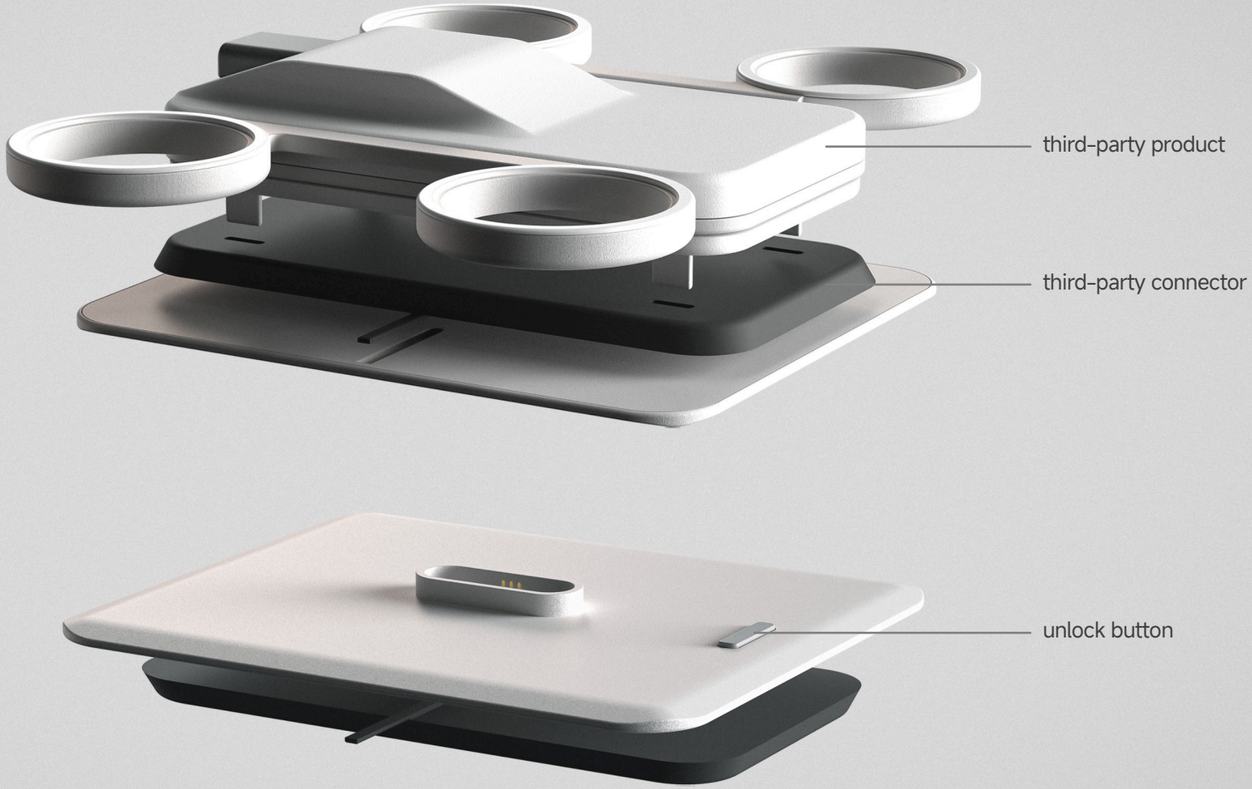
Connecting type C

The third-party supplies connectors specifically designed for their own products



*connected via pin port, USB-C and Wi-Fi

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Connecting type D

Users can 3D print the connector to assemble various products

*connected via pin port, USB-C and Wi-Fi

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7.6 Deliver

Design description

The above presentation encapsulates the design concept of Flowing Oasis. First, an overview of the concept is conveyed through the overall interior renderings, showcasing the spatial sense of the design. This is followed by a detailed focus on the four key areas: seat design, console design, side plate design, and back trunk design.

For the seat design, sculptural fabric with 3D knitted texture is employed to create a textured, modern aesthetic. The front console design incorporates an embedded aroma diffuser and a wireless charging pad. It also features three M-size modular base interfaces, demonstrated in the concept through the integration of a gaming controller station and a smart plant pot. These examples illustrate the console's ability to support various product functions, enhance the atmosphere, provide fresh air, and accommodate diverse leisure activities within the vehicle.

The rear console primarily serves as an armrest, but also includes two M-size modular base interfaces. As examples, a smart plant pot and a mini drone station are connected, with the latter showcasing how the modular base concept can cater to niche user needs and creative flexibility.

