A DURABLE IN-CAR INTERFACE DESIGN FOR FUTURE LIGHTYEAR MODELS

A USER-CENTERED APPROACH IN AVOIDING OBSOLESCENCE OF THE IN-CAR EXPERIENCE

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TU Delft

Lightyear

INSTITUTE DELFT UNIVERSITY OF TECHNOLOGY

PROJECT MASTER THESIS

COMPANY LIGHTYEAR

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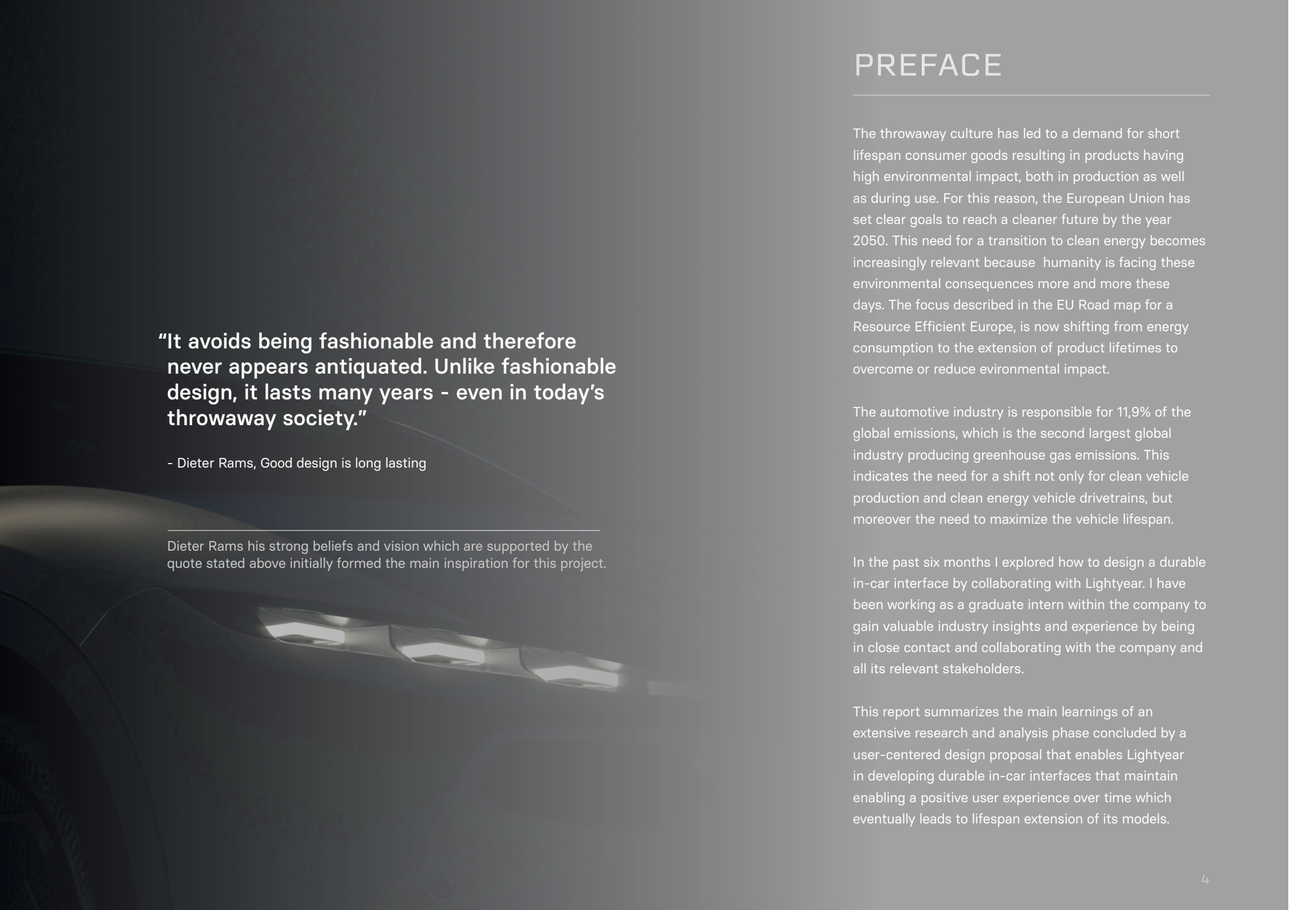

“It avoids being fashionable and therefore never appears antiquated. Unlike fashionable design, it lasts many years - even in today’s throwaway society.”

- Dieter Rams, Good design is long lasting

Dieter Rams his strong beliefs and vision which are supported by the quote stated above initially formed the main inspiration for this project.

PREFACE

The throwaway culture has led to a demand for short lifespan consumer goods resulting in products having high environmental impact, both in production as well as during use. For this reason, the European Union has set clear goals to reach a cleaner future by the year 2050. This need for a transition to clean energy becomes increasingly relevant because humanity is facing these environmental consequences more and more these days. The focus described in the EU Road map for a Resource Efficient Europe, is now shifting from energy consumption to the extension of product lifetimes to overcome or reduce evironmental impact.

The automotive industry is responsible for 11,9% of the global emissions, which is the second largest global industry producing greenhouse gas emissions. This indicates the need for a shift not only for clean vehicle production and clean energy vehicle drivetrains, but moreover the need to maximize the vehicle lifespan.

In the past six months I explored how to design a durable in-car interface by collaborating with Lightyear. I have been working as a graduate intern within the company to gain valuable industry insights and experience by being in close contact and collaborating with the company and all its relevant stakeholders.

This report summarizes the main learnings of an extensive research and analysis phase concluded by a user-centered design proposal that enables Lightyear in developing durable in-car interfaces that maintain enabling a positive user experience over time which eventually leads to lifespan extension of its models.

ACKNOWLEDGEMENTS

Many people have supported and guided me during the graduation project.
Their help contributed to the successful completion, for which I am very thankful!

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BRAM — We collaborated quite a lot as we met each other frequently at the office, which I found to be very helpful and effective. Whenever I had a question or was in doubt about something, you were always there to give support or to refer me to the right people. With your broad industry experience within UX design you could always give me the information and inspiration I needed to proceed. I really enjoyed our casual conversations in which you passionately exchanged your thoughts about the Lightyear 0 and expressed your vision for future Lightyear models.

LIGHTYEAR COLLEAGUES — I would like to thank all the great people I have met and whom I got the chance to work with. You provided me with useful information and gave me the support I needed throughout the project. I really appreciate your interest in the project and the fact that some of you were highly involved along the way. Without your support I could not have achieved the result in the end, so thanks to all the inspiring colleagues that supported and assisted me during my time at Lightyear.

PARTICIPANTS — Thanks to all people who took part in the project by participating in the evaluation sessions and/or the user tests. You played an important role in the project. By your co-operation I was able to do the evaluation sessions, user tests, and derive results based on real user data.

FAMILY & FRIENDS — Thanks for always being there for me in good and bad times. You supported me during my studies and have given me the opportunity to pursue my passions for which I am very grateful. Lots of love!

EXECUTIVE SUMMARY

A significant problem within the automotive industry and for in-car interfaces in general, is the fact that the in-car user experience becomes obsolete at a much faster pace over time compared to the potential lifespan of the car itself. Moreover, there is also a societal future need for long lasting products in order to have a positive impact on sustainability to achieve the goals as decribed in the EU Road Map to a Resource Efficient Europe by 2050 (Cooper, 2010)(den Hollander 2014). Both these statements form the personal incentives and indicate its relevance. This project aims at developing a design proposal of a durable in-car interface for future Lightyear models. This proposal is based on updateability by designing a both physically and digitally updateable in-car interface. The design process is done through a user-centered approach which can be utilized for future designs of in-car interfaces or as a approach in itself.

PROBLEM

When the user experiences a sense of obsolescence of the in-car experience, it causes users no longer perceiving the interfaces as useful and/or meaningful, which causes them no longer regarding the interfaces as useful and/or meaningful. This results in people perceiving the product as if its no longer relevant although it still has a substantial life to come. For an in-car interface many resources were acquired for development and production purposes. Subsequently, a user-centered design approach of extending product lifetime, is not (yet) focussed on within the automotive industry, and especially not within the design fields of in-car interfaces.

CHALLENGE

The main challenge is to create a durable in-car interface by doing research, user tests, and apply design principles within in-car interfaces to manage obsolescence of the in-car user experience.

LITERATURE

In order to come up with a suitable concept, extensive literature research, context research, future framing, evaluation sessions, and user tests are done in order to identify design principles that a conceptual solution can be built upon. The concept includes three main principles based on existing literature and methods for managing obsolescence described by the following typologies:

- **Extended Use**
- **Recovery**
- **Long Use**

These principles are named this report respectively: Smart Support, User as Creator, and Concept of Time.

RESEARCH AND EVALUATION

The user evaluation sessions and user tests provide insights in use and to validate interaction design principles. Three principles have been tested in order to establish clear guidelines for the final design proposal. The objective of the user tests was to gain knowledge about to what extent these principles facilitate the user's behaviour, needs, wants, expectations, and preferences.

DESIGN PROPOSAL

After the evaluation and testing phase a clear design proposal can be formulated. It is concluded that the design of an in-car interface should have a supporting system that analyzes the use and gives feedback and recommendations on the basis of a performed analysis by this sytem which is customized to the users average rides and interface use. Secondly the design should have a modular principle aiming at updating physical functional modules. Lightyear should provide installation support for updating physical modules and/or panels. In terms of payment, most users prefer paying by one time purchase for (physical) updates over time, to make a well considered decision on what and when to update.

ESSENTIAL FACTORS

In order to solve the problem, it requires not only a new way of designing in-car interfaces, but also demands to rethink product lifecycle management, product value proposition, and a circular business model in order to enable successful implementation. Though the prospect of this needed change starts by a change in mindset on durability of the in-car experience for both the future user as well as Lightyear as a company.

PHYSICAL INTERFACE DESIGN

More visualisations and explanation on the physical design can be found in part 14.1

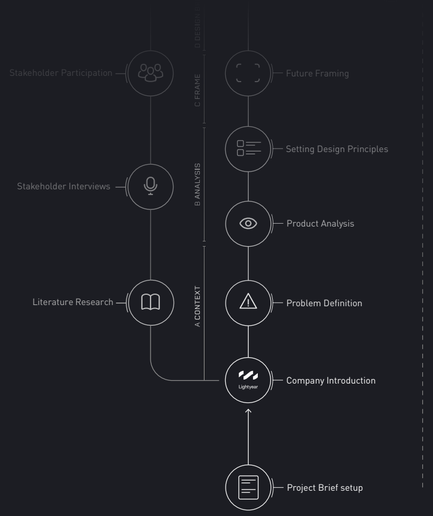
FINAL DIGITAL INTERFACE DESIGN

Two screens of the final digital interface design - More visualisations and explanation can be found in part 14.1

INDEX

ABBREVIATIONS

EV	Electric Vehicle
ICE	Internal Combustion Engine
OEM	Original Equipment Manufacturer
HMI	Human Machine Interaction
IVI	In-Vehicle Infotainment
IC	Instrument Cluster
SID	Sustainable Interaction Design
SUS	System Usability Score
UX	User Experience
HVAC	Heating, Ventilation, and Air Conditioning



PHASE A
CONTEXT

1. PROJECT INTRODUCTION

This master thesis was made possible through a self-initiated collaboration between me as a graduate student, the Delft University of Technology and Lightyear. After I submitted my initial research proposal to Lightyear, they were immediately interested and they offered me the opportunity to start my project within the UX team of Lightyear. By sending out the research proposal to potential supervisors, I have also been able to find a passionate team of supervisors who support and guide me during the project.

ROLE OF LIGHTYEAR

Lightyear offers me the opportunity to work on my project on location in a professional setting. The company helps me during the project by providing knowledge and gives me advice and guidance when necessary from within different disciplines. Collaborating with the design team and research strategy teams helps me to set up a realistic assignment that could actually contribute to the goals of Lightyear. The facilitating role of Lightyear ensures that I can work in a professional manner for an existing company and a real (future) product.

ROLE OF DELFT UNIVERSITY OF TECHNOLOGY

The role of the university is to be the authority by checking whether my project is academically relevant and meets the academic requirements. The team of supervisors from the university is there to support me when additional substantive knowledge is needed and to guide me through the process when necessary. However, it is appreciated when the student has an assertive attitude and which I wholeheartedly accept to do so.

1.1 LIGHTYEAR

As our world moves toward more sustainable energy sources, Lightyear is driving the development of clean mobility in the automotive industry. By enabling electric vehicles to be scalable for everyone, everywhere, we will accelerate the sustainability transition and have a positive impact (Lightyear, 2022).

THE STORY

Lightyear is a company founded in 2016 by former members of the Solar Team Eindhoven. This Team won the World Solar Challenge four times between the years 2013 and 2019. Lex Hoefsloot is the co-founder and CEO of the company that truly believed in his vision of enabling clean solar powered consumer cars together with four other members of the Solar Team Eindhoven. He and his team wanted to do something to catalyze the transition to clean mobility in the automotive industry.

With the knowledge gained of building a car that runs on a solar powered drivetrain, they had the dream of building their own consumer car and launching it on the highly competitive automotive market. For many people it seemed like an impossible plan but for these five team members it seemed like their possible future. And here we are, in the year 2022 the first ever consumer solar powered car will be launched on the market.

"Efficiency is at the heart of everything we do: our proprietary technology, embedded in the core components, including the powertrain, thermal management system, and solar roof, is optimized to that one end."

(Lightyear, 2022)

1.2 PROBLEM DEFINITION

As stated earlier, Lightyear is an innovative company with a very specific product that makes use of unique solar powered technology as well as the implementation of technologies aimed at maximum efficiency. This makes their vehicles not only super efficient in use regarding energy consumption, but it is also a big step towards a clean mobility solution.

THE PROBLEM

Despite these advanced technologies all contributing to the vision of a cleaner future, there is still a problem that is not being covered within the automobile industry. Which is the fact that the user experience of in-car interfaces becomes functionally and psychologically obsolete at a much faster pace over time compared to the actual lifespan of a car itself.

This principle might even be a trigger for users to renew their car, even though this relatively fast demand for product renewal is not directly needed in the first place (Blevis, 2007). These short periods of vehicle ownership create a high demand in short lifetime consumer goods. Products with life-spans far shorter than those technically possible eventually result in more waste during production and use compared to products with a far longer life-span. This way of using and producing products that is highly influenced by this demand within the consumer market leads to a negative impact on sustainability aspects in general, which is unwanted in order to reach the targets described in the EU Road Map for a Resource Efficient Europe (Cooper, 2010).

INITIAL PROBLEM STATEMENT

"The user experience of the in-car interfaces becomes obsolete at a much faster pace over time compared to the actual lifespan of the car itself."

Argumentation for problem statement further explained and summarized in part 1.3 in this report and is also supported by later findings during the project.

EXAMPLE 1 – WORKAROUND
NO BUILT–IN NAVIGATION SCREEN

Figure 1a - Phone and parrot device to add functionalities

EXAMPLE 1 – SOLUTION
THIRD PARTY PRODUCTS

Figure 1b - Phone holder as additional needed element

The rapid innovations in technology mean that people themselves add additional devices to their existing interfaces. Shown here is a phone that is used both as a navigation device due to a newer digital interface and the use of a high-resolution display with sharper contrast.

EXAMPLE 2 – WORKAROUND
ADDED LARGE IN–CAR DISPLAY

Figure 2a - Tablet obstructing driver's vision

EXAMPLE 2 – SOLUTION
INABILITY TO KEEP UP WITH INNOVATIONS

Figure 2b - Apple Carplay future plans to utilize multiple screens

Software services like Apple Carplay and Android Auto are being used widely within the in-vehicle infotainment systems nowadays. It clearly indicates the shortcomings of the current digital interfaces and the demand for using up to date interfaces that fits within their ecosystems.

EXAMPLE 3 – WORKAROUND
USING TOO MANY PERSONAL DEVICES

Figure 3a - Blocked functionalities by personal devices

EXAMPLE 3 – SOLUTION
THIRD PARTY PHYSICAL ADD–ONS

Figure 3b - Thrid party add-on instrument cluster

In this case, the need to have an instrument cluster within the Tesla Model 3. This may be due to an obsolete user experience, but in this case mainly because the driver's needs are not met with current in-car interface.

1.3 PROBLEM ANALYSIS

In order to analyze the problem definition, the problem must be viewed from all relevant angles. To do this, in this project I apply the 360° argumentation method which is often used within the automotive industry by companies such as the VW Group and Audi. By looking at the problem from multiple perspectives, a solid foundation for the project and argumentation for developing related solutions can be formed to further build upon.

RELEVANT ANGLES

The relevant angles to analyze the problem definition are stated below and whill be further explained and substantiated in this section:

- OBSOLETE USER EXPERIENCE
  PEOPLE
- LONG VEHICLE DEVELOPMENT TIME
  TECHNOLOGY
- OEM BECOMING SOFTWARE CENTERED
  TECHNOLOGY
- EVs HAVE POTENTIAL LONGER CAR LIFESPAN
  BUSINESS
- COMPANY VISION ON SUSTAINABILITY
  BUSINESS
- SOCIETAL RESPONSIBILITY
  PEOPLE

PROBLEM
360° ARGUMENTATION

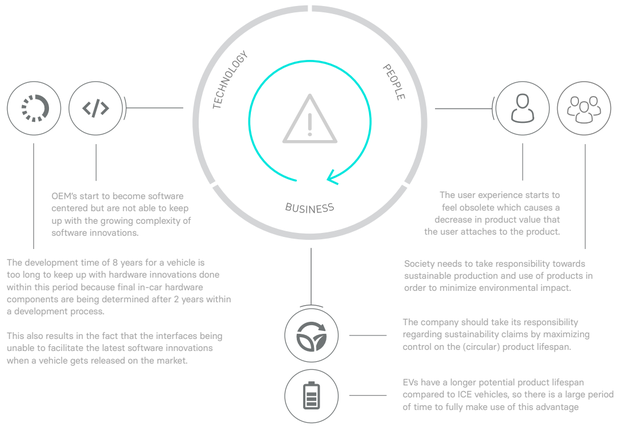


Figure 4 - 360 analysis of the problem from all relevant angles

OBSOLETE USER EXPERIENCE

The problem of obsolescence highly influences the user experience and is closely related to the vehicle's longevity. Once a product is in use, it can be assumed that it still is of a certain value to the user in its context of use. So when the feeling of obsolescence arises among users when the product is in use, it is plausible that the attached product value is likely to decrease. This decrease in value will eventually lead to a decrease in brand loyalty, and maybe even a loss in customer retention. (Lightyear Masterplan Circular Business, 2022)

VEHICLE PRODUCTION TIME

The average lead time for the process of developing a car from bottom up is about 4 years. The design phase of the car and therefore also the hardware design of the in-car interfaces are already determined during the first 3 years of the process and set for production afterwards (See figure 5). Due to the lead time of 4 years to develop a car, the physical interfaces are already at least 1 year old when launched on the market (see figure 5) (Sherman, 2015).

The design, development, and production times of a new-generation car have the consequence that both the physical and virtual interfaces may already feel outdated, when the user (unconsciously) compares it to other devices such as a smartphone (see figure 5). Users are used to physical and/or virtual interfaces that have a relatively faster turnaround time (2x faster) in development and therefore likely to feel more up-to-date compared to the in-car interfaces of their cars.

LEAD DEVELOPMENT TIME OF SMARTPHONES VS CARS

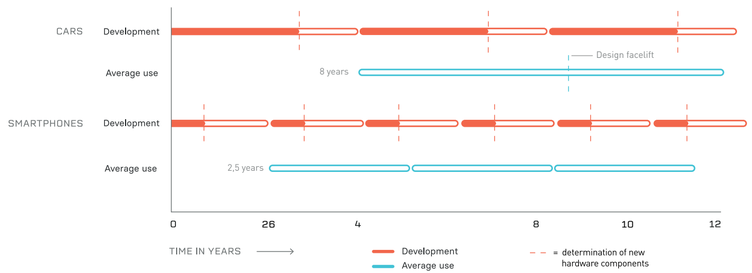


Figure 5 - Graph of car development lead time vs smartphone development lead time

OEM BECOMING SOFTWARE ORIENTED

Due to the increasing connectivity trend of cars, software is becoming an increasingly important element of the car. For this reason, many OEMs are setting up software teams that are responsible for building a cohesive experience. Because not everything can be implemented and developed in-house, this team often collaborates with third parties and suppliers, which leads to an average development time for successfully implementing software of about 3 years. These systems are not always backward compatible and thus require extensive redevelopment every few years to stay up to date with new features and performance (McKinsey & Company, 2020).

Software complexity is expected to grow by almost 300% over the next decade. As a result, OEMs and tier one suppliers will struggle to cope with the increased complexity. Productivity is not keeping pace with complexity, making it harder for them to innovate. OEMs are waking up to the issue and are not expecting a quick solution (McKinsey & Company, 2020).

RELATIVE GROWTH OVER TIME, FOR AUTOMOTIVE FEATURES, [1] indexed, 1= 2008

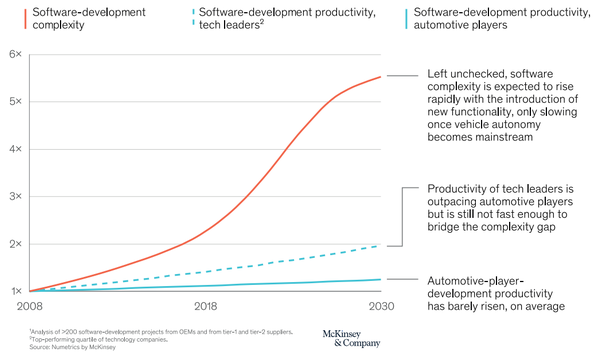


Figure 6 - Graph by McKinsey & Company, indicating the OEM software shortcomings

SOCIETAL RESPONSIBILITY

A throwaway culture has led to business promoting, producing and selling short lifespan consumer goods to maximize company profits to develop the same products over and over again to generate higher profits each year. This has led to an increasing impact on the environment for these short lifespan products due to the high paced market releases of complete new product versions. Production of these goods is the first cause of environmental impact. Subsequently, for many of these consumer goods, it is widely acknowledged that the major part of the environmental impacts is caused during the use phase, in particular through energy consumption (Abele et al. 2005). It is therefore needed for society to take responsibility by creating demand for long lasting products that focus on sustainable use with minimized waste and maximized longevity in order to minimize the overall environmental impact. Subsequently, the road transportation industry is the second largest (11,9%) industry producing the CO2 emissions globally (see Appendix 25).

POTENTIAL LONGER CAR LIFESPAN

The average lifespan of Internal Combustion Engine (ICE) passenger vehicles has increased from 9 years to 12.5 years (Deetman et al., 2018). However the average length of ownership of ICE passenger vehicles is only 8.4 years (Blackley, 2020). So the average length of ownership for ICE passenger vehicles show that owners already renew their cars while the vehicle's lifespan is far from over. After renewal the used car could become part of the so-called used-car fleet. Which is often controlled by third parties and the life-time and ultimate disposal of the product is therefore no longer in control of the original manufacturer.

The potential lifespan of current Electric Vehicle (EV) models is expected to be 15 to 20 years (Yano et al., 2016). Since the average length of ownership of EV's is not known yet, as the market introduction of the vast majority of EV's took place about 5 years ago with some exceptions, it is therefore crucial to think of ways to utilize this relatively longer lifespan by maximizing its longevity per owner.

LIFESPAN COMPARISON:
ICE PASSENGER VEHICLES VS PASSENGER EV'S

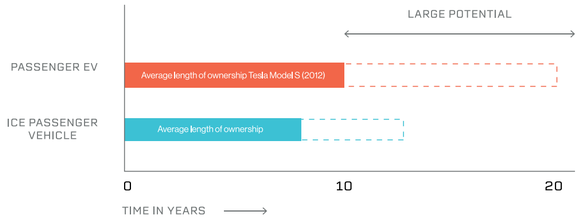


Figure 7 - Bar graph showing the potential longer period to gain to make use of expected longer EV lifespan

COMPANY VISION ON SUSTAINABILITY

The claims and promises that Lightyear makes are legit and (partly) met in the Lightyear 0 but could be less relevant to the overall sustainable goals once the user experience becomes obsolete. Once essential elements such as in-car interfaces, that have impact on extending the vehicle lifespan and/or end of life, are being included aswell within the design, it could claim to have an inclusive vision on sustainability. If done properly, it could take full responsibility and take the measures needed for its sustainable goals as a company.

1.4 BENEFITS FOR LIGHTYEAR

Once a durable in-car interface design will be achieved that is able to support and provide the intended in-car experience by Lightyear, it could result in substantial benefits for Lightyear as a company.

1. OUT OF THE BOX MINDSET

Having a durable in-car interface would complement the image of Lightyear as a company to think out of the box by being truly innovative in a risk taking way, which is also the image that Lightyear tends to have.

2. BRAND LOYALTY AND BRAND PROTECTION

The company mission, vision and intended brand image would perfectly fit this approach could increase the company's trustworthiness and therefore increase brand loyalty among users and establish a positive brand image that radiates a clear philosophy.

3. CUSTOMER RETENTION

The ability as a company to offer support and provide services that enable the maintenance of the intended qualitative in-car user experiences, could result in customer retention as a positive outcome.

4. HIGHER PROFITS

Stepping into the market beyond delivering virgin new products, could increase company turnover and profits. Usually these markets are dealt with by third parties, varying from trusted to less trusted third parties over the life-time and ultimate disposal of a product.

1.5 THE CHALLENGE

The overall challenge lies in creating durable interfaces that maintain their relevance over time by its lifetime extension. As stated by Harper: Ideally products should be designed in a way that they can be updated somehow once they cease to function according to their original purpose and relating intended interactions. This all comes to an holistic approach aimed at a sustainable overall user experience and even micro interactions related to that experience (Harper, 2017).

DURABILITY OF THE IN-CAR INTERFACES

Put another way, the challenge is to learn how to set durability as a focus of interaction design. This should eventually enable an extension of the product lifetime that contributes to the goal for a sustainably-viable future, rather than by expecting such effects to be solely the dominion of legislation and public policy (Blevis, 2007; Fry, 2005). So as designers within the automotive industry, I think we should take responsibility for creating a cleaner future by also taking the durability of the in-car experience into account regarding sustainability as a greater goal.

So for this project the main challenge is to iteratively find out, test, and learn how to apply sustainable interaction design principles within the in-car interface as a method for managing obsolescence of the in-car user experience. Eventually the challenge is to create a feasible concept that forms a solution to manage obsolescence.

The challenges can be formulated by the following research questions:

1. **How can we utilize the expected product lifetime of the car as long as possible?**
2. **How do we ensure that the interface is kept up to date during the vehicle lifespan?**

2. RESEARCH SETUP

In this part of phase A the setup and structure of the overall project is shown on a step by step basis in chronological order (see figure 9 and 10). In addition, the methodology approach is being described and the reasoning behind it. The main project outline visual is also used for each starting page of phase A-F, to visually indicate the corresponding part of the project.

MAIN TAKEAWAYS PART 2

- The project has a parallel structured workflow, with different activities performed simultaneously
- The research methodology approach is more pragmatic oriented as this is often used within the automotive industry
- All argumentation for decision-making within this project will be supported by a 360° argumentation of the specific case. This way the options or situation will be viewed from all relevant angles.

2.1 PROJECT OUTLINE

The project could be split into two halves; first part is the understanding part and the second part is the designing part. Along the vertical axes you can see that the project will pass through six phases named A to F, corresponding with the different phases described in the report index.

1. UNDERSTANDING

The first part will be about analyzing the project context in order to define the relatively undefined project assignment. Since the goal of the project is to come up with a future concept for in-car interfaces for Lightyear, it is needed to establish a clear overview on the current situation and context in order to create a future vision within a future context. In the understanding phase a clear overview of the problem, company, current product, evolution of dashboards, and supporting literature is established in order to further define the design brief for the designing phase.

UNDERSTANDING | PARALLEL WORKFLOW

The understanding part, activities such as doing literature research, stakeholder interviews, and participatory sessions with stakeholders, will be performed in parallel together with phase A to C. In this way an iterative process is possible by involving stakeholders when necessary during the analysis phase working towards the synthesis phase. During the framing phase, multiple stakeholders have been involved in order to realize a feasible and proper design brief that can be defined at the end of the first part.

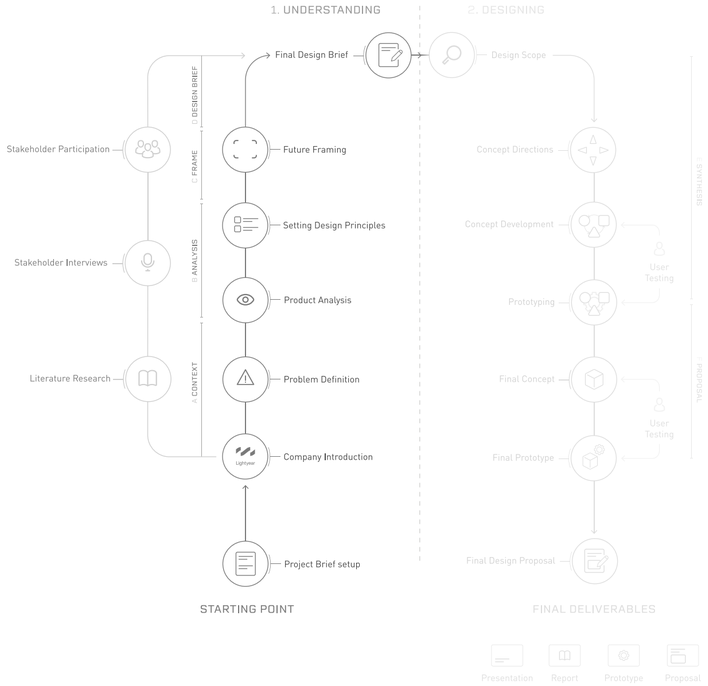


Figure 9 - Visual project overview, 'Understanding'

2. DESIGNING

The second half, which is named the designing part, can be described as the iterative synthesis that transitions into a final design proposal. This part builds upon the qualitative data, insights, and literature results retrieved in the first part. So essentially this part is about coming up with feasible concepts that can be tested via working prototypes in order to construct a design proposal that is feasible for further implementation. (see figure 10)

DESIGNING | USER CENTERED APPROACH

During the designing part, a user centered approach will be taken starting from the concept development until the final working prototype. An iterative way of involving users as much as possible by testing the concepts potentials in the way of qualitative interviews as well as user testing by the use of working prototypes. Phase E will be mainly about synthesizing all the way from possible concept directions towards a final concept that can be tested and evaluated by potential users. Part F will be mainly about choosing and developing a final concept that can be iteratively optimized by performing user tests by means of a working prototype. All done for the end goal to come up with a design proposal at the end of the last phase.

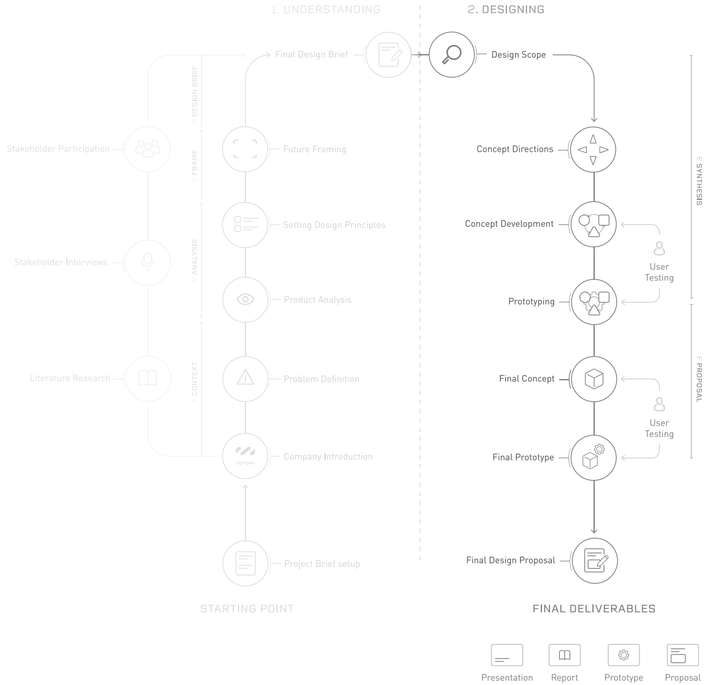


Figure 10 - Visual project overview, 'Designing'

2.2 METHODOLOGY APPROACH

APPROACH

Because the concepts to be created will be future-oriented and the fact that Lightyear has already developed a clear vision for the future, this project is different from other projects regarding following one specific research methodology approach. For this reason a tailor-made methodology would fit the project better as discussed with the supervisory team as well as with internals from Lightyear. Because the first design developments for upcoming high volume models have already started, creating a completely new view on the use of the car is not necessarily the intention, but potentially could contribute to see the future context and use from different perspectives. Because of the aspects mentioned before and the concept feasibility as one of the main criteria for this project, I have decided not to use one of the existing research methods that are more aimed at creating a new future vision (i.e. ViP, Speculative Design etc.) but to construct a tailor-made method that supports the process and leads to new insights where necessary.

360° ARGUMENTATION

Although the project includes various existing research techniques and tools from well-known design methods in order to gain possible new insights, the overall basis of both the structuring of the steps within the research process can be best described as the 360 Argumentation approach. This method is often used within the automotive industry to define the problem and eventually come up with design solutions in a more comprehensive and pragmatic way. This method structure is chosen due to the fact that it can be considered as an effective way to present argumentation and decision-making steps of the current context, concepts, design options, and final design. This method creates a view on the problem, the situation and their possible solutions, from all relevant angles giving you a well-founded whole in which you can choose realistic and desirable solutions that are relatively easy to follow. In essence it includes all relevant context factors derived from the DESTEP* analysis framework.

*DESTEP stands for Demographic, Economic, Sociocultural, Technological, Ecological and Political/Legal.
(See appendix 12 on this methodology)

METHOD
360° ARGUMENTATION

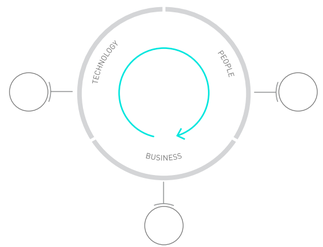
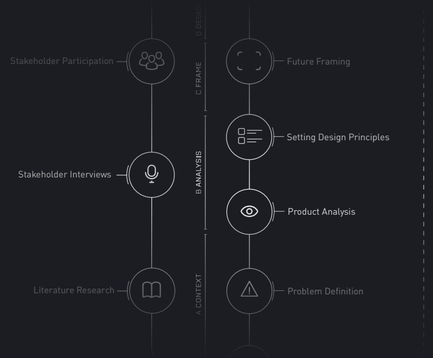


Figure 11 - Visual of 360 argumentation principle

ADDITIONAL METHODS/TOOLS

During the project, sub-methods derived from existing research methods such as Design fiction (Grand et al., 2010), Vision in Product design (Hekkert et al., 2011) and Context Mapping (Sleeswijk Visser et al., 2005) were also used. However, only techniques have been used from the aforementioned research methods to process, structure and visualize data. These do not form the basis of the final choices that are made, but are more an additional tool to use during stakeholder participation sessions or qualitative interviews with stakeholders.



PHASE B
ANALYSIS

PHASE B ANALYSIS 28 – 47

3. PUBLICATIONS

In this section, an extensive in depth analysis of existing literature is done. This entails both an analysis of different types of obsolenscence, Sustainable Interaction Design (SID) principles as well as the meaning of sustainability and durability and how these two principles are intepreted in this report for clarification purposes.

The theories and results retrieved are being supported by examples and short case studies in this section. A theoretical focus point for this project is also highlighted in a visual overview.

MAIN TAKEAWAYS PART 3

- **Focus for this project is on product durability and thereby maximizing product longevity, there are 3 types of durability**
- **Focus for this project is to avoid and/or minimize technological obsolescence and psychological obsolescence as its consequence**
- **The focus for this project is mainly on the principle for 'Renewal & Reuse'**

3.1 UNDERSTANDING SUSTAINABILITY

MEANING OF SUSTAINABILITY

The term sustainability is broadly used to indicate programs, initiatives and actions aimed at the preservation of a particular resource (RMIT University, 2017). Sustainability as a notion of viable futures can be defined to include aspects of the environment, public health, social equality and justice, as well as other conditions and choices about humanity and the biosphere (Fry, 2005). In what follows, the focus is primarily on environmental sustainability and the link between interactive technologies and the use of resources, both from the point of view of how interactive technologies can be used to promote more sustainable behaviors and—with more emphasis here—from the point of view of how sustainability can be applied as a critical lens to the design of interactive systems, themselves (Blevis, 2007).

The second meaning of the application of sustainable interactive systems, which is in essence an interface, could be seen as the interfaces which can be achieved by implementing sustainable interaction design (SID) principles mentioned later in this report.

So the meaning of sustainability is mostly a positive design consequence to enable a sustainable future. In order to later understand and analyze the effects of a design on the environment, we need to deconstruct sustainability aspects of a product in the form of a rubric (see appendix 3). This rubric will be used later in the project to evaluate concepts and prototypes by their possible effects.

CONCEPT OF DURABILITY

Next to that, the aim for sustainability in design and its related interactions also include specific meaning with regards to the concept of durability, so in essence the capacity for an interaction to sustain over time.

In this report "sustainability" will be the overall term used to describe the durability of a concept in three ways:

- Durability with the use of **enduring materials** or materials that age gracefully;
- Durability, as a concept referring to **materials that make it easy to repair or to upcycle** design objects;
- Durability related to **design solutions that can be updated continuously** by means of technology or replaceable elements that safeguard against their obsolescence.

Now that the difference between the overarching term "sustainability" and the concept of "durability" is clear, the interpretation of the two terms used in this report is set. The three means of durability principles mentioned above will be included in this report ranging from materials to concept directions.

FOCUS ON DURABILITY

The focus for this project will be on product durability for the reason that this implies physical product qualities which mainly infleunces the in-car interface itself and its longevity. So durability will always be the starting point and sustainable behaviour could be a possible side effect of the concepts but it is not intentionally designed for in the first place.

3.2 OBSOLESCENCE IN DESIGN

Meaning of obsolescence in product design: “Product obsolescence refers to the time and state in which a piece of technology or product ceases to be useful, productive or compatible. Product obsolescence may occur when a company stops producing, marketing or supporting a sold or developed product.” - Techopedia.com

MEANING OF OBSOLESCENCE

As stated in the literal meaning of obsolescence in product design, it is the phase where the user no longer feels the need to use a product which could be affected by several kinds of obsolescence in product design. By thinking about the experiential aspects of obsolescence and the approaches wherein interplay of these aspects translated through a design, it is likely that the results should have a positive effect on the overall user experience (Remy et al., 2014).

Obsolescence can be described by four different categories: Technological obsolescence, Social (Psychological) obsolescence, Economic obsolescence, and Ecological obsolescence. Which then could be explained by several types of obsolescence that could individually or in combination have an impact on the product’s usefulness and lifetime.

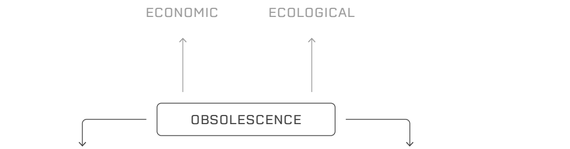


Figure 12 - Structure of Obsolescence and its different types

TECHNOLOGICAL OBSOLESCENCE

This is the major type of obsolescence that is the most tangible one and therefore can be clearly experienced by the consumer. This category of obsolescence causes the product to be no longer functional, which forces the consumer to replace the product (Vanderseypen, 2018).

FUNCTIONAL DEFECT

The product is no longer functioning and suitable for repair due to the way of configuration only aimed at assembly and/or defect delicate parts. Which implies the replacement of the whole product (Centre Européen de la Consommation, 2013)

SOFTWARE OBSOLESCENCE

Products become obsolete by increasingly demanding software that requires the purchase of new hardware to support it. Such software can reduce hardware performance by, for instance, being slower, and some functionalities may also not be usable anymore (Vanderseypen, 2018).

INDIRECT OBSOLESCENCE

Products become obsolete by increasingly demanding software that requires the purchase of new hardware to support it. Such software can reduce hardware performance by, for instance, being slower, and some functionalities may also not be usable anymore (Vanderseypen, 2018).

OBSOLESCENCE BY NOTIFICATION

A method of indicating to consumers that (a part of) the product its obsolescence by notifying the consumer about it, and optionally indicating the need to replace parts or the whole product.

OBSOLESCENCE BY SOPHISTICATION

Complexity in (parts of) products could be more prone to breakdown and more difficult to repair. Sophistication in expertise to repair it may not be wanted due to the high investments required for it.