The side plate design is a multifunctional ensemble, with each side plate featuring a foldable table for leisure or work purposes, a storage compartment, and an S-size hanging modular base. The products showcased in this design include an ambient light, which doubles as a power bank when detached, and an automatic hand sanitizer dispenser. These elements are tailored to fit entry and exit scenarios, enabling users to conveniently sanitize their hands during commutes.

The back trunk design features a storage drawer and a counter that connects to L-size products via a DC power supply. Product examples include an XBox console, complementing the earlier gaming controller, and a coffee machine, aligning with the leisure activities outlined in the NDRAs.

This overall design approach highlights Flowing Oasis's ability to merge aesthetics, functionality, and modular flexibility, offering a refined and immersive in-car experience.

The four principles of the modular base correspond to the business strategy and user experience innovations outlined in the vision phase, completing the concept's logic.

Type A and Type B are designed for products that meet high-frequency demands. These products are either directly provided by the official manufacturer or structurally modified in collaboration sessions to ensure compatibility with the vehicle's ergonomics and safety requirements.

Type C and Type D, on the other hand, are aimed at third-party products. Users can attach their own products using connectors provided by third parties for modular base integration. Alternatively, users can design and 3D print their own connectors via the Oasis platform, allowing for a DIY approach that personalizes the connection to suit their specific products.

Summary

In addition to the explanation above, it is worth noting that the connected products presented are merely examples used to illustrate the system innovation concept and may not yet be fully mature. In the Flowing Oasis concept, the co-idea process and modular base system theoretically offer unlimited possibilities for product integration into the vehicle.

This is the core of the Flowing Oasis concept—designed to create a personalized sense of belonging for each owner by combining warm, home-like interior spaces with the ability to customize the interior to meet various in-car behaviors and needs. In this space, users can truly feel the warmth of home, fully relax, and maintain their pursuit of an orderly life through elegant, simple, and integrated design.

This is the project’s answer to delivering a "Refreshing" experience.

Part E : Evaluation

The final section aims to allow simulated users to experience the design within a three-dimensional space through the VR prototype. This process serves to validate the feasibility of the physical interaction in the design. The section concludes with a discussion and reflection on the entire project, based on the results of the tests, feedback from the collaborator and supervisors.

8. Evaluation

8.1 VR Prototype

Purpose of prototyping

To further validate the effectiveness of the design concept communication and the feasibility of the modular connection logic, a life-sized prototype was built in VR.

The goal was to engage the target user group in subsequent testing, allowing them to immerse themselves in a simulated in-car environment within a three-dimensional space. This setup enabled users to experience the form, CMF, atmosphere, and develop a clearer understanding of how the modular bases function.

Prototype set-up

This project utilized Luxion's KeyVR software as the platform for experiencing the VR prototype, where components from the CAD model were grouped and assigned materials before being imported (see Figure 53). Interaction was carried out using the Meta Quest 3 headset and controllers.

Due to the real-time rendering requirements of the VR prototype, the visual fidelity—such as the resolution of lighting and material details—is significantly lower compared to static renders. This is one of the inherent limitations of VR prototypes at this stage. Therefore, during the subsequent testing phase, participants will first be given an introduction to the project, followed by a presentation of the final rendered visuals.

Interaction logic

After importing the CAD model into VR and integrating it into five interchangeable virtual environments, a safe movement boundary of approximately 20 square meters was designated in the physical space. Once testers put on the headset, they were able to walk, crouch, and sit within this boundary, allowing for movement in all directions and real-time adjustments to their perspective height, corresponding to their view in the VR environment.

Two controllers facilitated interaction: the left controller was responsible for teleportation within the space and switching between 360° viewpoints, while the right controller managed various functions, such as changing environments and moving, rotating objects.