EXAMPLE
TECHNOLOGICAL OBSOLESCENCE

Figure 13 - BMW i3 2013 screen and interior

The BMW i3 2013 was a revolutionary design as it was one of the first small EV’s aimed at urban everyday mobility. The i3 Nav screen seems to have it all but rules out all possible third party software updates. As CarPlay and AndroidAuto rely on a touch screen interface, which is not supported by the screen installed. It would require a major interior redesign for BMW, which is often not prefered by consumers, so this model becomes technologically obsolete.

SOCIAL [PSYCHOLOGICAL] OBSOLESCENCE

This category of is more a subjective type of obsolescence that most of the time occurs unconsciously among users. In this case products are considered obsolete although they are still properly functional most of the time (Aladeojebi, 2013; Centre Européen de la Consommation, 2013). Therefore "Social obsolescence" could also be described as a matter of obsolescence with psychological user implications. It can be divided into two types of obsolescence.

PSYCHOLOGICAL OBSOLESCENCE DUE TO THE CONSUMER

According to research done in consumer behavior, it is known that a majority of consumers feel a strong desire for new products. By having this strong desire for the "new", they contribute to the reduction of product lifetime (Brouillat, 2015). This type of obsolescence can be described by three types of motivating factors among consumers (Vanderseypen, 2018).

- Pristinians - Consumers that are more attracted by untouched products
- Technophiles - People who are constantly seeking for the newest technologies
- Known as boring - The familiar is seen as boring by the user and therefore the desire for the unfamiliar rises

MARKETING STRATEGIES

Marketing activities can be considered as external influences that motivate the user to replace their current products. This can be done by several models that intentionally make consumers desire new products over their current ones (Vanderseypen, 2018).

- Heavy promotion of annual model updates
- Involving the opinions of others by showing the incremental features of the new products as beneficial
- The manufacturer's justification for renewal by using the consumer's desire for the new

EXAMPLE
SOCIAL [PSYCHOLOGICAL] OBSOLESCENCE

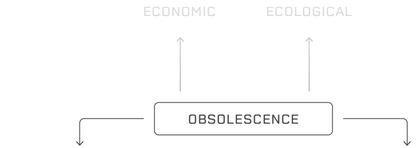
Figure 14 - Polestar commercial still image Scan QR code to watch full commercial

This Polestar commercial was shown during the half-time show of the Super Bowl 2022 and is exactly how social obsolescence is enabled by means of a marketing strategy. Which could lead to a feeling of obsolescence among drivers of ICE vehicles or maybe even Tesla owners that Polestar was hinting at, in this remarkable commercial. This commercial also implied ecological motives (see Appendix 1) by picking on current (non-sustainable) brands.

FOCUS ON TECHNOLOGICAL AND SOCIAL

Economic and Ecological obsolescence of course play an important role in the concept of obsolescence but are considered to be types of obsolescence driven by external factors such as policies, governments and other industries. They can be considered mostly as indirect factors that can create the effect of obsolescence as stated by E. Van der Seypen. For these two forms of obsolescence a detailed explanation can be found in Appendix 1.

These factors will be taken into account during the project but it is chosen to mainly focus on the Technological and Social obsolescence factors from the conceptualization phase onward (See figure 15).



SOCIAL [PSYCHOLOGICAL]

- Psychological obsolescence due to the consumer
- Marketing strategies

TECHNOLOGICAL

- Functional defect
- Software obsolescence
- Indirect obsolescence
- Obsolescence by notification
- Obsolescence by sophistication

Figure 15 - Focus point regarding obsolescence for this project

PLANNED OBSOLESCENCE

Planned obsolescence is also an ever growing phenomenon in product design (Dalhammer et al., 2016). This could be explained as intentionally designed products with obsolescence as one of the key drivers for renewal in order to maximize profits and outperform competition. This phenomenon refers to entities (i.e. firms, governments, consumers etc.) that act deliberately to incentivize or force the replacement of a product for a new one. However, this debate concerning whether the entity has really planned this obsolescence will not be covered and therefore left out of the scope in this report (Dalhammer et al., 2016). Also supported by the fact that Lightyear would not be led by these specific business motives.

CONSEQUENSES OF OBSOLESCENCE

The concept of obsolescence also results in positive implications such as for example innovations and technological improvements (Aladeojebi, 2013). Therefore, Brouillat (2015) argues that obsolescence can foster new and more efficient technologies, which has a positive impact on consumer welfare. As an illustration, we could mention that cars are now less polluting and more secure than before (Centre Permanent pour la Citoyenneté et la Participation, 2014).

Although it drives supply diversification, price range growth and technological improvements, it has detrimental effects on the environment in terms of waste and resource depletion, as well as consequences on social welfare (Vanderseypen, 2018). One of the indirect consequences is that social obsolescence could increase pressure on overall working environments resulting in poor working conditions, due to increasing demand for production.

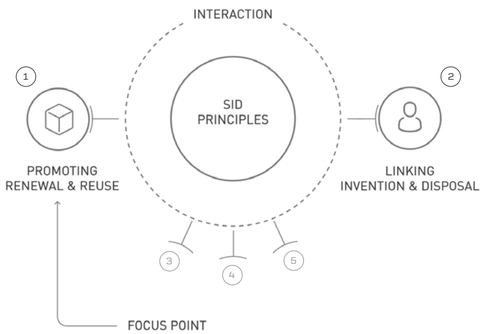
However, the main consequence and therefore the main concern for obsolescence is definitely the negative impact on the environment due to the increased carbon footprint of sped up productions, shortened product life cycles and improper waste processing at the end of life stage of a product.

3.3 SUSTAINABLE INTERACTION DESIGN (SID)

When designing interactions to be sustainable in itself due to their longevity, the design can be based on so-called Sustainable Interaction Design principles that will likely increase the chance of achieving the intended sustainable aspects of them.

As stated by E. Blevis (2007): “If things are designed and constructed with sufficient quality and modularity, people may be inclined to look after them and selectively update them creating the effect of achieving longevity of use.”

So if these principles are applied in the right way, they could contribute to a better future within product design and use. The SID principles are listed on the right:



SID PRINCIPLES

Blevis, E. (2007)

1. Promoting renewal & reuse - design of objects or systems with embedded materials of information technologies implies the need to first and foremost consider the possibilities for renewal & reuse

2. Linking invention & disposal - any design of new objects or systems with embedded materials of information technologies is incomplete without a corresponding account of what will become of the objects or systems that are displaced or obsoleted

3. Promoting quality & equality - need to consider quality as a construct of affect and longevity and quality in the sense of anticipating means of renewal & reuse, thereby motivating the prolonged value and providing an equal experience to new owners or to owners over time.

4. De-coupling ownership & identity - implications for sharing materials, intellectual commons, and sense of self-hood which must be considered as part of sustainable design of interactions with digital artifice

5. Using natural models & reflection - an approach to interaction design-even by the design of its removal-that prompts sustainable relationships to nature and that SID begins with a reflection on this principle of making the world of the artificial more like the natural world with respect to sustainability

FOCUS ON PRINCIPLE 1 AND 2

For this project the focus point will be on Promoting renewal & Reuse (1) because it opens up the more physical and concrete concpetual solutions compared to the more abstract ones aimed at sustainable behaviour. (See Part 3.1)

The first two design principles can be considered as two opposite principles which result on the one hand sustainability as durable products (1) and on the other hand behavioral change (2). The other three principles stated above will be considered as principles that could work both ways and are methods to achieve (1) and (2).

3.4 APPLICATION OF SID PRINCIPLES

EXAMPLE 1
LINKING INVENTION & DISPOSAL

Figure 16 - Braun portable radio TP1 and Ipod

The Apple iPod and the 1959 Braun TP1 radio module by Dieter Rams - Aesthetically familiar design but used for an entire new product category. Keeping a minimal yet familiar aesthetical style could have a positive influence on the overall product acceptance among users. In addition this product is still updateable through software updates and thereby it potentially could extend the product lifespan.

EXAMPLE 2
PROMOTING RENEWAL AND REUSE

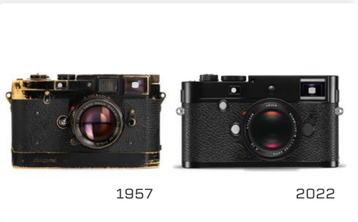


Figure 17 - Leica MP and M1 camera models

Leica MP camera (Analog) and Leica M1 camera (Digital) - Interchangeable lenses form backwards compatibility principle of critical components to be updated while the aesthetic design language maintains the same. So the overall product aesthetics reach an heirloom status among users over time.

EXAMPLE 3
PROMOTING RENEWAL AND REUSE

Figure 18 - Three different smartphone configurations as mock

Project ARA was one of Google’s projects focussed on creating a modular smartphone design in the age of ‘right to repair’ that allowed each phone to be one of a kind. But even more important: it was easy to repair and to renew different elements.

Note: Google canceled the project due to its misfit within the product portfolio at the time and high potential risks involved.

CONCLUSION

The sustainable interaction design principles as stated by E. Blevis 2007 are design principles to take into account during the entire design phase of this project. They could be seen as a visionary principle to hold on to when designing elements that interact and work together in order to achieve a maximized longevity of the overall user experience as an end goal. These principles could also be used to evaluate designs in later stages in order since these principles can have an impact on the interactions which eventually form the overall user experience.

3.5 UNDERSTANDING INTERFACES

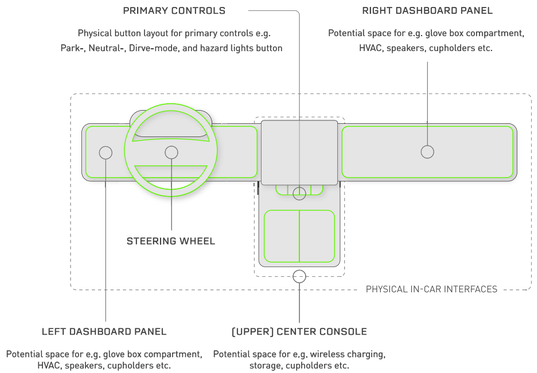
An interface (literal meaning):
"a point where two systems, subjects, organizations, etc. meet and interact"

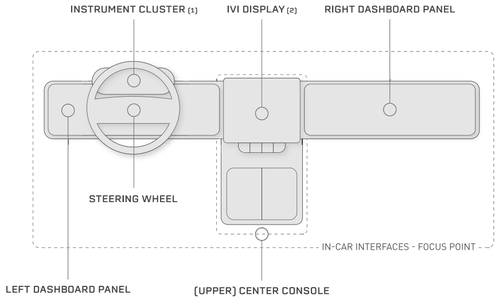
For this project the interface can be seen as the dashboard which is the 'system' and the passenger/driver being the 'subject'. The interface is the designed system that facilitates the interactions between these two.

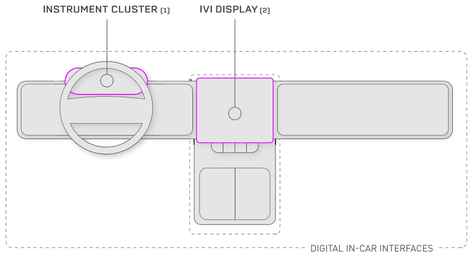
The interfaces in this project concerns all elements of the dashboard that are designed to facilitate a certain interaction. Herein form the instrument cluster, the In-Vehicle Infotainment screen and the center console the overall in-car interfaces. A distinction is made between the physical interface and the digital interface. These are highlighted in the visual below.

ERGONOMICS

In this project, key ergonomics of occupants related to their in-car interface use, are left out of scope. However for further concepts and designs in the project, the measurements and postions of design elements in relation to the user are based on conventional interface dimensions to ensure feasibilty in terms of ergonomics as much as possible.







"Sustainability in design is about improving the technology we use when we design systems in terms of energy consumption, performance, and longevity of use."

- (DiSalvo et al., 2010)

4. EVOLUTION OF INTERFACES

This section shows a visual analysis of the evolution of in-car interfaces over time. To have a clear overview how dashboards have evolved over time it is needed to pick a car that on average is the most used, representative for its time with each model, and a middle class car loved by many generations, in order to make an insightful comparison.

MAIN TAKEAWAYS PART 4

- There have been a clear paradigm shift in design focus towards in-car interface designs from the year 2012 onwards, which went from entertaintment focussed to connectivity focussed
- Physical secondary controls have also become part of the all-in one virtual interfaces since 2019

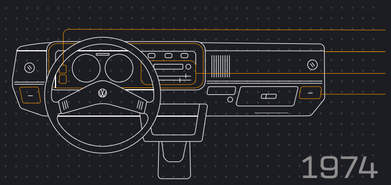
4.1 TIMELINE OF VW GOLF

It is undoubtedly the Volkswagen Golf that from the 70's on it has been a successful and that has enabled the automotive progress for everyone for eight generations long. More than 35 million units of the Volkswagen Golf have been produced in the last 45 years which makes it the most sold European model in history. The VW Golf embodies and is highly valued by its versatility, functionality, reliability and quality in all its models.

The interior of the VW Golf has evolved to meet modern requirements and facilitate new technologies without losing its original charm, while it took its place within the automotive industry for decades.

Figure 19 - First model VW Golf MK1 (1974-1983)

Figure 20 - Latest model VW Golf MK8 (2012-2019)



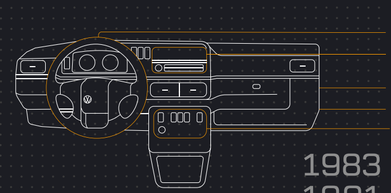
1974
1983

KEY FEATURES

- MFA computer (Multi-Functional)
- Angular Look and Feel
- Panasonic Radio Cassette
- Introduction of Air Conditioning

VW GOLF MK1

The introduction of the MFA computer meant that the lower dash console (which previously housed 3 instruments) was replaced with a blanking plate. Note, many owners have since re-installed the instruments for a better look.



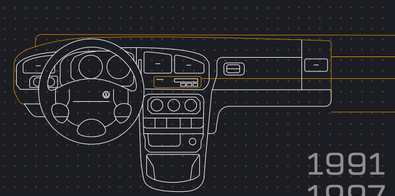
1983
1991

KEY FEATURES

- Power steering
- Gama Radio (Digitized LCD screen) Single DIN, upgradeable by user
- ABS (Anti-blocking system)
- More rounded stylistic elements
- Automated secondary controls

VW GOLF MK2

The successor of the Golf Mk 1 established the manifestion of the "Golf Phenomenon. It becomes the mirror image of the brand with a cross-class status. As Volkswagen said at the time: "Continuity in the concept, progress in detail and quality."



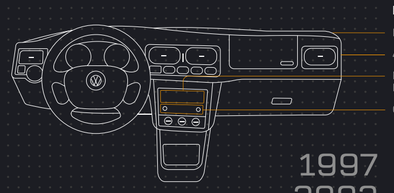
1991
1997

KEY FEATURES

- Front Airbags
- Cruise control system
- Automated station search radio Single DIN, upgradeable by user
- More spacious interior

VW GOLF MK3

This model is more aimed at driving performances by focussing on the aerodynamic characteristics and the wider track. The wider track also created more space for the interior which gives the occupants more headroom and legroom.



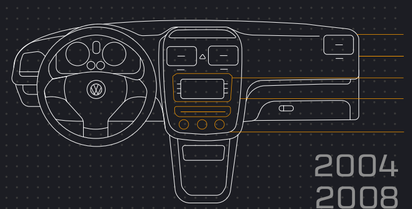
1997
2003

KEY FEATURES

- Rounded stylistic elements
- 4Motion drive
- Multi Functional Display and Double DIN, upgradeable
- CD player

VW GOLF MK4

The longer roof and steeper rear increased the interior space for this model. The introduction of VW 4Motion also makes this model a milestone one in its series.



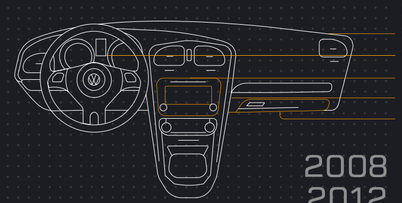
2004
2008

KEY FEATURES

- Sporty and performance appeal
- Automated rain sensor
- Multi media connectivity
- RCD 300 CD player (LCD screen) Double DIN, harder to upgrade
- Variety of Climate Control options

VW GOLF MK5

The overall style of the 5th VW Golf model can be seen as a more sporty approach to its predecessors. The RCD 300 CD player with the option to connect a digital MP3 player built in the middle console became dominant as cassettes became more a thing of the past.



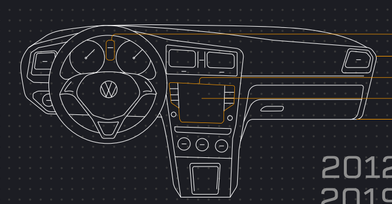
2008
2012

KEY FEATURES

- Start/Stop system
- Combi Display between IC dials
- First touchscreen Multimedia
- DVD navigation system
- Knee Airbag

VW GOLF MK6

The 6th Golf marks the beginning of the digitalization of the car dashboard. Due to technological developments the car now offers an infotainment system that is suitable for multiple media in order to listen to music, use the built in navigation as well as connecting devices through USB.



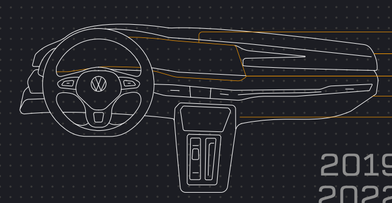
2012
2019

KEY FEATURES

- Active Info Display
- Voice Control and Gesture controls
- Discover Media system
- 3D Map Display
- Bluetooth and WLAN Hotspot

VW GOLF MK7

The 7th VW Golf is well known for its performance innovations with full connectivity interfaces and by improvements on efficiency and energy consumption . It also marks the first model within the compact class to also have an all-electric variant.



2019
2022

KEY FEATURES

- Digital Innovision Cockpit
- Head-up display
- Haptic Climate control buttons
- Semi-autonomous driving
- Voice and touch commands

VW GOLF MK8

The focus of the brand new 8th model of the Golf series lies on enhancements of the digital experiences by implementing a seemingly wide screen. The voice-activated infotainment system allows for online music streaming and other internet services where connectivity on the go is one of the main features.

As it has been visually presented that the in-car interfaces and overall layout of the dashboards of the VW Golf clearly made a transition in the past 50 years, it also has made its transition regarding the use of new technologies over the past decades. As described in the previous timeline as well as the one presented below, you can see that the user interfaces were primarily mechanical aimed and which also resulted in physically operated user interfaces. All due to the technology and production limitations during its time periods.

GPS NAVIGATION

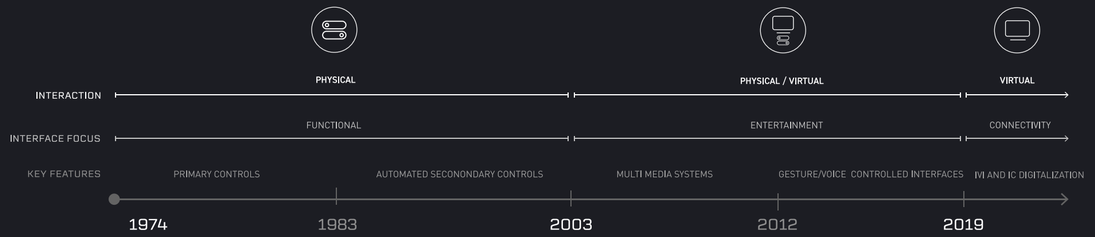
One of the major infuences on the overall layout and implementation of screens within the in-car interfaces was the innovation of built-in GPS navigation systems, which was introduced from the year 2008 for the VW Golf MK6. The implementation of large sized screens led to the fact that in-car interfaces became more screen oriented as the rest of the layout of physical elements and functionalities were designed around the screen.

INFOTAINMENT

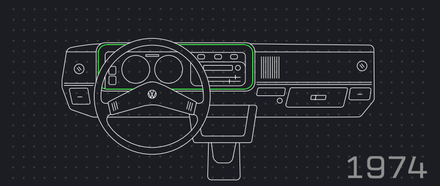
After several years it became apparent that the car not only needed to be functional, but in addition should also be a space of entertainment, so that is why things such as the cassette player, radio, and cd players got built into dashboards. Within the interface of the MK1 (1974-1983) it was just a basic cassette player and frequency radio, but starting from the MK5 (2004-2008) it became a multimedia with a touchscreen display that offered a wide variety of media that could be played/operated next to displaying user driving info.

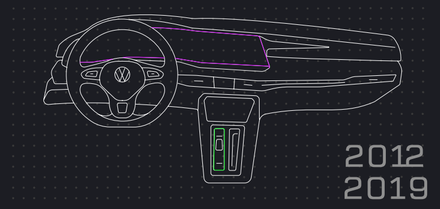
CONNECTIVITY

The car as a connected object into the ever growing network of user connectivity in relation to other users, object and its environment took its entry within the MK7 (2012-2019). From this model on it is not only entertainment but also the car as an object that is able to communicate bidirectionally and connect with systems outside of the car.



4.2 INTERFACE LAYOUT





Digital interfaces Physical interfaces

In comparison of both location and type of interface being used in the earliest and latest model VW Golf, it is clear that a shift all the way from a clustered physical interface to a fully virtual interface with almost all functionalities embedded ,aside from the primary driving controls and stalks behind the steering wheel.

TECHNOLOGICAL INNOVATIONS

The rapid technological innovations have mainly caused the paradigm shift of in-car interfaces over time in terms of functionalities. Because of new technologies being implemented in almost all our everyday products, users will also change their requirements in terms of (basic) needs concerning new functionalities within cars. Concrete examples that have led to a change in functionalities, configuration, and layout of in-car interfaces are:

Sound carrier: Radio > Cassette Player + Radio > CD + Radio > Bluetooth > Cloud based
The sound carrier changed from physical, to wireless, to virtual

Navigation: Maps > Separate GPS on VGA Display > Built-in High Res GPS > Cloud based
Navigation functionalities changed from physical, to digital add ons, to virtual

Comfort: No HVAC > Ventilation > HVAC > Automated Climate Control by HVAC
The comfort experience has changed over time from no to visible manual air vents to automated climate control through sometimes sleek hidden air vents

AESTHETIC TRANSITIONS

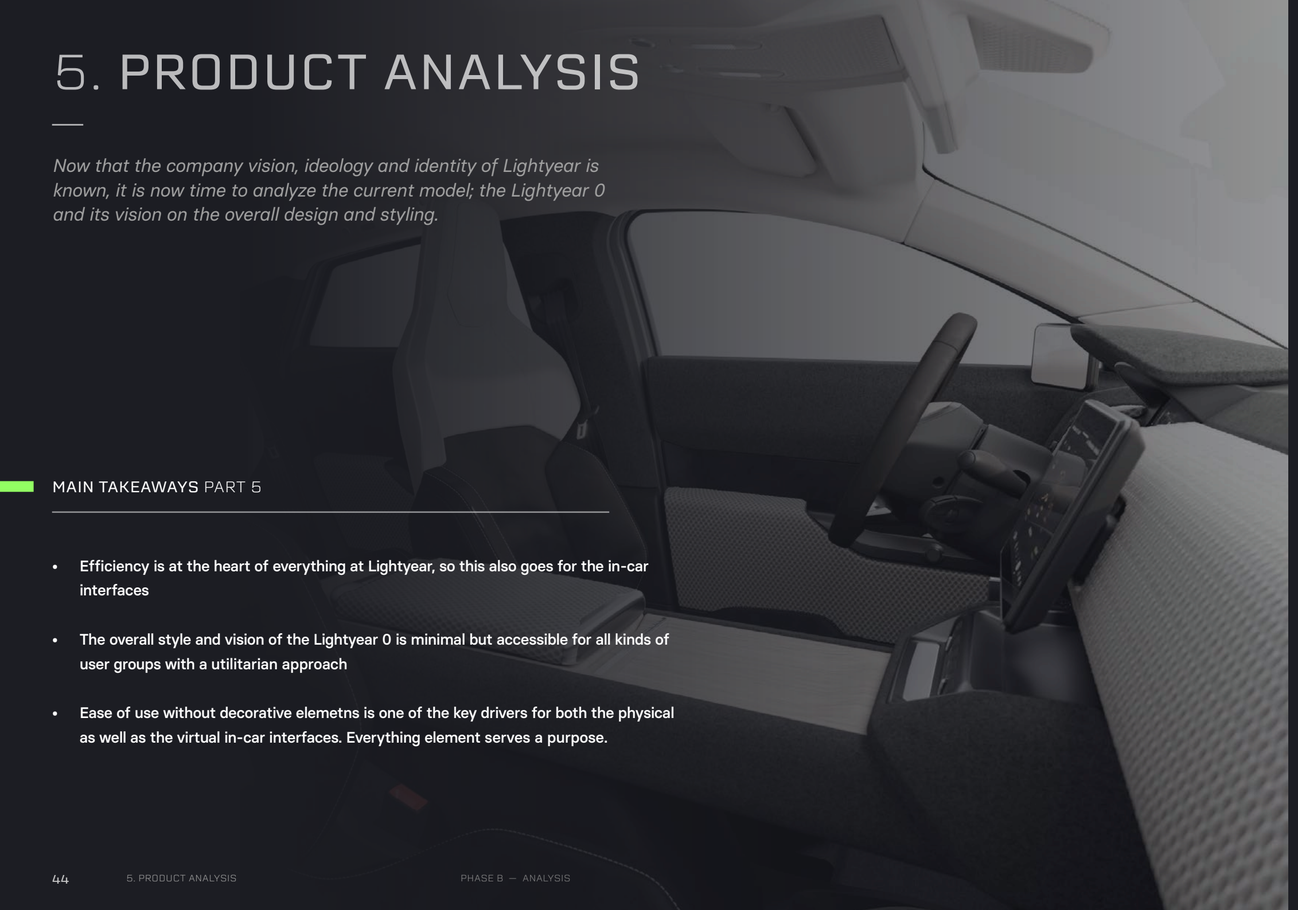
A change in style caused by aesthetic trends and ever changing context (cultures, societal needs, policies etc.) also affects the physical interfaces which are designed based on different style principles compared to its predecessor. Next to production costs of the in-car interfaces, this change in style forces designers to make compromises in terms of functionalities and influences design choices that have to be made.

FUTURE TRANSITION COURSE

The change of future in-car interfaces is always insecure as it is highly dependable on a lot of internal decisions and contextual factors. About ten years ago there started a trend towards a so-called “full glass cockpit” with only a screen in which all functional elements were built in, which was something that felt very innovative and new at the time. However, it now appears that the average user has noticed that physical buttons and second controls in combination with the screen seem to work best. Now the trend is heading more towards brands looking for this optimal balance within the in-car interface.

5. PRODUCT ANALYSIS

Now that the company vision, ideology and identity of Lightyear is known, it is now time to analyze the current model; the Lightyear 0 and its vision on the overall design and styling.



MAIN TAKEAWAYS PART 5

- **Efficiency is at the heart of everything at Lightyear, so this also goes for the in-car interfaces**
- **The overall style and vision of the Lightyear 0 is minimal but accessible for all kinds of user groups with a utilitarian approach**
- **Ease of use without decorative elemetns is one of the key drivers for both the physical as well as the virtual in-car interfaces. Everything element serves a purpose.**

5.1 LIGHTYEAR 0

This is the first Lightyear model that they will bring to the consumer market, it will be called the Lightyear 0. This model will be produced in a relatively small number of 946 cars and is therefore called the 'Exclusive Series'.

Being a long range solar EV, the car achieves 725 km range (WLTP) on a single charge with support of its 1075 Wp solar cells, which deliver 12 km extra per hour charge in the sun (Dutch irradiance). This patented double curved solar array achieves 215 Wp/m² and is fully automotive compliant. The solar cells cover a total of 5m² on the roof of the car. All these performance features are made possible by an ultimate balance in lightweight materials such as carbon and aluminum for the chassis, while maintaining rigorous safety standards (Lightyear, 2022).

VISION | LIGHTYEAR 0

The possible future

Lightyear strives for a clean future, which means a zero emission future, by providing a highly efficient solar powered car that makes clean long range mobility possible and thereby getting a step closer to this strong belief. The idea behind the car is that it should express itself as if it belongs to the possible future while expressing future freedom as one of its core values.

(More information about the vision behind Lightyear 0 can be found in Appendix 2)

UI/UX | LIGHTYEAR 0

Digital Interface

The overall style of the interface could be described as minimal approach but rather utilitarian than minimalistic in general. Decorative elements can be seen as redundant and are therefore not included in the design. The only element that serves a decorative purpose within the style of the virtual interface is done through the application of the Lightyear branding colors (orange and teal), in order to create a cohesive branding throughout all their media and products.

Clear communication

All language used within interfaces is understandable and not too technological in order to radiate the natural and human feeling that the car its characteristic addresses. The vision regarding the use of language within interfaces is therefore: descriptive, functional, and efficient, all done through a human tone of voice. This way, Lightyear still wants to keep the product accessible for all kinds of user groups, and thereby tries to be inclusive also within the UI/UX.

UI/UX | LIGHTYEAR 0

Efficiency within UI/UX

The benefits that users earn from driving a solar powered car could potentially seem very complex to perceive for the average user, it is therefore the aim to create an user interface that is accessible to the average user and easy to understand. The efficiency in use is of high value within the interface, it should be easy to understand and every action should be easy to access and complete in order to reach an objective. This applies to both the physical as well as the digital interfaces and this approach is highly intertwined within the two.

Usability

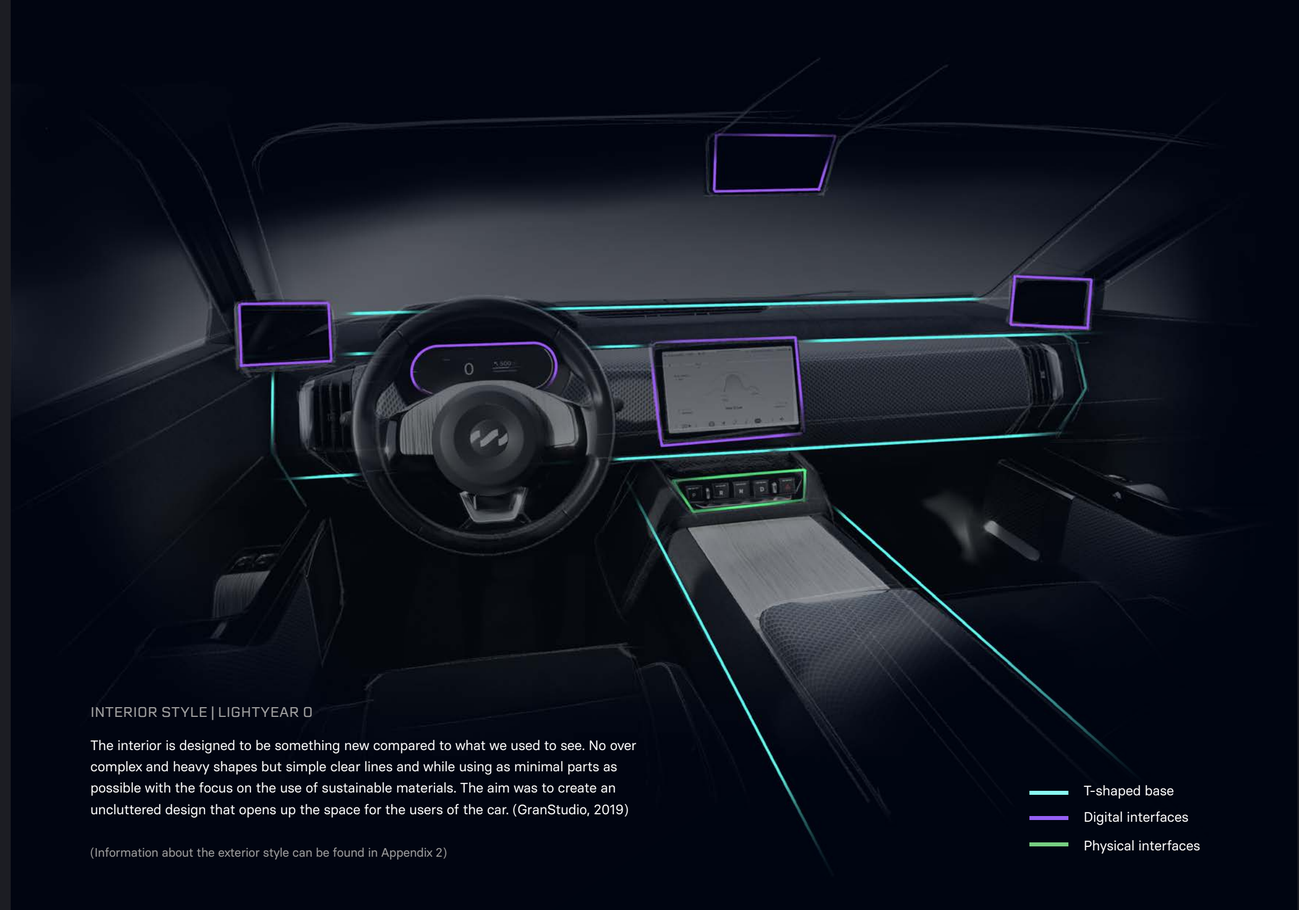
Usability within the interfaces of the Lightyear 0 is of high value. This is again aimed at an inclusive user group so that means that design decisions have been made to accommodate this. Firstly, the positioning and overall layout of the interfaces (digital and physical) are designed in a conventional way in order to achieve efficiency. The design and structure of the interfaces is put together with maximum effectiveness in mind by eliminating all redundant elements while striving for a minimal yet functional interface. The overall UI and therefore UX could be described as an engaging utilitarian design by involving the user in the solar features and corresponding benefits of the car.

Figure 21 - Lightyear 0 interior and digital user interface on IVI display

IVI DISPLAY

IC DISPLAY

Figure 22 - Digital user interface mock ups for Lightyear 0

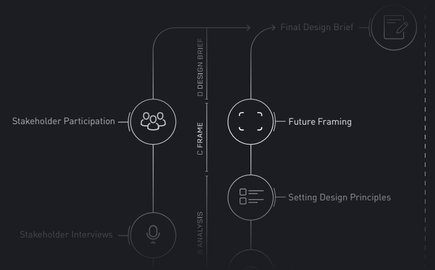


INTERIOR STYLE | LIGHTYEAR 0

The interior is designed to be something new compared to what we used to see. No over complex and heavy shapes but simple clear lines and while using as minimal parts as possible with the focus on the use of sustainable materials. The aim was to create an uncluttered design that opens up the space for the users of the car. (GranStudio, 2019)

(Information about the exterior style can be found in Appendix 2)

T-shaped base
Digital interfaces
Physical interfaces



PHASE C

FUTURE FRAMING

6. THE STARTING POINT

In this part the foundation of creating the future frame and the so called buidling blocks for the future concept visions. This can be seen as creating the starting point for the design phase in the second half of the project. By doing different kinds of research and getting insights from various relevant fields that all take part within the possible future, a solid foundation can be formed to use as an starting point for the next phase of setting the design brief (Phase D).

MAIN TAKEAWAYS PART 6

- **The design domain from where the future context is determined : Future-proof in-car user interface for upcoming Lightyear models**

6.1 EXPERT INTERVIEWS

In order to get a clear overview of the problem and especially the vision and expectations for the future, it is essential to view the situation now and get insights from as many angles as possible. Therefore a total of 7 qualitative semi-structured interviews were conducted in order to retrieve as much insights as possible to eventually formulate the final design brief. The information is also used for the collection and formulation of the context factors taken into account, which is explained in the next parts of phase C as well.

Overview of the experts that are involved for the first phase of the project and its topic:

COMPANY	CONTACT	POSITION	INTERVIEW FOCUS
Lightyear	Bram Bos	UX Lead	(Future) In-car User Experiences
Lightyear	Charlie Box	Product manager	Future of mobility and its perception
Lightyear	Evita Goettsch	Strategy Design Research	Future of mobility and its perception, Research methods
Lightyear	Henk de Bruin	VP Sustainability	Vision on sustainability, Possible concept implementations
Carros Magazine, BNR Petrol Head	Carlo Brantsen	Editor-in-chief, Podcast Host	History of in-car interfaces, Future expectations of mobility
Berlin Senate, Audi and VW Group	Dr. Michael Minschke	Head Digital Transformation, (Former) Head Infotainment and HMI	Human Machine Interactions within in-car interfaces
Reframing Studio	Prof. Matthijs van Dijk	Owner and Founder, Author ViP '(Research method)	Future framing, Research methods

In addtion to this list of experts, a lot of informal conversations with Lightyear internals also helped to formulate and collect relevant context factors.

6.2 DESIGN DOMAIN

After having done substantial literature research, field research and stakeholder interviews, a clear domain can be defined by all this information retrieved. In order to start the deconstruction phase for framing the future by doing observations and considerations in the form of so-called factors or building blocks, we need to determine this domain in which these starting points are relevant (Hekkert & van Dijk, 2011). So the domain (or scope) could be described as the description of the field where this project aims to make a contribution to.

After considering all information retrieved in the stages before setting the domain, the “filter” that will be looked through to the world where we look for context factors is set.

DESIGN DOMAIN/SCOPE

Future-proof in-car user interface for upcoming Lightyear models

7. CONTEXT BUILDING

In this part the process of building a future frame will start. The goal for this part in the process is to create a possible future context that is relevant enough and opens up a solution space for the concepts to tackle the problem (stated in part 1.3). As mentioned in te previous part, it is now needed to collect as many relevent context factors as possible. By doing so we can take all relevant aspects into account that might be of influence on the future context as possible.

MAIN TAKEAWAYS PART 7

- A total of 60 context factors were collected as "building blocks" to shape the future context
- Based on expert interviews, observations, conversations with Lightyear internals, and literature research all 60 context factors could be labeled, categorized , and clustered
- Thematic relations where found between clusters in order to come up with 3 descriptive axes that set a future context. Three variations of possible futures could be formed from these found axes:

  Sense of Responsibility, In-car interface (purpose), and Sense of Control

7.1 CONTEXT FACTORS

The context factors, previously described as building blocks can be ordered into different kinds of factors that can be considered as a trend, development, principle or state. All factors are considered to be considered as a (in)dependent category that is either technological, social, psychological, ecological, biological, demographical and/or cultural effect on the future. All context factors collected can be found in the Appendix 4.

All 60 context factors are derived from existing literature, observations, or named by experts across various fields. The factors have been collected with the set design domain in mind and can all form potential building blocks to eventueally shape the future scenarios.

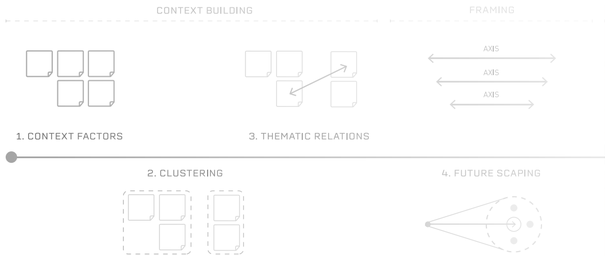
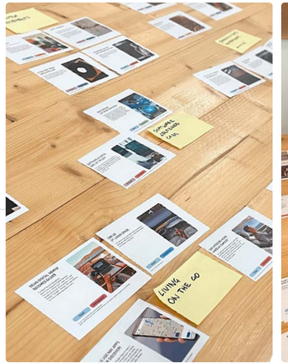


Figure 23 - In this visual the first steps of the future framing process is being described

7.2 CLUSTERING FACTORS

After having collected the relevant context factors, the next step will focus on ordering the factors into clusers by looking for connections, opposites and/or simularities. The goal of this step is to find relations that are most dimonant en eventually together can form a framework of clusters that can explain your future context.

In total there are 15 clusters found and described in Appendix 5. In order to understand the clusters and the method of finding them, both a visual map as well as an method explanation is given in Appendix 6 which explains how the clustering was formed.



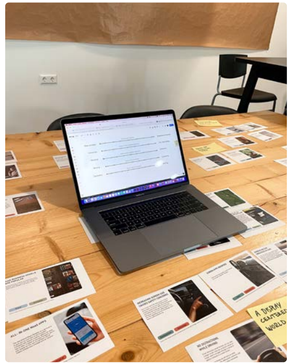


Figure 24 - The participatory session with Lightyear members from UX and Design Strategy teams

7.3 THEMATIC RELATIONS

The thematic relations can be described as axis formed by two or more clusters on both ends. Togehter they will will shape the future by defining its dimensions and thereby creating in this way interior views for the future. In this case, for the project it is most needed to find the interaction views related to those future views. These relations between the clusters are called also often called driving forces, and help to build a single narrative that connects the independent narratives told by each cluster (Hekkert et al., 2011).