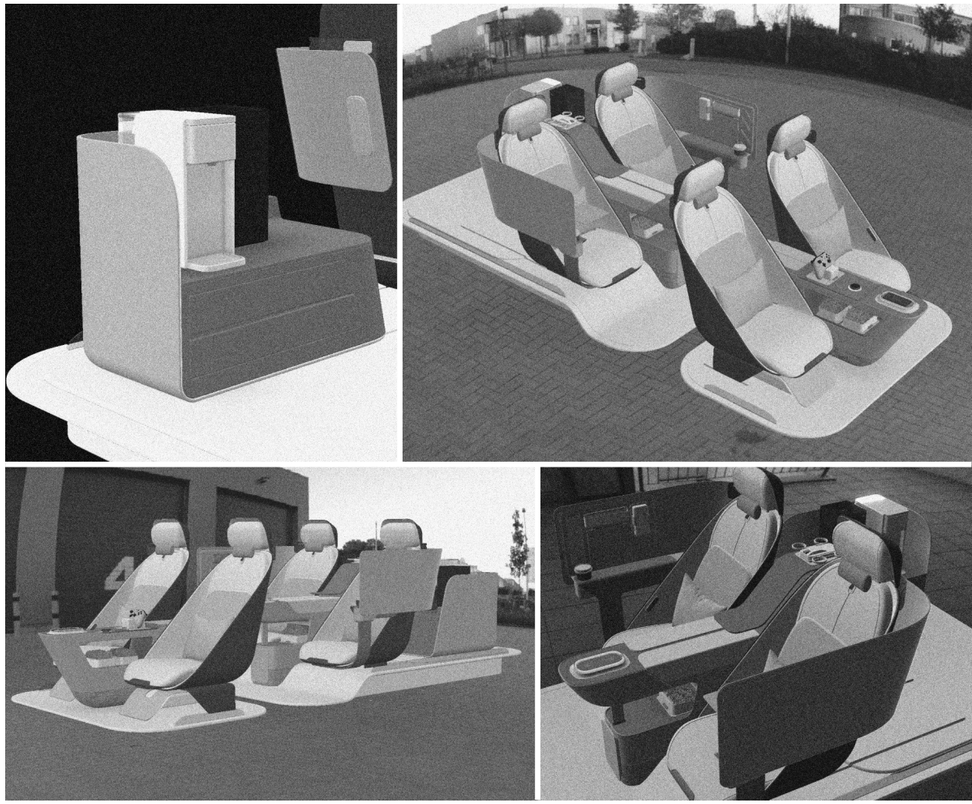


Figure 54. The VR prototype was developed using the KeyVR real-time render engine

8.2 User Test

The participant

Due to equipment and venue constraints, the VR prototype testing will be conducted with a group of master's students from the Faculty of Industrial Design Engineering at TU Delft, serving as the simulated target users mentioned earlier. The participants are aged between 22 and 32, do not have children, and have a basic understanding of Xiaomi's brand and home products.

Eight participants were invited individually for the test (coded as A to H). As factors such as gender and specific age do not significantly impact the content or results of this test, detailed participant information will not be disclosed. Before the test, participants will be asked to read and sign a consent form (see Appendix D) and confirm that they do not experience symptoms of VR sickness.

Participant A to H
master's student
22 to 32 years old

Figure 55. Participants from the target user group for simulation

Test set-up

The entire test was conducted in the open area of the Faculty of Industrial Design Engineering. The test environment consisted of a workspace that included a desk for the testing equipment, document signing, and post-test discussions, as well as an open space of approximately 20 square meters behind the desk. The VR experience was achieved by streaming the VR headset, which was connected via cable to a laptop. An iPad was used to rate task difficulty, record answers to questions, and document discussion notes, as shown in Figure 56.

Figure 56. The test equipment set-up

Figure 57. Photographs of the process of user testing

8.2 User Test

Test process

The entire testing process took approximately 20 minutes and was divided into seven stages.

1. Project introduction & user test purpose (1min)

Goal: A brief introduction to the project's topic and present the final visual deliverables. Inform the participants about the purpose of the test.

2. Instruction on how to use the VR equipment (2min)

Goal: Ensure that participants understand how to use the VR equipment, interact within the VR environment, and adjust the device to fit their head size and interpupillary distance for optimal comfort.

3. Freely explore and observe within the VR prototype (3min)

Goal: Allow participants to develop a basic understanding of the design within the 3D space, including its form, tactile feel, and CMF. Additionally, help them further adapt to the control logic within the VR environment.

4. Complete three tasks sequentially (6min)

Goal: Validate the feasibility of the modular connection logic, including the clarity of product segmentation and the ease of understanding the assembly of modular bases of different sizes.

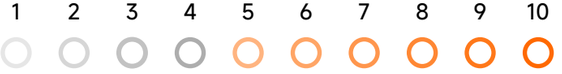
Task 1 - Please identify all in-car products that are connected using the logic of the modular connection, including two L size, five M size, and two S size products.

Task 2 - Please try to remove these products using the right contreoller in VR, then also remove the M size and S size modular base from the car.

Task 3 - Please rotate and observe the objects you have removed, and try to explain the assembly logic of different-sized products in the car based on the modular base concept, according to your understanding.

5. Rate the difficulty of completing the each task (1min)

Goal: Quantify the difficulty of understanding and operating the modular connection by assigning a score between 1 and 10 (with higher scores indicating greater difficulty) to assess the feasibility of the design.