Based on earlier reserach done stated in the previous phases, the following dimensions seem to open up a variety of interaction views. They are also likely to be the most suitable dimensions that represent Lightyears vision for the future as well as to provide enough solution space for new innovative, and sometimes even more experimental, concept directions.

A total of 3 axes were chosen eventually because of their potential to create different interaction views for and more importantly they could be combined and form a framework that is realistc and feasible by matching Lightyears future vision.

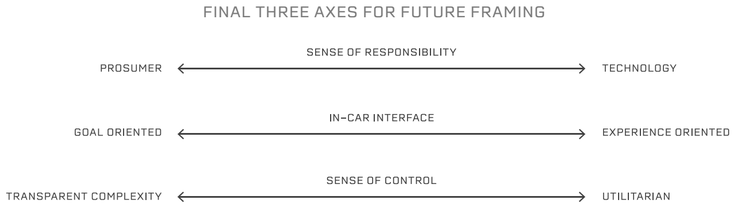


Figure 25 - In this visual the first steps of the future framing process is being described

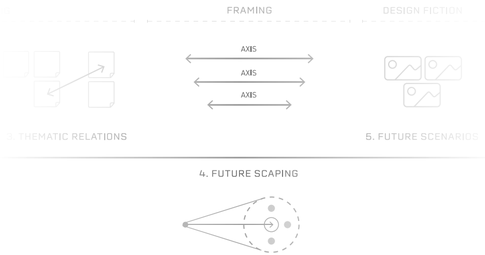
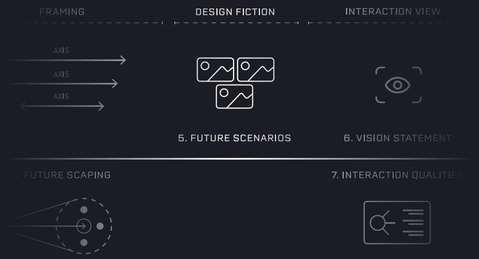


Figure 26 - The evaluation and decision-making process of choosing the final three axes is being described in Appendix A to B.



8. FUTURESCAPING

Based on the axes composed as a result of the context building activities, future scenarios can be created. This method that goes through all possible combinations of axes, in order to evaluate all possible future scenarios that can potentially evolve.

In this part you will find the final chosen combination of axes that results in a future scenario. This scenario is being described both with a narrative and a supporting visual for immersion purposes during the next phase. Evaluation of all possible axes combinations, which is a total of 8 combinations, is being described and further explained step by step in Appendix 9.

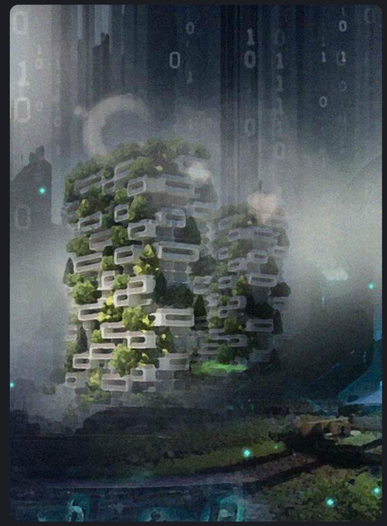
MAIN TAKEAWAYS PART 8

- 3 Future scenarios were formed called:
  "Faith in Tech", "The New Bauhaus", and "Sensing Sustainability"
- A combination of "Faith in Tech" and "The New Bauhaus" is chosen to be the most suitable future context to design for as it challenges to find the balance between them
- Final concept could eventually be a possible, a plausible, or even a probable solution. The only thing that matters is whether it is the right fit for users within the future context

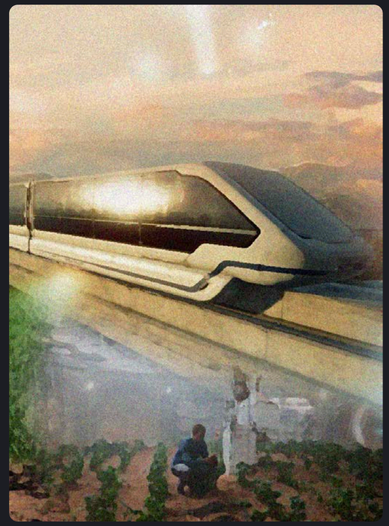
8.1 FUTURE SCENARIOS

This part describes the scenarios emerged from the analysis (explained in Appendix 10) of the axes supported by: an interaction desription, visual preview, and the chosen points on the axes for each future scenario.

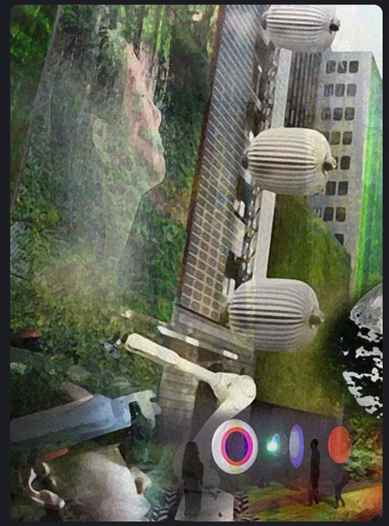
The related narratives for each scenario with its full size visual can be found in Appendix 11.



"FAITH IN TECH"



"THE NEW BAUHAUS"



"SENSING SUSTAINABILITY"

*This scenario is further explained in Appendix 11, as it is not chosen as future context.

RELATED AXES

INTERACTION DESCRIPTION

Advanced in-car interfaces serve the user to understand its sustainable goals
Car/company, Goal-oriented, Transparent complexity

In this interior scenario, people feel not sustainably responsible since they make use of a technologically advanced product that is doing it all. The interfaces inside the car are all goal-oriented and therefore the purpose of interactions is always clear. The user understands the interfaces and technologies by its transparency in design.

“FAITH IN TECH”

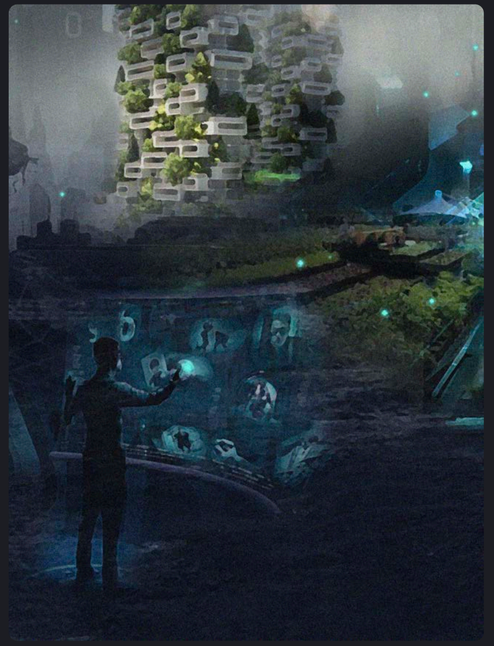
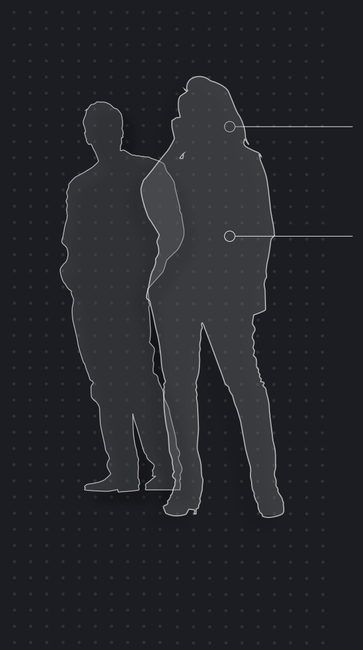


Figure 27 - Visual otf the “Faith In Tech” scenario, full size visual can be found in Apppendix 11

FUTURE USER – FAITH IN TECH



USER TYPE

A TO B USERS

Users see the car as a mean to go from A to B in the most sustainable way. Having a pleasant user experience over time is one of the benefits that is seen as a product standard. They tend to rely fully on the product itself.

MINIMAL USER EFFORTS

Drivers in this group are concerned about charging convenience and cost, with little time or mental energy to make adjustments to their lifestyles. Therefore they rely fully on the product/technology that should do it all.

INTERFACE FEATURES

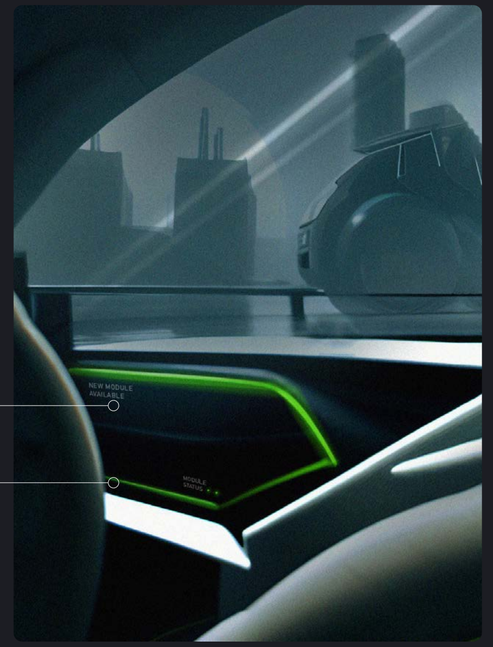
SYSTEM SUPPORT

The car notifies the user about updates and provides potential new alternatives in order to improve/renew the current interface.

LIVE STATE

The system knows the current state of the in-car interface and acitvely displays this at each specific model when relavant.

FUTURE IN-CAR INTERFACE – FAITH IN TECH



RELATED AXES

INTERACTION DESCRIPTION

Responsible use of function-based interfaces towards clear sustainability goals
Prosumer, Goal-oriented, Utilitarian approach

In this interior scenario, users feel environmental responsibility and are therefore willing to take action by being a prosumer. The interfaces inside the car are all goal-oriented and therefore the purpose of interactions is always clear. The user understands the interfaces by making use of its utilitarian design approach.

“THE NEW BAUHAUS”

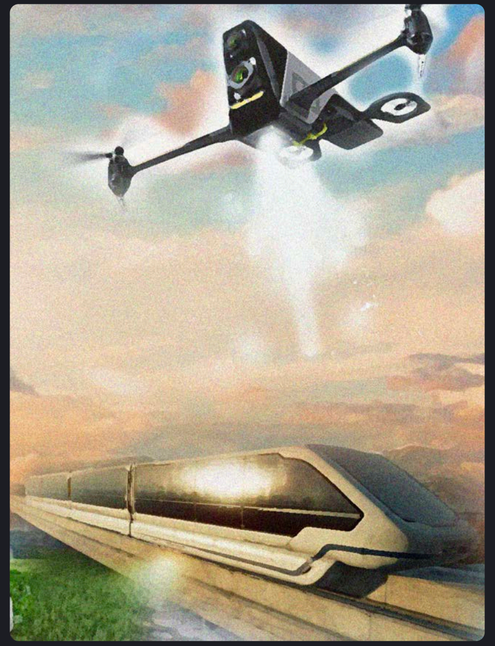
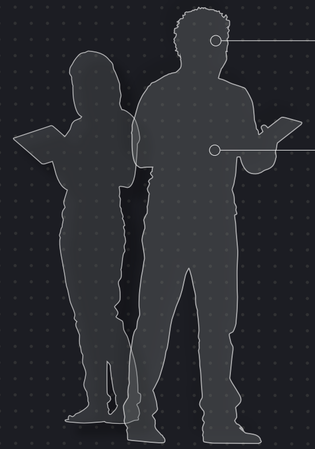


Figure 28 - Visual of the “The New Bauhaus” scenario, full size visual can be found in Apppendix 11

FUTURE USER – THE NEW BAUHAUS



USER TYPE

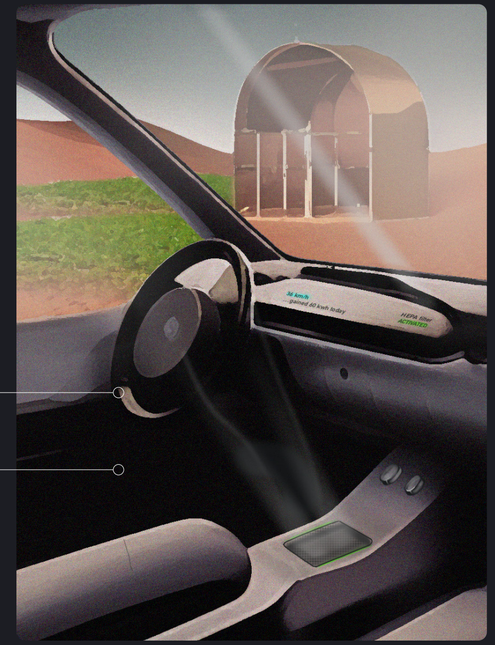
ENTHUSIASTS

Users see the car as something joyfull, which is full of explorative fun and ever changing user experiences. They try to get the most out of it by actively keeping it up to date and there by making it a sustainable means of mobility.

ASSERTIVE ATTITUDE

This user group is likely to spend higher budgets and put more energy in comfort and new features to enhance and extend their in-car experience. They are actively engaged in striving for the greater good of having positive impact on the environment.

FUTURE IN-CAR INTERFACE – THE NEW BAUHAUS



INTERFACE FEATURES

UTILITARIAN

Every element has a clear function and is an attribute to sustainability. Zero redundancy is the aim across the entire in-car interface.

OPEN CHARACTER

The in-car interface invites the user to constantly think of new upgrades. It has an open character that shows its accessibility with functionality as its main product quality.

8.2 DESIGN FICTION

For this project, design fiction is used as a method to retrieve feedback from experts through conducting semi-structured interviews during hte research phase as well as to let participants envision the future as it could be during test evaluations. This fairly new tool that provides a sense of immersion into a future, provided the most valuable insights about a concept interacting within those possible future scenarios.

DESIGN FICTION AS A TOOL

The purpose of creating a future world through immersive materials like a visual together with a narrative that describes this world and the way people behave and interact in it, serves as a tool to let people envision these possible futures. Design fiction is a new approach, which integrates scientific research of the world as it is now and a world as it potentially could be. It is a method toolbox for design research for the evaulation of a potential complex future (Grand et al., 2010). See figure 29 for a visual representation of the method and its explorative potential.

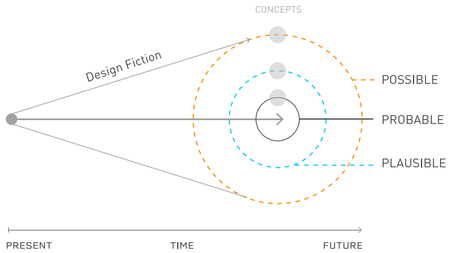


Figure 29 - Future Cone that explains the design fiction method to evaluate possible futures

In this stage of the project the final future scenarios are being used as a method to collect feedback from experts as well as to formulate a proper design brief for a concept aimed at one (or a combination) of one of these futures.

The feedback collected at this stage was mainly retrieved from experts within Lightyear and my supervisory team in order to formulate a feasible and still challenging design brief for the second half of the project.

> **“People don’t want to feel like they’re ‘deteriorating’, and this scenario feels like a scenario that gives people the perception of a better world as a benefical side effect while living consciously. ”**
>
> - part of the feedback on The New Bauhaus scenario

> **“This gives the large group of consumers who want to contribute to a better future but that do not now how, an attractive proposition by just making use of technology that does it for them.”**
>
> - part of the feedback on Faith in Tech scenario

8.3 FINAL SCENARIO

Based on the feedback from the design fiction sessions from Lightyear internals as well as conversations and discussions with my supervisory team, the future scenario that opens up a solution space for potential concepts will be a combination of the “Faith in Tech” scenario and the “The New Bauhaus” scenario.

BALANCE ALONG AXES

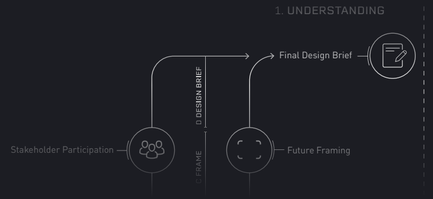
By combining these scenarios that both have the same end goal in the form of creating a more sustainable future, it is therefore needed to find balance along each axis. So that implies finding balance with all concepts the user is experiencing through interfaces with a balance in the sense of control, the sense of responsibility, and a balance in the interface being goal- or experience- oriented.

POSSIBLE, PLAUSIBLE, PROBABLE FUTURES

The final future scenario shows a possible future wherein interactions are being described of how the user interacts with products in its environment. The final scenario is showing an extreme worldview on the future that opens up the “possible” solution space and serves as conversation starter for later ideation and imagination during the process.

So this does not directly imply that the concepts to be created within the final scenario, should also be the most extreme and experimental options. Sometimes the plausible or even the probable concepts end up being the best concept directions to take because other criteria such as feasibility or ease of use criteria have higher priority for example.

Figure 30 - All possible combinations and variations of balanced approaches within future concepts



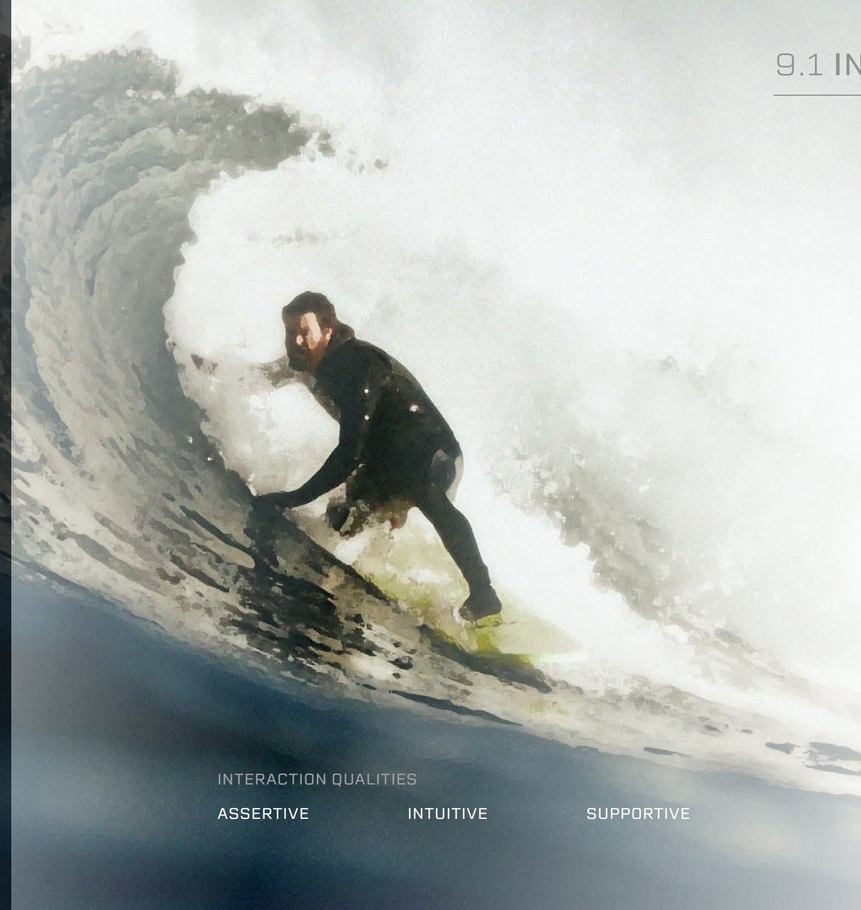
PHASE D
DESIGN BRIEF

9. ENVISIONING

Before the final design brief can be formulated, first an envisioning of the future product, its intended interactions, and intended product qualities need to be set to use as a base for starting the designing phase. Eventually these findings, the SID principles, principles of durability, and focus points of obsolescence in design, will be taken into account for the conceptualization phase.

MAIN TAKEAWAYS PART 9

- **Analogy of wave surfing describes the inteded interaction:**
  Assertive, Intuitive, and Supportive
- **The vision statement within the future scenario is:**
  "We want people to enable a more sustainable future, by providing a positive user experience through adaptive in-car interfaces."
- **Potential product qualities to include in the concepts:**
  Versatile, Open, and Serving



9.1 INTERACTION ANALOGY

ANALOGY DESCRIPTION

Surfing can be described as an interaction between the surfer (the user) and the waves (the technology) both having an influence on the overall performance of the surfer by means of a surfboard (the interface).

The direction of the waves (current) is **never the same** so the surfer should be able to act in an **intuitive** way when the (changing) wave direction is noticed by the surfer.

In some situations, the waves do the work to move the surfer on his board or to cover the intended distance, but if it doesn't, the surfer has to act in an **assertive** way to achieve this. By doing so, the surfer his **effectiveness** of the performed actions become immediately noticable.

The role of **support** is continuously transferred through collaboration between the surfer and the waves during the activity.

WAVES AS CONTINUOUS FLOW

In addition to the interaction qualities, the fact that waves continuously recur makes it an environment where surfing as an acitivity can be performed. So it facilitates the possibility of taking on a new wave every time again in order to have an unique and exciting surfing experience over and over again.

These recurring new waves form a flow that could also be seen as the interfaces that provides a positive unique experience over and over again.

9.2 VISION STATEMENT

The vision statement is formulated based on the chosen future scenarios in which the interactions with the product assumingly will take place in the future. A clear vision that describes the purpose and the relationship between the future user and future object can be formulated by means of a vision statement.

The vision statement contains the interaction qualities derived from the interaction analogy as well as the purpose of creating a sustainable future by using certain products. By including all these characteristics the vision statement is stated as follows:

VISION STATEMENT

“We want people to enable a more sustainable future, while having a positive user experience by means of a durable in-car interface.”

9.3 PRODUCT QUALITIES

The interaction qualities descirbed within part 9.1 about the interaction analogy can be translated into product qualities that help shape the character of the product. These product qualities can be used as benchmarks to evaluate later in the design process.

The product has to have certain qualitative characteristics in order to elicit the intended interactions. So by determining the product qualities, the user of the product will experience/use the product (i.e. interact with the product) as we defined it (Hekkert et al., 2011). At a later stage I could check and verify whether these still match the intended interaction or if they should be adapted in order to achieve the inteded interactions.

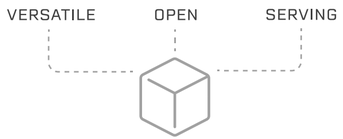


Figure 31 - Potential product qualities to enable the intended interactions

10. DESIGN BRIEF

SCOPE

Problem statement

The user experience of in-car interfaces becomes functionally and psychologically obsolete at a much faster pace over time compared to the actual lifespan of a car itself.

See part 1.3 about the Problem Definition for more information

Domain

Future-proof in-car user interfaces for upcoming Lightyear models.

See part 6.2 for about the Design Domain for more information

User Group

Future user group: The future focus group is people that see mobility as a method of transportation from A to B and who are willing to contribute to the environment by driving a Lightyear model.

This (future) focus group is based on market research performed by the marketing/strategy teams at Lightyear. A more specific explanation will be given later in the project.

FUTURE FRAMING

Future scenario

Balanced efforts between prosumers and technologies making use of utilitarian interfaces or serving the user in order to achieve a more sustainable future.

Scenario combination of: ‘The New Bauhaus’ and ‘Faith in Tech’

See part 8.3 about final scenario for more information

Vision Statement

“We want people to enable a more sustainable future, while having a positive user experience by means of a durable in-car interface.”

See part 9.2 for an explanation about the vision statement and part 8.1-9.1 about the process

ENVISIONED PRODUCT

Interaction Analogy

Wave surfing

Interaction Qualities

Assertive | Intuitive | Supportive

Product Qualities

Open | Versatile | Serving

10.1 DESIGN CRITERIA

DESIGN CRITERIA

Based on the challenges mentioned, the following design criteria can be formulated to use as benchmarks within the design evaluation phase and for later conclusions. In this way the design proposal can be formulated and evaluated with the set criteria as parameters to conclude whether the final design complements these criteria or not.

1. Versatile (Product Quality)

The product should be versatile in a way that it can accomodate the user needs based on their use and its context of use. The versatility aspect of the product should be continuous in a way that the product is always able to be adapted or that it can be adapted by itself.

This criterion is derived from the intended interaction qualities described in part 9.1

2. Serving (Product Quality)

The product should always support the user to help improve the overall user experience and should express a snense of service to the user. In this way its ensured that the user is always able to have a positive in-car experience and if not, the product supports the user to improve the in-car experience.

This criterion is derived from the intended interaction qualities described in part 9.1

3. Open (Product Quality)

As the product should have included a sense of adaptability (versatility), the product should be transparent in its complexity. It should therefore be open enough to multiple types of users in order to ensure ease of use and let the user interact with it in an intuitive way that is inviting enough for the user to act assertively.

This criterion is derived from the intended interaction qualities described in part 9.1

PROJECT GOAL

The main goal is to create an in-car user interface that maintains its functional and psychological relevance until the end of a car's lifespan by means of a holistic concept approach which is also feasible for Lightyear for future implementation.

PROJECT CHALLENGES

The main challenge is to create a holistic concept in-car user interface that is durable by being able to maintain its relevance over time both from a functional as well as psychological viewpoint

Secondly a challenge is to either find an optimal balance between virtual and physical interfaces within the car or how to keep this balance optimized over time.

Also aspects of style, status, and self-image affect the preferences for the demand in new products, so it is a challenge how to deal with these time sensitive principles.

FIXED PROJECT LIMITATIONS

- The user group for future models is somewhat speculative, because the current user group only consists of (potential) buyers of the Lightyear 0
- Limited time of approx. 10 weeks for concept development and optimization
- Limited time of approx. 6 weeks for user testing and optimization

DELIVERABLES

Presentation Report Prototype Proposal

10.2 CONCEPT FOCUS

FOCUS ON TRANSITIONING THE INTERFACE RENEWAL

For the use of in-car interfaces there are still a lot of contextual changes that could have an influence on the interface design as well. Therefore it is chosen to find a more specific focus moment of interaction, because this sets clear design constraints for the conceptualization phase. As the main focus point, the transition from the in-car interface renewal is chosen. During transition of in-car interface renewal, the user can experience how to interact with the interfaces once it starts to become obsolete.

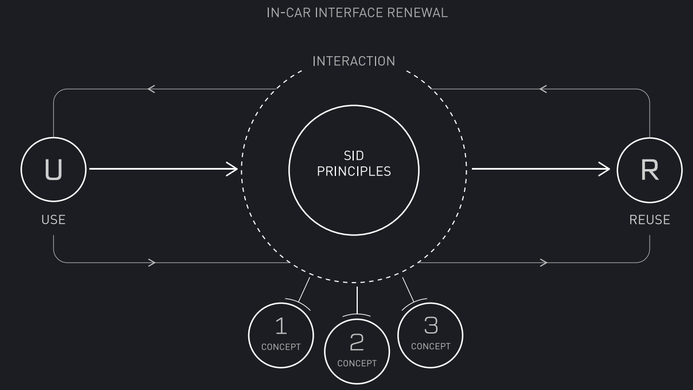
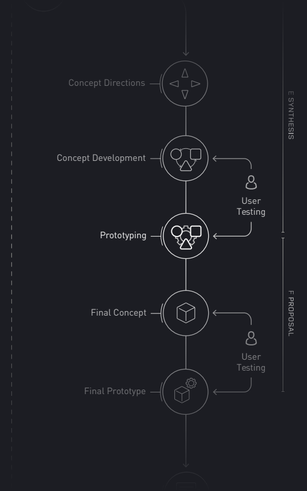


Figure 32 - Concept focus is during the transition of the in-car interface renewal



PHASE E

SYNTHESIS

11. CONCEPTUALIZATION

The concept directions must show the possible routes to take, each of which has its own form in terms of elaboration in order to meet the vision statement as best as possible. In this way the eventual chosen concept is likely to be a good fit in its future context.

In this way, a good direction can be chosen by means of different approaches that can be further elaborated and tested. During this phase it is therefore the intention to form clear directions that can be further developed within the ideation part.

MAIN TAKEAWAYS PART 11

- **Three concept diretions are described and visualed and form the design principles that potentially can extend the overall product life**
- **The concept directions:**
  1. User as Creator (prosumers configuring own interfaces over time)
  2. Smart Support (supportive system and installation service)
  3. Concept of Time (emotional durability)
- **The concept direction evaluation with experts and general users as participants, it appeared that the main princple should be Direction 2.**
  Direction 1 and direction 3 are sub princples to be tested.

11.1 CONCEPT DIRECTIONS

By having three outlying concepts that differ just enough to value and evaluate its specific principles, an ideal balance or mix is easier to establish within the final concepts to be tested through related prototypes.

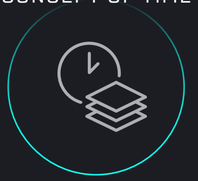
The three concept directions clearly rely on three different principle directions. The selection of the directions is based on earlier literature research, expert interviews, as well as the new findings from participatory sessions with Lightyear internals.

The concept directions are based on the following elements: the underlying SID principle of Promoting Renewal & Reuse (see part 3.3, p. 34), the future scenarios (The New Bauhaus & Faith In Tech, p. 58-61), customer archetypes trargeted by Lightyear (p. 59 + p. 61), typologies for design approaches for preserving product integrity in a circular economy (see Appendix 12) (M. den Hollander, 2018), and studies found in the book "Products that last" that are presented for each direction below (C. Bakker et al., 2014).

USER AS CREATOR

SMART SUPPORT

CONCEPT OF TIME

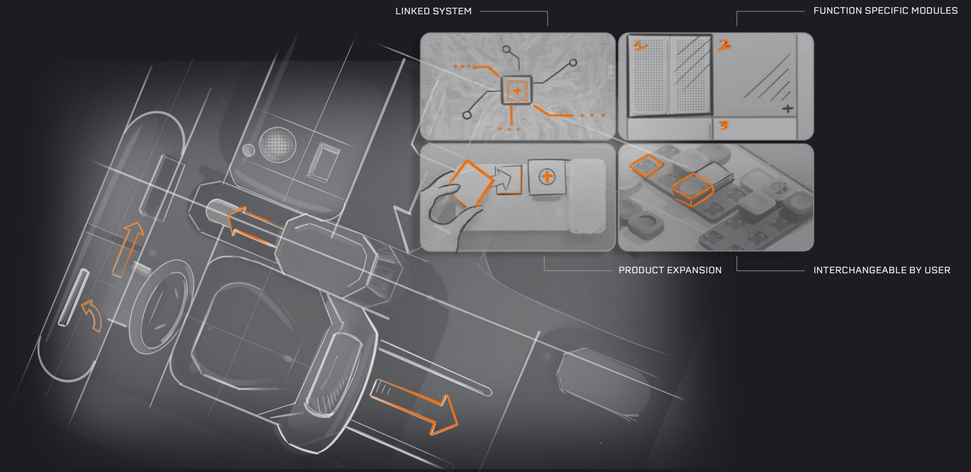


The concept directions with each descriptive name entitled

	USER AS CREATOR	SMART SUPPORT	CONCEPT OF TIME
FUTURE SCENARIO	The New Bauhaus	Faith in Tech	Not Applicable
FUTURE USER	Enthusiasts	A to B users	A to B users + Enthusiasts
THEORY DOMAIN	People constantly crave for the new and show ambiguous affinity with their 'stuff'. They follow the latest fashions and acquire new things for the practical reasons and/or symbolic motives. Personal preferences which are made based on context, situation and mood. If products are adaptable over time according to the user needs it could potentially result in being a long-life product. (C.Bakker et al., 2014)	People their awareness increases of the (un)intented side effects that their behaviour and use of products. People start to adapt themselves to the living conditions instead of the other way around, as they start to care more about what the influence of their use of products means for their environment. With user awareness of the impact of use or state of the product, the system can act accordingly to ensure that the product lasts longer. (C.Bakker et al., 2014)	Things around us that grab back to times that evoke a sense of nostalgia could potentially create a sense of familiarity and is therefore likely to be valued more by its user. In addition, the ever rising appraisal of (gracefully) degrading (aging) materials could contribute to long-life product as well. This appreciation of time by letting the product age gracefully or embracing products that remind you of the past, is likely to result in highly valued products that remain relevant over time. (C.Bakker et al., 2014)
DESIGN TYPOLOGY	Extended Use Postponing Obsolescence: Design approaches for extended use Designing for: Maintenance, Repair, Upgrading (M. den Hollander, 2018))	Recovery Reversing Obsolescence: Design approaches for recovery Designing for: Recontextualizing, Refurbishment, Remanufacturing (M. den Hollander, 2018)	Long Use Resisting Obsolescence: Design approaches for long use Designing for: Emotional Durability, Physical Durability (M. den Hollander, 2018)

INITIAL IDEATION

USER AS CREATOR

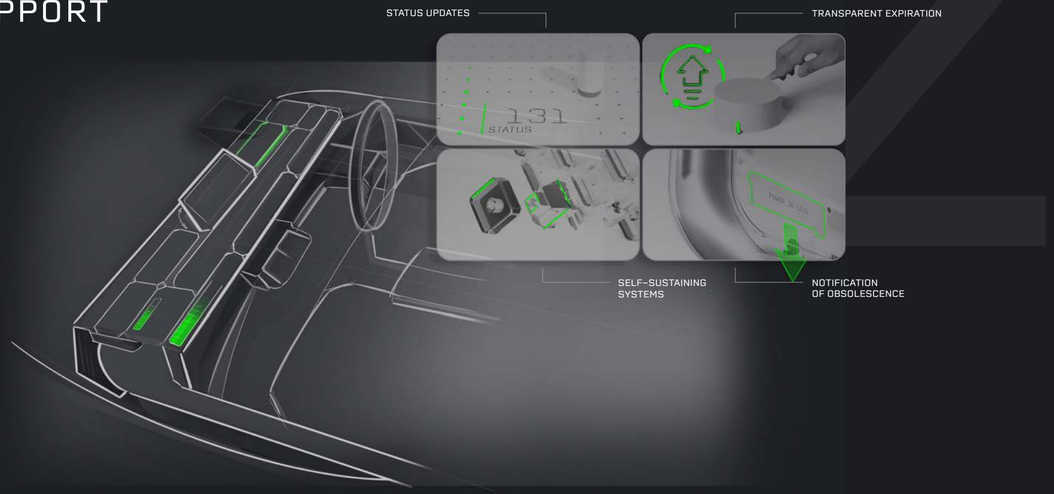


KEY FEAUTURES

- Users proactively configurate their own interface setup, functionalities and setup to keep it up to date
- Interfaces are (partly) customizable according to the user's needs
- Creations of new or updated elements can be shared and exchanged within communities

INITIAL IDEATION

SMART SUPPORT

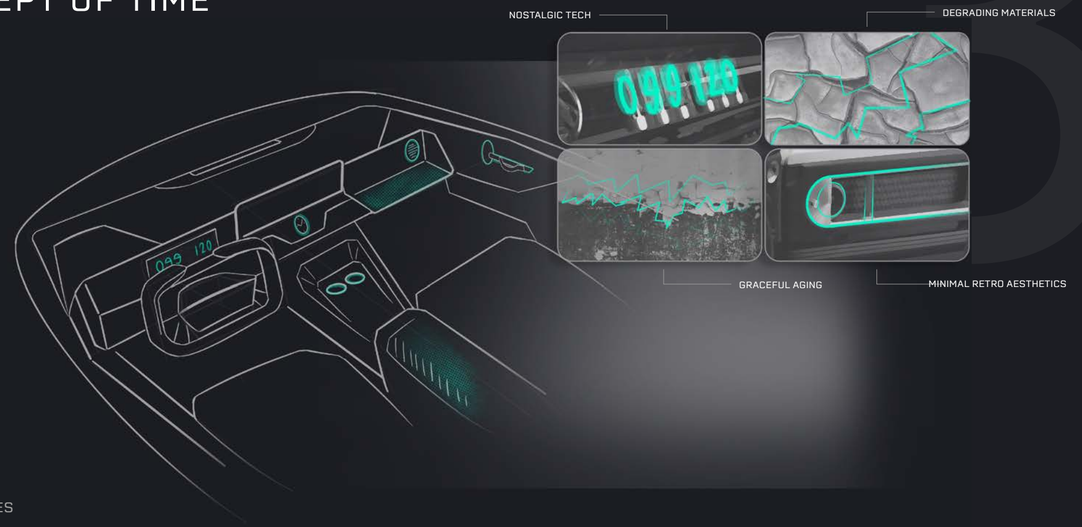


KEY FEAUTURES

- Interfaces keep themselves updated by advanced transparent technologies
- Materials and interface hardware degrade over time but indicate the need for renewal to users by giving the signal to do so
- Interfaces facilitate updateability by being smart and showing how and what have been changed or needs to be changed

INITIAL IDEATION

CONCEPT OF TIME

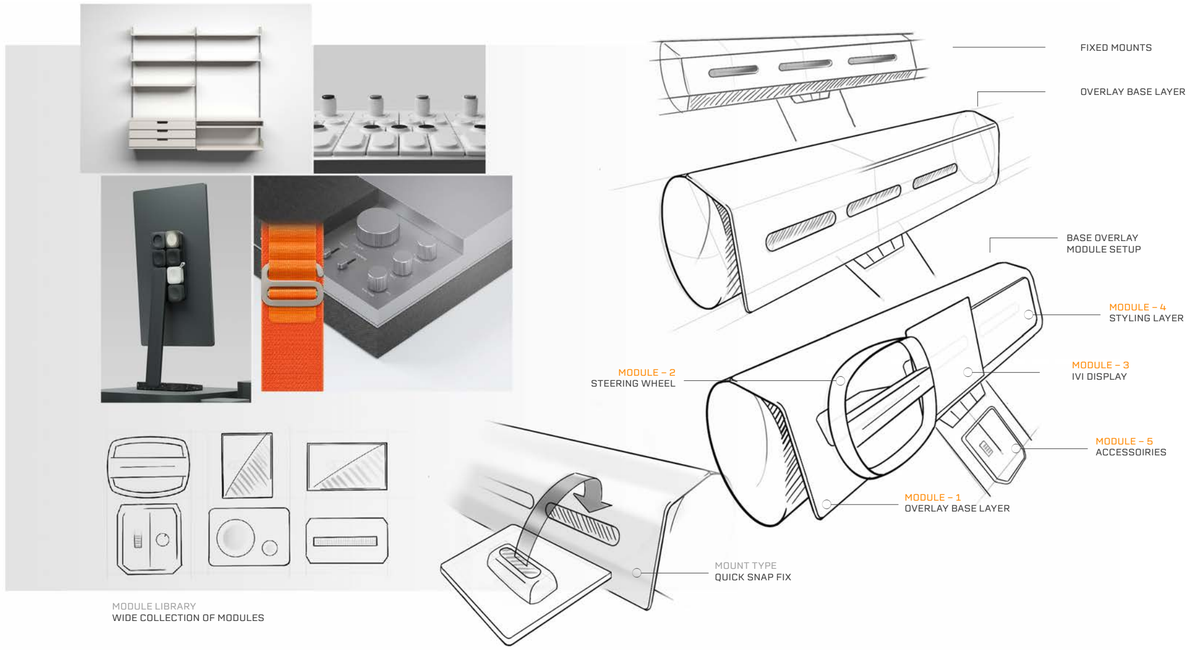


KEY FEAUTURES

- Parts of the interface time sensitive e.g. graceful aging, degrading materials etc.
- Minimal retro style as a way to relive time e.g. creating a sense of familiarity, minimal style etc.
- Personal attachment to elements within physical interfaces e.g. graceful aging, nostalgic technologies etc.

11.2 CONCEPT DEVELOPMENT

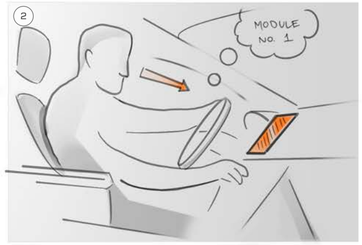
CONCEPT DIRECTION
USER AS CREATOR



For more ideation sketches see Appendix 13

USER SCENARIO
1. USER AS CREATOR

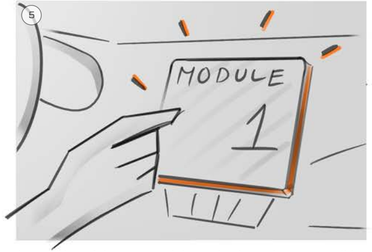
User experience starts to feel obsolete by the user when interacting with interfaces within the center console.



User observes that it is mainly the obsolete physical IVI Display causing this obsolete user experience.