6. Q&A sessions (5min)

Goal: Seek explanations for the scores given, and discuss the factors that influenced the perceived difficulty. Additionally, ask about the subjective impressions of the design to assess whether it created a refreshing experience and a sense of belonging. Finally, encourage participants to imagine and discuss the potential opportunities for more product possibilities based on the modular connection logic.

Question 1 - After hearing the standard explanation, please explain why you gave the above score.

Question 2 - Please describe how you think the design and layout differ from traditional car interiors. You can use one or two keywords to express the impression it gives you (e.g., "This is a car providing a sense of...").

Question 3 - Now that you have a basic understanding of this design, can you imagine what other in-car products you would bring and connect into your car?

7. Free discussion (2min)

Goal: Provide the participant with an opportunity to add and share any additional insights or thoughts on the topic.

8.2 User Test

The rating results

The test was conducted successfully and provided a series of valuable feedbacks that helped validate the feasibility of the design. The difficulty ratings given by participants for the three tasks are shown in Figure 58.

Participant	Task 1	Task 2	Task 3
A	3	1	4
B	6	3	2
C	2	2	1
D	5	3	2
E	4	2	1
F	7	4	4
G	2	6	3
H	3	1	2

Figure 58. The rating results of the difficulty of completing three tasks

For the three tasks—identifying all different-sized connected products, moving all connected products, and understanding the assembly logic between the modular base, products, and the car through rotation and observation—the average difficulty scores were 4, 2.75, and 2.375, respectively.

This indicates that the first task was relatively more challenging but still within an acceptable feasibility range, while the second and third tasks were simpler. Overall, we can conclude that the logic is sufficiently feasible, as the average difficulty scores for all three tasks are below 4.

Impressions of the design

Without knowing the designer's intended message for Flowing Oasis (i.e., a refreshing experience and a sense of belonging), participants described their first impressions of the design using the following keywords:

 # Natural
 # Refreshing
 # Relaxing
 # Smooth
 # Automatic
 # Entertainment
 # Homely*3
 # Minimal*4
 # Cozy*2
 # Warm*3
 # Luxury
 # Tidy
 # Organized
 # Dynamic
 # Make me feel lazy
 # Be willing to stay longer

Other products opportunities

After understanding the modular connection logic, participants imagined themselves owning this car and proposed additional in-car product ideas to inspire us, such as:

 # Hiking equipment
 # Nintendo Switch*2
 # GoPro
 # Speaker
 # Camera
 # Laptop*2
 # Microwave & oven
 # Air purifier
 # Trash bin
 # Ice machine
 # Chinese tea set
 # Filter coffee maker
 # Projector
 # iPad
 # Cushioning & sofa

8.3 Discussion of the Test

Limitation

There are several aspects of the user test that did not fully meet the ideal expectations:

First, as mentioned, the real-time rendering quality of the VR prototype could be improved. The current frame rate, around 20 frames per second, results in a noticeable difference between the visual experience in VR and the actual feel of an interior in a real-world setting.

Second, the VR prototype only includes part of the car's interior and lacks the exterior design. As a result, the experience feels open in terms of visual and spatial perception, missing the enclosed sensation typically associated with being inside a real car.

Third, although the participants share a similar age range and family background with the target user group, they all come from a design background. This makes them more sensitive to product interaction and design concept communication. To obtain more realistic feedback, additional testing should be conducted with non-design professionals.

Lastly, more participants are needed to achieve more rigorous scientific results. The current number of participants is insufficient to meet the requirements of a robust scientific experiment, which introduces a certain degree of experimental error.

However, overall, this validation phase has provided valuable insights for the project. It has also allowed us, as traditional product designers, to experience the impact of digital virtual space applications on the product design process. The convenience of 3D experience testing significantly enhances the efficiency of prototype testing.

Feedback on the feasibility

For task 1, this was reported as the most challenging task by participants. Several participants noted that distinguishing between M and S size products was difficult due to the minimal size difference. In contrast, L size products were easily recognizable. This could cause some confusion for users when selecting the appropriate modular base for the first time, as they might be unsure which base fits a particular product size. Additionally, some participants mentioned that visual obstructions in the VR prototype made it difficult to locate the corresponding product touch points.

In the hypothetical production concept, in addition to clearly marking the sizes that each modular base accommodates, more detailed customization services should be offered through the Oasis platform—whether during co-idea sessions or through online product ideation suggestions. Furthermore, the size difference between M and S-sized modular bases could be made more pronounced to help users distinguish between them more easily.