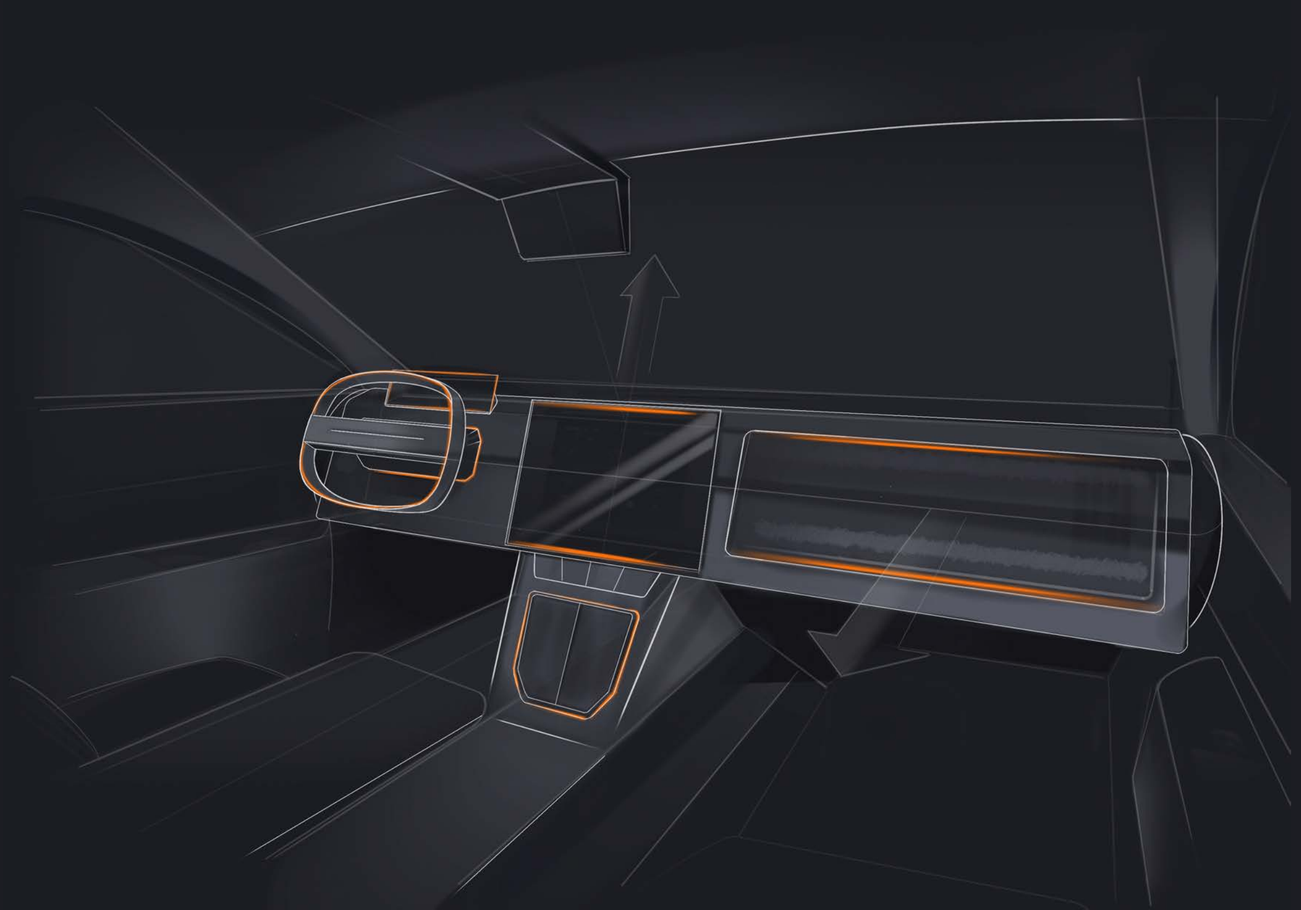
The user orders the latest IVI module to replace the old IVI Display with a new module.

The old IVI display is easy to detach and exchange with the new module by the user.



Integrating of the new module works through an accessible "plug and play" installation principle.

With the latest up-to-date interface the longevity of the intended in-car user experience will be extended.



CONCEPT DIRECTION

USER AS CREATOR

This concept direction is based on the principle of the user being central within the process of the interface upgrades over time. This direction is there to explore whether the user likes to be (partly) the creator of its own interface configuration over time or not.

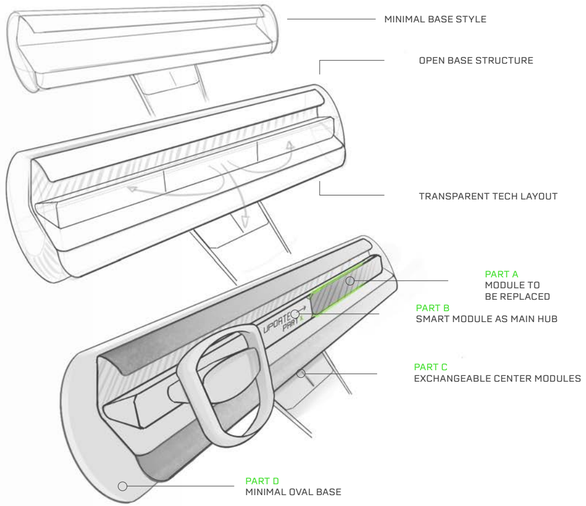
ASSERTIVE ATTITUDE

Meaning the user is the creator in this direction, it implies that the user should also notice some sense of obsolescence and should be able to locate the cause of this feeling of obsolescence. After noticing and observing this, the user should have an assertive attitude in willing to change the interface configurations by acting actively in order to make a change in the interfaces. This attitude is essential for this direction and is therefore the determining factor that makes or breaks this direction.

USER RESPONSIBILITY

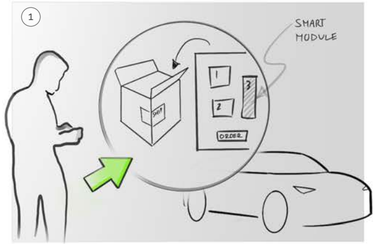
Within this direction the user should feel a sense of responsibility accompanied with a feeling of having control over the interface.The design of the overall interface and the elements it consists of, should all have a utilitarian design approach that is goal-oriented.

CONCEPT DIRECTION
SMART SUPPORT

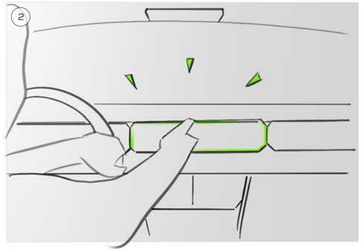


For more ideation sketches see Appendix 13

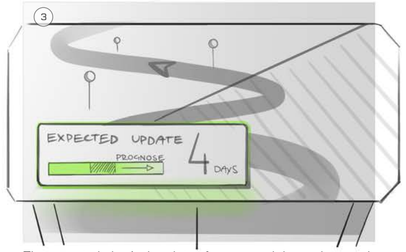
USER SCENARIO
2. SMART SUPPORT



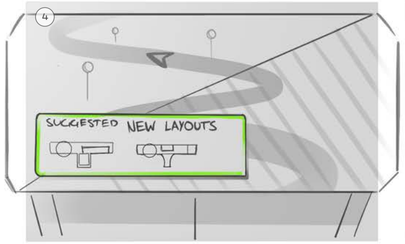
User purchases his/her new Lightyear with the integrated smart interfaces.



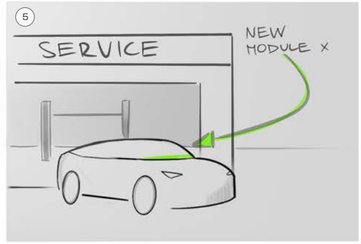
The smart support module which is located in the center, indicates that there is an physical update available.



The expected physical update of a new module can be opted for by the user in 4 days by the user.

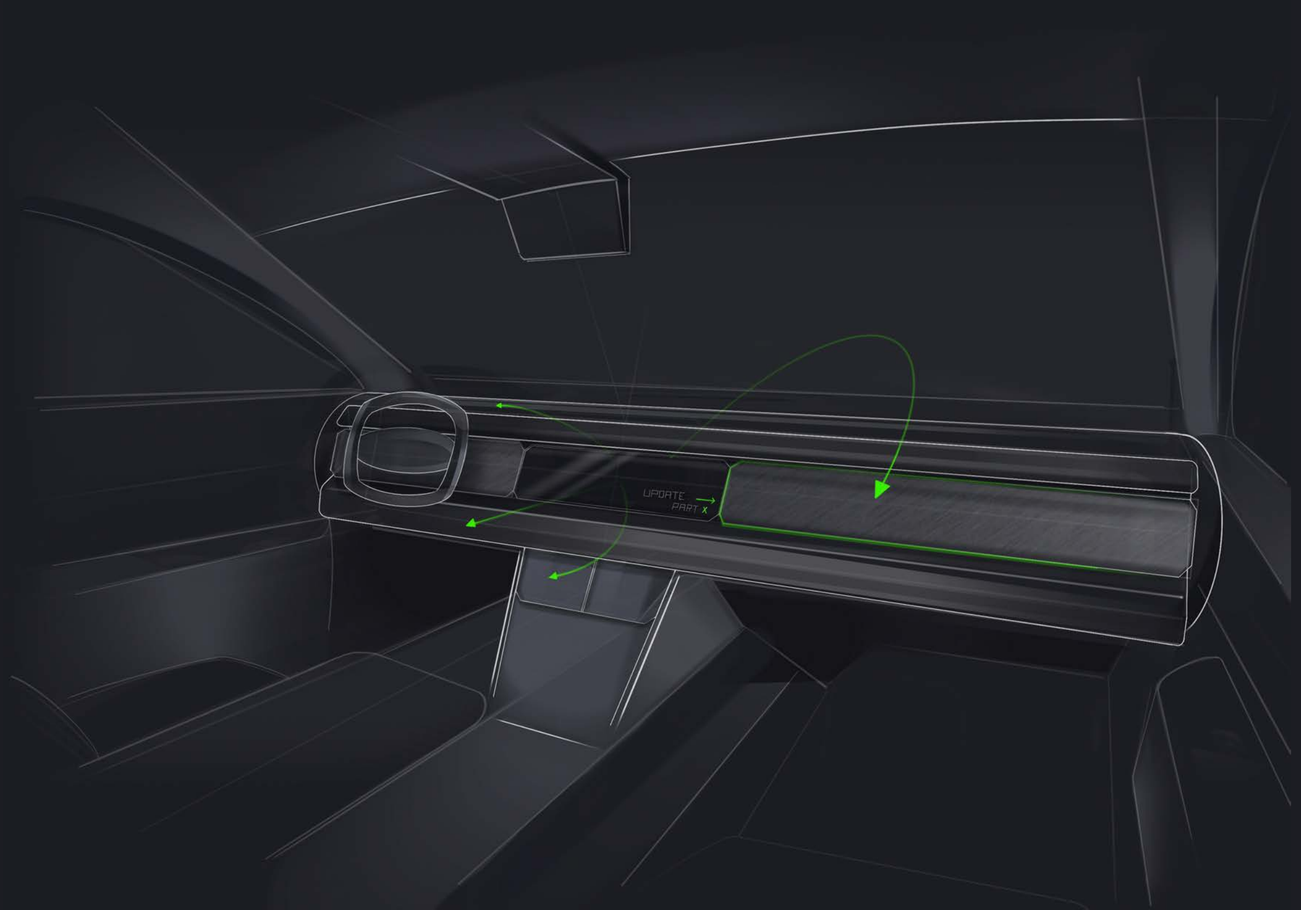


After 4 days the physical interface update is available and the system proposes new layouts according to the user its current dashboard layout.



The user decides to go for a physical interface update and gets his/her car to a LY service hub.

The new physical module has been installed and the in-car interface is up to date again. The longevity of the in-car user experience will be extended.



CONCEPT DIRECTION

SMART SUPPORT

This concept fully relies on the principle of the smart interface that supports the continuous recontextualization of the in-car interfaces. This is done through a central system (e.g. the IVI Display) that provides the information to the user of the current state and that is suggesting possible improvements.

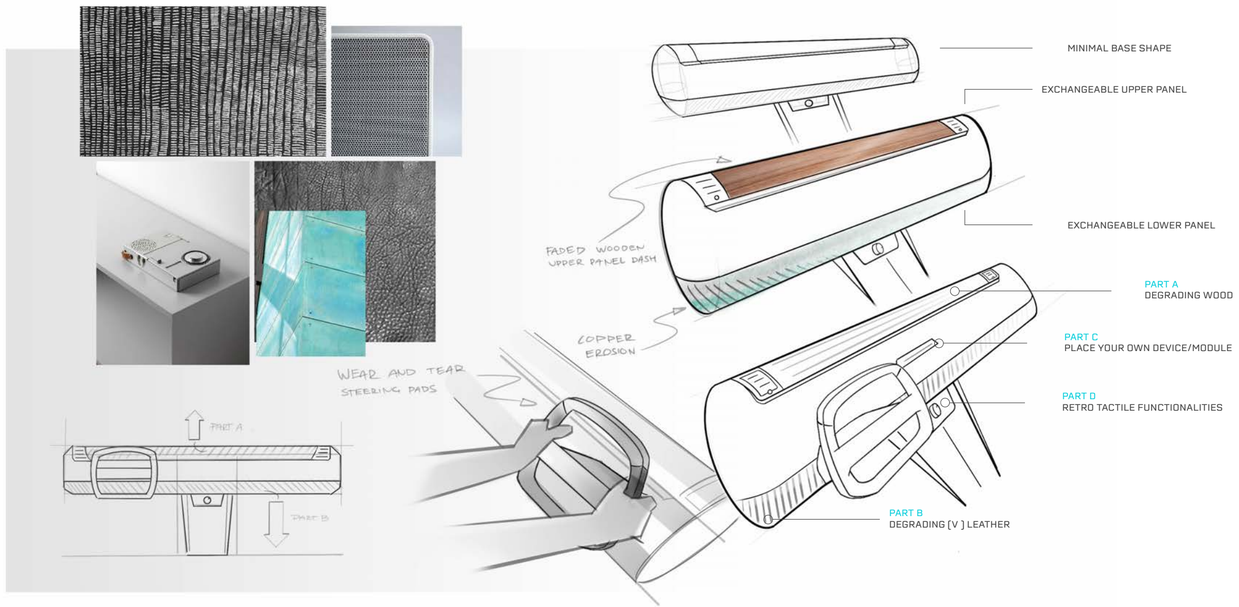
SYSTEM SUPPORT

This concept direction is there to explore the possibilities of having a smart system that notices whether a specific element is obsolete or not and how to change this. It does so by analyzing the current interface layout/configuration and will provide a new alternative if needed. It will also indicate the element to be replaced and it also has the ability to (optically) to change physical elements within the interface through advanced technologies.

PRODUCT RESPONSIBILITY

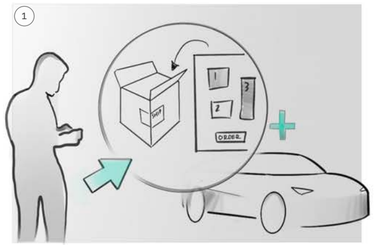
For this direction the product is responsible for the recontextualization of the interfaces over time by actively checking the current interfaces and acting accordingly when needed in order to keep it up to date. In this way the user will have minimal responsibility over the renewal of the in-car interfaces over time and could be ensured by Lighyear that the car is up to date.

CONCEPT DIRECTION
CONCEPT OF TIME

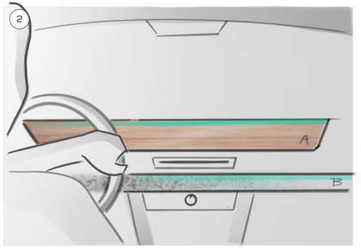


For more ideation sketches see Appendix 13

USER SCENARIO
3. CONCEPT OF TIME

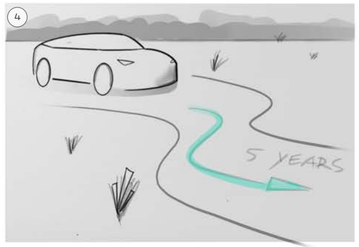


User purchases a car including personally picked panels that the user likes because of materials, quality, styling etc.

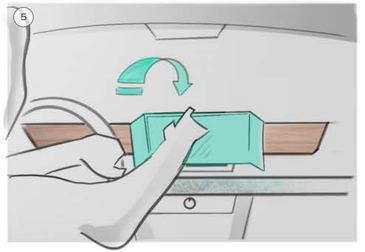


The personal panels are well integrated into a minimalistic timeless interior.

User decides to plugin own devices into the dashboard, which in this case functions as the IVI display.

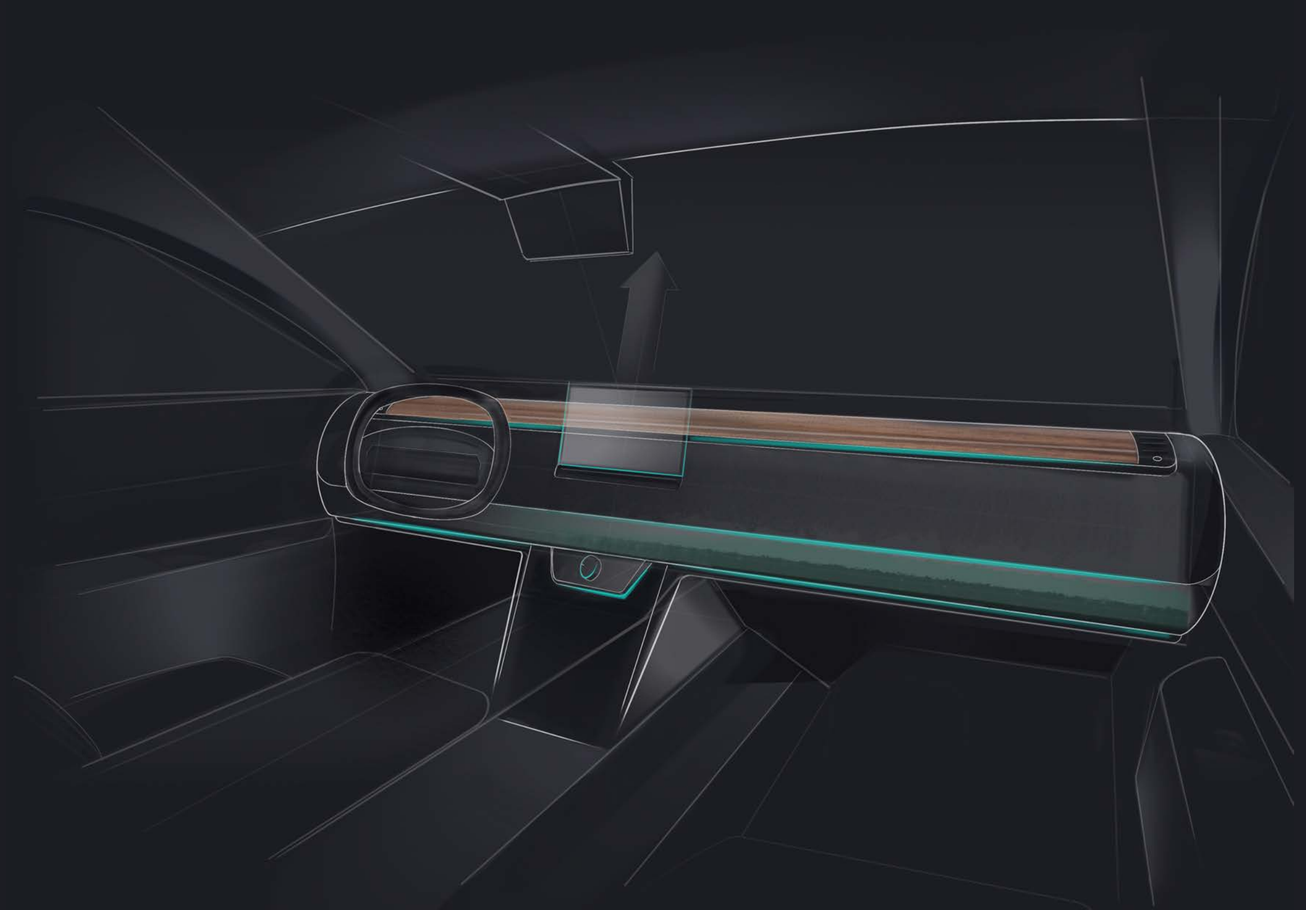


The user drives the car for +- 5 years and gathers experiences that will be valueable memories to the user.



After a certain time period, new innovations do require the user to update the digital in-car interfaces with a new (personal) device.

While the in-car interfaces now consist of the latest technologies, the user still values the personal items although the in-car interfaces have had some substantial adjustments.



CONCEPT DIRECTION

CONCEPT OF TIME

The concept of time is based on the principle of creating a sense of emotional value to the interfaces and thereby extending the lifespan in use of it. The concept direction is based on the principle of creating value by integrating materials that are connected to previous experiences that the user had with the car. This sense of emotional value can be done in multiple ways within this concept direction to demonstrate this principle.