As for task 2, moving products of different sizes, participants reported no difficulty, except for a few who were unfamiliar with handling controllers in the VR environment, leading to minor interaction challenges. However, the modular product movement logic was clearly understood, indicating that the interaction design was well communicated.

For task 3, regarding the understanding of the assembly logic for different-sized products and modular bases, participants similarly reported that the task was not difficult. This indicates that the overall modular base logic, including physical interaction and assembly design, was well thought out. Notably, all participants unanimously agreed that the assembly process for M and S-sized products was very simple and easy to understand. However, three participants expressed confusion about the assembly of larger L-sized products, which are secured using two clips and a snap-fit mechanism through dual slots.

Indeed, L size products typically require more secure fixation to ensure stability, which can lead to more complex structural designs. Simplifying this process to make it more intuitive will be a key direction for future research.

8.3 Discussion of the Test

Feedback on the design

Although none of the participants explicitly expressed the impression of a sense of belonging in their feedback, it is important to note that a sense of belonging is not a commonly used phrase. Many participants used terms such as "Homely" "Cozy" "Relaxing" "Warm" "Organized" and "Makes me feel lazy and willing to stay longer"—all characteristics aligned with the earlier definition of a sense of belonging. In this regard, the design successfully conveyed its intended concept.

Additionally, the term "Automatic" mentioned by some participants aligns with the design's context of L3 non-driving behavior, while terms like "Smooth" and "Minimal" correspond to the design language consistent with Xiaomi's identity. Some participants also noted that the design clearly offers many "Entertainment" Opportunities, which aligns with the high-frequency needs (leisure) addressed by the design's NDRAs context.

Others shared subjective impressions such as "Dynamic" and "Luxury" which, while debatable, still reflect the participants' positive evaluation.

Overall, Flowing Oasis effectively communicates its design concepts through its form, CMF, and other elements.

Feedback on product opportunities

Most participants expressed excitement about the logic of integrating new products, with only one participant stating the personal preference of driving and were less concerned with NDRAs or the activities of other passengers in the car. This also reflects real-world user scenarios.

Participants suggested additional product integration possibilities based on their personal habits and preferences, including both mainstream and niche products, such as cameras, laptops, and even a Chinese tea set or a record player. This also provides a reference for future opportunities where Xiaomi can directly offer other official in-car products.

It also demonstrates that the Oasis platform has significant potential for product integration, indicating that this logic holds promising prospects for practical application.

8.4 Discussion of the Project

Rethinking the system strategy

At this point, we will discuss the value created by the entire project and the deliverables it has presented.

Flowing Oasis introduces an interior design concept, presented through 3D visualizations and a VR prototype as the key design deliverables. Unlike traditional automotive interior design projects, the focus of this concept is not on the complete interior design of the vehicle, but rather on components like the console, which serve as the modular connection hub to create the overall effect. This sets it apart from traditional automotive design projects.

After discussions with the collaborator, it became clear that this represents a current design transition trend in the industry. With the advent of smart technology, electrification, and automation, traditional car design is gradually shifting towards product design.

As a result, we revisited the design output and developed a new idea not initially explored in the project. We realized that this design outcomes could be positioned as a front or rear console design applicable to any vehicle, rather than just an interior design concept for Xiaomi cars. Although consoles currently vary between vehicles, electrification is creating more flexible interior spaces, and the console may eventually evolve into a standalone product.

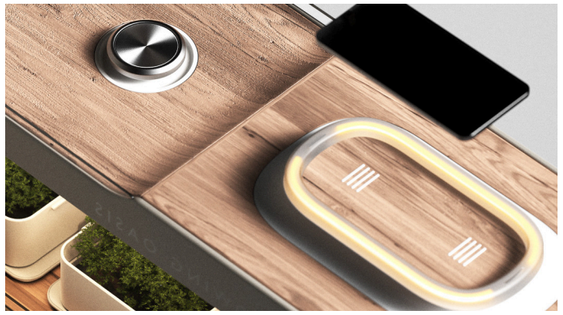


Figure 59. Imagine the console as a standalone product

In this case, Xiaomi could build an ecosystem of products centered around this console, allowing the IoT products featured in the Flowing Oasis platform to connect seamlessly with it. Within this scenario, users would not need to purchase a Xiaomi's car to enjoy Xiaomi's signature product connectivity features, and other OEMs could collaborate directly with Xiaomi.

This business strategy is more progressive, but if realized, it could significantly expand the application of this system's logic. This interesting concept emerged as a major insightful takeaway during the project's development.

8.4 Discussion of the Project

Continue enhancing the feasibility

After discussing the design, the supervisory team pointed out that the feasibility of some product cases, based on visual assessment, still requires improvement. Although these product cases are presented as conceptual examples rather than the core design focus of this project, they still hold value for reflection and optimization.

For example, the coffee maker does not appear to be a product that could naturally fit into a non-RV vehicle. Concerns include the safety of the water tank during bumpy rides, as well as the short-term high-power operation of the heating element, which may not be suitable for use while driving.

Indeed, not all products are specifically designed to be used inside vehicles. However, if their feasibility can be ensured through simple structural modifications and optimizations, then the project can successfully demonstrate the Type B connection logic.

The coffee maker case, in its current form, lacks some practical application. Exploring ways to improve its feasibility through better structural or interaction design is a topic with great developmental potential and could become a challenge I will address in my future work.

Figure 60. Continuous optimization of the feasibility of specific products for in-car applications (using the coffee maker as an example)

Further explore promising techonology

Although the time scope of this project is set for 2027, most of the technologies applied in the concept are those currently in practice. After further discussion, incorporating more promising yet not widely implemented technologies could potentially provide additional inspiration for the design concept.

For example, haptic feedback technology could be integrated. When the driver touches the screen, the screen could produce tactile feedback through vibrations, giving a sensation similar to pressing mechanical buttons.

TDK's PowerHap multilayer piezoelectric actuator provides powerful haptic feedback. This tactile sensation allows users to distinguish between buttons and sliders with their fingertips, freeing their eyes (TDK Global, 2023).

Figure 61. Automotive haptics in action

In addition, AI and robotics also have great potential for in-car applications. Although many OEMs have already integrated large models into their vehicles, the application and interaction forms of AI will become more diverse in three years. While we cannot yet predict the specific features of future AI-enabled cars beyond the current capabilities (such as voice assistants and AI-generated content), exploring and hypothesizing new AI-driven concepts within this project would add significant value.

More imaginative outcomes

As for the design itself, the collaborator believes that Flowing Oasis aligns well with Xiaomi's philosophy and differs from traditional automotive interiors, resembling more of a living space.

However, as an exploration within the design team, they encouraged me to push the product's form and visual expression to be more dynamic, bolder, and more imaginative if I had more time to refine the design works.

Indeed, the design language for this project has been grounded in a minimalist home style and Xiaomi's simplistic philosophy from the ideation phase. As Xiaomi EV design consultant Chris Bangle mentioned during the SU7 press conference, a car is an inherently emotional product. Introducing more radical and bold ideas, while exploring how to balance practical feasibility with Xiaomi's minimalist philosophy, could lead to unexpected insights.

8.5 Reflection

Personal reflection

I am very proud of successfully completing this project, which required significant time and effort. It served as a comprehensive showcase of the skills I developed throughout my graduate studies.

From a design perspective, this project explored automotive interior design through the lens of a product designer. Rather than focusing solely on attractive aesthetics, I prioritized user experience and feasibility, taking a more rational approach to automotive design. While this experience has been invaluable for my career, I recognize that there is still room for improvement in areas such as form, proportions, and component details. I could also have been more imaginative in exploring emerging in-car interaction methods, especially with the rapid development of AI. Who knows—perhaps in three years, we might not even be using smartphones in cars? Though the design is not perfect, these reflections motivate me to keep refining my ideas.

From a research perspective, I initially relied heavily on existing literature and the company's strategy to guide my thinking. However, I soon realized that this approach risked turning the thesis into a business report, lacking original contribution. I began critically evaluating the relevance of each analysis, focusing on identifying research gaps and creating value within the company's context. For instance, in the literature review, I found that while some conclusions were useful, they might not always apply to the specific conditions of my project. This led me to assess which conclusions could be adopted, which needed further validation, and which should be reconsidered. Similarly, in brand analysis, I learned how to provide fresh insights by identifying areas for improvement from an external perspective.

From a project management perspective, this project involved coordinating multiple stakeholders—my academic supervisor, the company, and my personal learning goals. Effective communication was key.
I built connections in an international environment and gained valuable experience in cross-border collaboration, skills that will be crucial in my future career.

My initial learning goals were to expand my academic research capabilities, understand professional workflows in the automotive industry, and develop design skills in systems and business strategy beyond product design. I believe I have successfully made significant progress in all these areas, stepping out of my comfort zone. Additionally, this project pushed me to improve my communication and presentation skills.

Designers often have many ideas, but the ability to clearly and effectively communicate those ideas to an audience is essential. The process of completing this project highlighted the importance of these skills, and I will continue to refine them moving forward.

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Appendix

A. Original project brief

DESIGN FOR our future

TU Delft

IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

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

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

STUDENT DATA & MASTER PROGRAMME
Complete all fields and indicate which master(s) you are in

Family name	Wang	7134	IDE master(s)	IPD ✓	DfI	SPD
Initials	f.w		2nd non-IDE master			
Given name	Fengrui		Individual programme (date of approval)			
Student number	5805244		Medisign			
			HPM			

SUPERVISORY TEAM
Fill in he required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in **by the Chair** of the supervisory team

CHECK ON STUDY PROGRESS
To be filled in **by SSC E&SA** (Shared Service Centre, 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.

APPROVAL OF BOARD OF EXAMINERS IDE on SUPERVISORY TEAM -> to be checked and filled in by IDE's Board of Examiners

Does the composition of the Supervisory Team comply with regulations?

YES	★	Supervisory Team approved
NO		Supervisory Team not approved

Comments:

Based on study progress, students is ...

★	**ALLOWED** to start the graduation project
	NOT allowed to start the graduation project

Comments:

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Name student Fengrui Wang **Student number** 5,805,244

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT
Complete all fields, keep information clear, specific and concise

Project title Product system innovation for intelligent cabin's hardware expansion concept

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

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

Electrification and intelligence represent an unstoppable development trend in the automotive industry, with the boundaries between automotive design and product design further blurring and converging. Xiaomi, a technology company that has just entered the electric vehicle industry, is trying to create the next generation of mobile living space. Xiaomi's intelligent cabin integrates Xiaomi smartphones, smart wearables, and Mi Home products to achieve seamless hardware and software connectivity, boasting comprehensive ecosystem-sharing capabilities and expansion potential. Equipped with multiple physical interaction touchpoints, Xiaomi's intelligent cabin enables magnetic or threaded fixing attachment to a diverse range of accessory products, facilitating the expansion and innovation of intelligent functions within the vehicle.
Such a concept will continue to evolve, adapting to an increasing array of innovative products under the brand and opening to third parties for open-source collaboration, giving developers exciting opportunities to explore new in-car features. Users can also combine modular products to create a unique driving, relaxing, and entertainment experience inside the vehicle.

space available for images / figures on next page

introduction (continued): space for images

image / figure 1 Intelligent cabin of Xiaomi EV

image / figure 2 Physical interaction touchpoints for the hardware expanson of Xiaomi EV

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

1. Derived from the concept of 'Human-Car-Home All-round Ecosystem', further enhance the strategy and viability of the hardware expansion product system: Based on the intelligent connectivity, modularity, user customisation, and open-source format for third parties, it is essential to consider integrating product opportunities in home and car scenarios and propose potential business strategies and system innovations.
2. Explore innovative features and forms for physical interaction touchpoints of the hardware expansion to better integrate with in-car scenarios and create a refreshing user experience: Currently, the hardware expansion physical interaction touchpoints in the Xiaomi SU7 cabin are located under the central screen, behind the front seats, and within the storage space below the centre console. Moving beyond the current execution concept, Further consideration for new design possibilities must be conducted.To meet physical and cognitive ergonomics and enhance the user experience, these touchpoints must better integrate with the cabin layout and components, such as the front and rear seats, instrument panel, front and rear consoles, side doors, reargate, and roof.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for.
Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence)
As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design the next generation system strategy and product solutions of the hardware expansion concept for Xiaomi's intelligent cabin to create a refreshing user in-car experience.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

The project will focus on a scope of the next three years, aiming to develop a system strategy and design for the hardware expansion concept facing the internal of the company. This endeavour will be divided into two main phases.
The first phase will involve research into the automotive industry context, user behaviour and trends within the mobile space, literature review and R&D engineering studies. Subsequently, leveraging Mi Home's IoT system as an internal reference, the product development model will be analysed. This phase will contemplate extending and integrating such an ecosystem into the car scenarios. It will propose the ideal stakeholder relationship, product development process, strategies, requirements, and system map.
The second phase will utilise the insights to design physical interaction touchpoints within the cabin, considering ergonomics and layout, aiming to construct the next generation of mobile intelligent space by effectively integrating the hardware expansions into the vehicle.

Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a ***kick-off meeting***, ***mid-term evaluation meeting***, ***green light meeting*** *and* ***graduation ceremony****. 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 course activities).*

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competences or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

I have had a strong interest in product design in the mobility domain since my bachelor's, and much of my projects have centred around it. With time, changes in how people live and interact with technology will lead to the creation of the automotive industry. This project has allowed me to explore the emerging design possibilities in this field and prove that I have the mature design ability to provide solutions for large corporations. At the same time, I would like to use this project to enhance my competence and experience in the following three areas:
Firstly, I want to learn a more scientifically rigorous research process. I aim for this project to genuinely consider the practicality of products and the needs of clients and end-users. This includes meticulous user research, design methods, ergonomics, and a highly academic report presentation.
Secondly, I want to challenge myself by thinking about strategy and system construction in product development.
Lastly, I want to interact more with automotive industry professionals to understand better the industry's content, requirements, and emphasis. I aspire to learn how to collaborate with clients, providing valuable experience for my future work.

Appendix

B. HREC approval

Date 25-Jun-2024
Correspondence hrec@tudelft.nl

TU Delft

Human Research Ethics
Committee TU Delft
(http://hrec.tudelft.nl)

Visiting address
Jaffalaan 5 (building 31)
2628 BX Delft

Postal address
P.O. Box 5015 2600 GA Delft
The Netherlands

Ethics Approval Application: Product system innovation for intelligent cabin's hardware expansion concept
Applicant: Wang, Fengrui

Dear Fengrui Wang,

It is a pleasure to inform you that your application mentioned above has been approved.

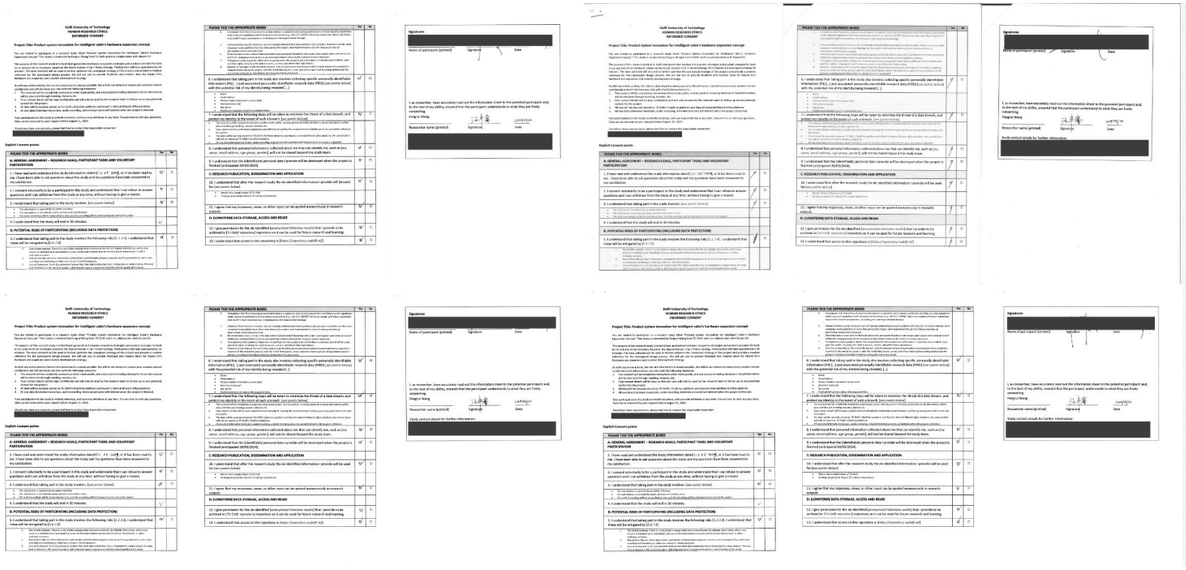
Thanks very much for your submission to the HREC which has been approved.

In addition to any specific conditions or notes, the HREC provides the following standard advice to all applicants:
• In light of recent tax changes, we advise that you confirm any proposed remuneration of research subjects with your faculty contract manager before going ahead.
• Please make sure when you carry out your research that you confirm contemporary covid protocols with your faculty HSE advisor, and that ongoing covid risks and precautions are flagged in the informed consent - with particular attention to this where there are physically vulnerable (eg: elderly or with underlying conditions) participants involved.
• Our default advice is not to publish transcripts or transcript summaries, but to retain these privately for specific purposes/checking; and if they are to be made public then only if fully anonymised and the transcript/summary itself approved by participants for specific purpose.
• Where there are collaborating (including funding) partners, appropriate formal agreements including clarity on responsibilities, including data ownership, responsibilities and access, should be in place and that relevant aspects of such agreements (such as access to raw or other data) are clear in the Informed Consent.

Good luck with your research!

Sincerely,

C. Consent form - online interview



Appendix

D. Consent form - VR protype user test