CONNECTING MATERIALS TO EXPERIENCES

This principle is based on the way of designing the information provision to the user. Past experiences in general are one of the important interacting factors that mediate the users emotional response and thereby might influence the personal relation between a user and a product (Lilley et al., 2019). By connecting previous experiences of the user with the car to materials that have a relationship with those experiences, potentially a connection to these materials can be formed by the user.

GRACEFUL AGING

One principle that is being applied within this direction is the possibility that products passively develop into personal items during usage. With this principle in mind designers could create products that 'age with dignity'. Some materials have a tendency to form and wear gracefully in time and therefore create an unique and irreplaceable product for the owner (Mugge et al., 2005).

11.3 CONCEPT DIRECTION EVALUATION

The concept directions that were a result of the research presented in the chapter before as well as the ideation phase are evaluated by multiple stakeholders in order to form well funded argumentation and decision making before developing the final concept.

METHOD

The evaluation was done by means of A3 posters presenting all three concept directions supported by an ideation page, a user scenario, and a contextual visual to illustrate the concept direction. Also all the directions were supported by an overview of all three design directions and its main features and related theories.

The evaluation sessions were both held in person by presenting the A3 posters on the wall (see figure 32 & 33) as well as digitally by means of a powerpoint slideshow and a survey. All participants were asked to fill in either a survey or to do a structured interview after observing the visual presentation of the concept directions.

The questionaire used can be found in Appendix 21

PARTICIPANTS

A total of 16 participants (see p. 92) were involved in this evaluation. This total of participants consisted of two groups of participants were used to evaluate the concept directions. A group of Lightyear internals (10/16) participated in the evaluation session, all with varied roles and expertises. In addition a group of participants of general users (6/16) were asked to evaluate the directions as well, who also had different expertises and roles in other fields of work.

EVALUATION SETUP

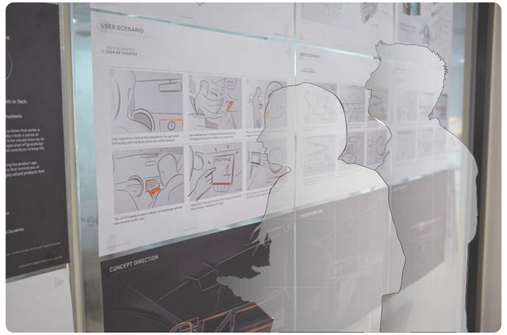


Figure 32 - Lightyear internals evaluating the wall presentation in the office

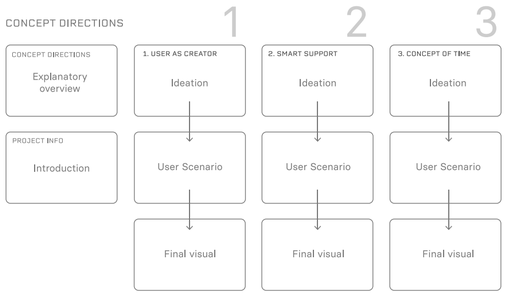


Figure 33 - Visual layout of the wall presentation in the office

EVALUATION RESULTS

USER AS CREATOR FOR SECONDARY FUNCTIONS

For the User as Creator direction, only a specific part of the in-car interface that covers the secondary controls and functions in a car, such as charging, infotainment options and storage affordances were indicated as suitable for this concept direction. This finding was supported by arguments that mainly were about the estimated risk and safety of self-installation by participants. It seemed risky for participants to change primary functional modules such as the steering wheel/column, the (main) IVI display, instrument cluster, stalks etc.

SMART SUPPORT AS MAIN PRINCIPLE

The main result of the evaluation was that participants prefer a combination of the direction Smart Support and Concept of Time but with Smart Support as the underlying concept principle. This was mainly supported by arguments that they liked the fact that the system would cover taking initiative in making suggestions. Most participants indicated that they did not prefer to come up with changes themself but rather would be provided with options to choose from.

CONCEPT OF TIME WITHIN SPECIFIC ELEMENTS

Another result was that the Concept of Time direction should be implemented within small elements of the in-car interfaces, but should not be the main concept principle because it seemed too abstract to most participants. However some participants liked this principle very much, because it seemed the most sustainable to them and easy to implement within current car interfaces layouts.

USER AS CREATOR

“I like the user as the creator a lot, it feels a bit like the phonebloks concept, which never made it (I think) but would be really cool. However it might be less feasible since highly customizable things like this cause a lot of problems in terms of implementation”
- Participant C, Business Development (Lightyear)

“The three modules (left, center and right) do make it look like an easy to customize layout with many possibilities, but I don’t think that the owner should be able to do the install of expensive pieces like a steering wheel (airbag) or IVI themselves. I think there’s too much risk.” - Participant D, Prototype Engineer (Lightyear)

SMART SUPPORT

“Smart Support: The concept direction itself is a warming thought, thinking that all people would simply follow a small group of inventors who are constantly developing new technologies which help the environment.” - Participant A, business entrepreneur (digital education)

“If we would let technology take care of most of the things we as humans do, it would be so much more efficient in all ways. However this is not realistic, we (as humans) want to stay in control of what happens.” - Participant B, UI/UX designer (digital education)

SMART SUPPORT

“I like the idea that you might value how your car looks and wouldn’t like to renew everything because it would lose a bit of the emotional value.”
- Participant C, Business Development (Lightyear)

“I do not collect anything, since I do not easily emotionally attach to things so the ‘concept of time’ direction would not work for me I think.” - Participant E, CTO (printing company)

CONCEPT DIRECTION PREFERENCES

Graph 34a indicates the overall preferences that participantshad with certain directions by observing the corresponding ideation, user scenarios and final visual for each direction. This Resulted into the following outcomes:

- 8/16 **(50%)** of the participants prefered a combination of concept directions: Smart Support (2) + Concept of Time (3)
- 4/16 **(25%)** of the participants prefered a combination of concept directions: User as Creator (1) + Smart Support (2)
- 4/16 **(25%)** of the participants prefered a combination of concept directions: User as Creator (1) + Concept of Time (3)

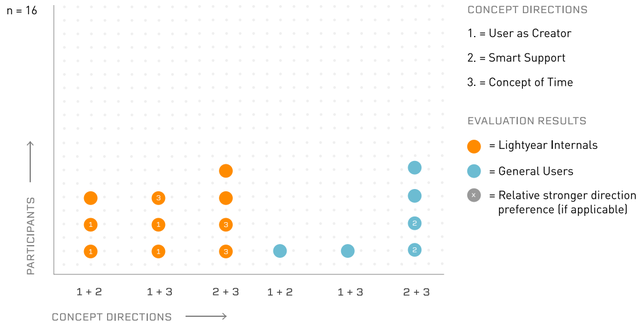


Figure 34a - Graph showing the concept direction preference after the evaluation sessions

PARTICIPANT TYPE	CAR OWNERSHIP	POSITION/BACKROUND
Lightyear Internals (n=10)	6-17 years (11 average)	UX Lead Customer Experience Lead Business Development Prototype Engineer UX Researcher Environment Health & Safety Officer Interaction Designer UX Designer Product Designer Customer Researcher
General Users (n=6)	2-45 years (9 average)	UI/UX, product owner (Digital education) CTO, Magazine printing company UX Design (student) Entrepeneur, business owner UX and mobility expert Infrastructure Project Manager

Figure 34b - Table presenting the participant types that were involved in the evaluation sessions

DISCUSSION

The method and setup used for the evaluation session could be of influence to the results. Namely, the setup that was presented in both a digital as well as a physical way could create a discrepancy within the results, because of the difference in layout as well as the size which was A3 (physical presentation) and standard laptop screen size (digital).

Lightyear internals who participated could be biased during evaluation. They might have had too much focus on the homologation ,production, and limitations instead of their imagination for future use for example.

The amount of general users that participated is fairly low compared to the Lightyear internals, so these two groups should be equal inorder to value them the same.

The arguments mentioned above should be taken into account before drawing conclusions by applying a sense of nuance to the intepretation of the results below.

> **“There’s a lot of opportunities in managing experiences, instead of just delivering a piece of hardware that is aging over time.”**
>
> - Participant F, UX Researcher (Lightyear internal)

> **“Instead of a one-time vehicle purchase, it feels like I am connected to the company and its service for the entire time of use.”**
>
> - Participant G, UX and Mobility expert (general user)

CONCLUSION

The preference indicated by participants, as shown in the graph (see figure 34a), clearly shows the direction of Smart Support combined with the Concept of Time (2+3). This direction was prefered most because they expected the product to take the first initiative upon which the user could react.

Modularity is seen as a positive principle that opens up possibilities in changing the layout and functionality of the physical interface because the user is able to select functionalities of an interface according to user needs and changing contexts.

The Concept of Time direction clearly evoked positive reactions because it felt the most sustainable and feasible principle, but it needs to be further tested how and to what extend it can be implemented. So this principle needs to be tested further within the final concept during the following phase.

By doing this concept direction evaluation, it gave insights needed before going into creating the final concept. These insights help to find a proper balance of principles to integrate within final concept that will be explained in the following part.

11.4 FINAL CONCEPT

The focus area for this project lies in the in-car interfaces as described in part 3.5, therefore the final concept entails both physical as well as digital interactive parts. And for this reason a physical interface linked to a digital interface needs to be created in order to demonstrate the overall user experience and its working principles with this final concept.

DESIGN CRITERIA FOR FINAL CONCEPT

The final concept is designed in a way that it complements all design criteria as described in part 10.1.

For this reason following criteria are implemented:

1. Versatile: The final concept is versitile by means of an adaptable physical interfaces through a modular system that consists of elements such as: the IVI Display, Look&Feel Panels, and functional modules.

2. Serving: The final concept is based on the principle giving support to the user by means of the digital interface that analyzes the interface use and provide the needed updates accordingly.

3. Open: The final concept should have an open character by its usability and understandibility. This is done by a physical interface that matches the digital interface concerning style and labels of the elements.

Based on the results derived from the concept direction evaluation session and the set design criteria (see part 10.1), a final concept can be created that has all design principles implemented to a certain extent to manage obsolescence of the user experience. The succession rate of implementation, usability and overall user experience will be tested as described in part 12.3.

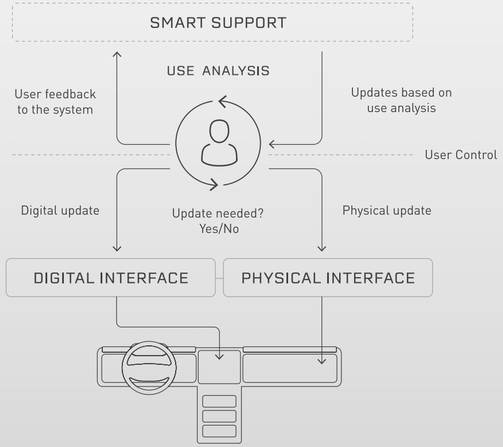
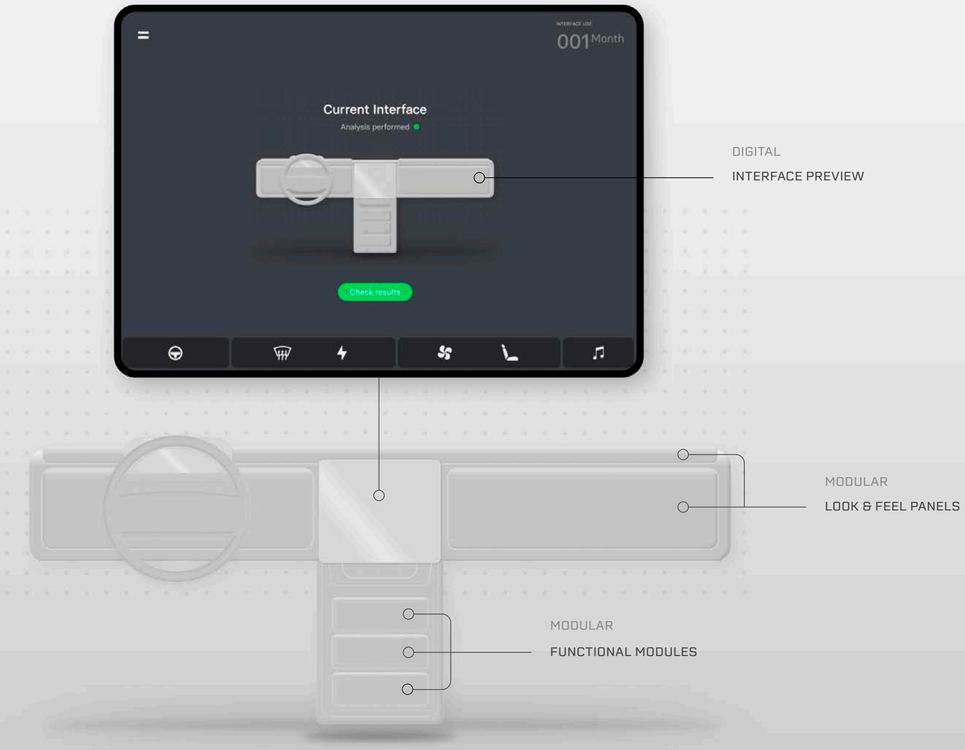


Figure 33 - Explanatory visual of the final concept structure

DIGITAL INTERFACE



FINAL CONCEPT SUMMARY

The main purpose of the final concept is that it should be an interactive way of demonstrating the concept of a sustainable interface to discover its updateability over time in multiple ways in a clear and convincing way to the user.

TESTING THE 3 PRINCPLES

As a result of the concept direction evaluation from part 11.3, the principles to keep the interfaces up to date can be positioned along the axes to indicate the balance of princples that the final concept consist of. The aim now for the final concept is to evaluate whether this balance is wanted or of it needs adjustments to get the idea and functionalities across that eventually will improve the user experience.

So the positions of the princples are not fixed yet, but it could better be described as flexibile principles that further need to be tested with users within the final concept in order to find the right balance of princples for the final design proposal.

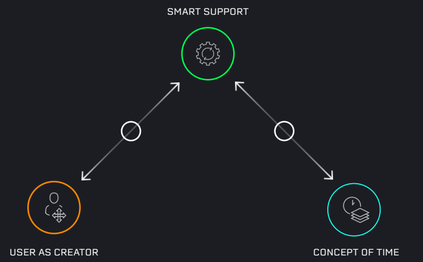


Figure 34 - Balance and extent of the implemented princples need to be tested

SENSE OF RESPONSIBILITY

As a result of earlier research and the concept direction evaluation, the final concept relies on a supportive system integrated into the in-car interfaces. This system supports the user by indicating the current state of the in-car interfaces and providing suitable solutions and alternatives for it according to specific context. For the final concept the responsibility initially lies at the smart system during use of the interface, and provides the user with useful information and allows the possibility to give feedback back to the system.

SENSE OF CONTROL

The user can decide whether to be the creator of specific modules or leave it up to the smart system that does the 'thinking' part for the user. The option whether to take full control of updating the interface or leave it up to the user is still the user's own choice. So the user's sense of control is a dynamic balance that can be decided upon during use of the interface.

EMOTIONAL VALUE

A form of personalization will be integrated into specific elements of the final concept in order to test the sense of emotional value within an continuously changing interface layout. This can be done either to an tactile personal item (e.g. materials, nostalgic design etc.) or through digital interfaces that create some sense of personality. (e.g. reliving earlier experiences, creating personal elements, choosing for personal materials etc.)

FUTURE USERS

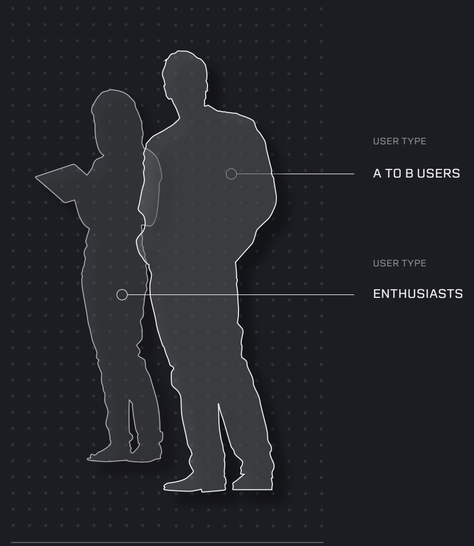


Figure 35 - Intended user types for the final concept

Future user types are derived from the futurescaping activities in part 8.1 as well as from the defined user archetypes by Lightyear.

COMMUNICATION

Clear communication is key to invite the user to interact with the system. And so the final concept needs to be designed in a way that the information provided during use is clear to the user. This can be done with the right focus on communication to the user, whether it is a notification message or a simple use cue. The way of providing information and notifications to the user is embedded into the final concept in multiple ways in order to get feedback on several types of communicative elements during the user tests.

AESTHETICS

Aesthetics are still of importance in order to match Lightyear's vision and aesthetic language, but for the final concept only serve to give a visual representation of how it potentially could look in order to give a sense of using a real product.

12. TESTING & PROTOTYPE

To evaluate the final concept and its implications, a extensive user test is needed to get insights and feedback from potential users. This is done by means of a working prototype that demonstrates the working princples that are implemented in the concept. These principles will be evaluated to see what balance is optimal for the final design.

This part covers the test pan and test procedure, explanation of the prototype used, and the user test results.

MAIN TAKEAWAYS PART 12

- **The 1:1 scale prototype consists of two parts; a digital interface and a physical interface both working together as one prototype**
- **The prototype is built to let participants experience how the concept of updating your interfaces over time would work to immerse them as much as possible**
- **The user test is done with general users as participants and will be all conducted and moderated through a specified protocol and setup**

12.1 TEST PLAN

In order to envision the working principle of the final concept and its future use, a user test is done by means of a 1:1 scale prototype. This test aims at finding design requirements, user needs, user expectations, design errors, improvements, and to discover potential additional features.

The test lets the user experience the overall process of using the in-car interface concept that is updatable over time due to its physical as well as its digital features. In addition, usability will also be evaluated, since this can result in useful insights for the final design proposal, the recommendations and for future implementation of the final concept.

TEST GOAL

The main goal of the test is to evaluate the overall use of the final concept. This is done for the reason to shape a design proposal supported by well funded user data and user feedback as a result of the user tests. By getting clear outcomes in different types with regards to user feedback, user expectations of and potential contextual use, a clear vision for the final concept and a preliminary design can be formed.

TEST METHOD

The user test will evaluate the final concept in a qualitative manner. The method of a Task Scenario based usability test is used to structure the test. This is done in order to let the participant experience the final concept through interacting with the prototype. By giving a brief task scenario that is realistic and shapes the final concept and its future context, the participant is likely to be more engaged and feels encouraged to take action (Wichansky, 2000).

RESEARCH QUESTION

What concept direction principles should the final concept consist of during use and during the updating process of the in-car interfaces?

For sub research questions see Appendix 14

USABILITY TESTING GOALS

Users must be able to perform the following main tasks by means of the prototype:

- Indicate their sense of satisfaction (so far) with their current interface during use
- Change a module themselves as indicated on digital prototype
- Order a specific module according to the use summary provided during use

The evaluation of the overall usability is don by means of the System Usability Scale (SUS) indicator to analyse the usability of the final concept.

TYPE OF PARTICIPANTS

1. General Users

See p. 111 for a table presenting the participant types that were involved in the user tests

By only having general users as participants, a conclusion can be drawn that is true to real data based on potential users. The results about feasible implementation of the final concept by Lightyear internals could be analyzed based on separate interviews in later stages during a possbile follow up after this project.

LOCATION

The location for the final user test was on the top floor of the Spaces building in Utrecht, where the Hub-Office from Lightyear is also located. The entire largely spaced open area was pretty much empty which resulted in a lot of attention for the prototype when entering the space.

For this reason and to not overwhelm the participants by alreaday seeing the prototype, the decision was made to take the test on two separate locations within the space. The first (pre-test) part A was done apart from the prototype without showing it and the second part (during-test) part B at the prototype itself. The last part C was mostly done at the same location as part A.

12.2 USER TESTING

PROCEDURE

Part A - Introduction (15 min.)

First briefly telling the participants about my project and the main motivation behind it, without giving too much information because this might influence the test.

To let participants feel comfortable before starting the actual user test, I will ask several intro questions to get them in the right mood and let them think about in-car interfaces in general.

See Appendix 16 for the exact questions used before the test

USER ARCHETYPE ALLOCATOR

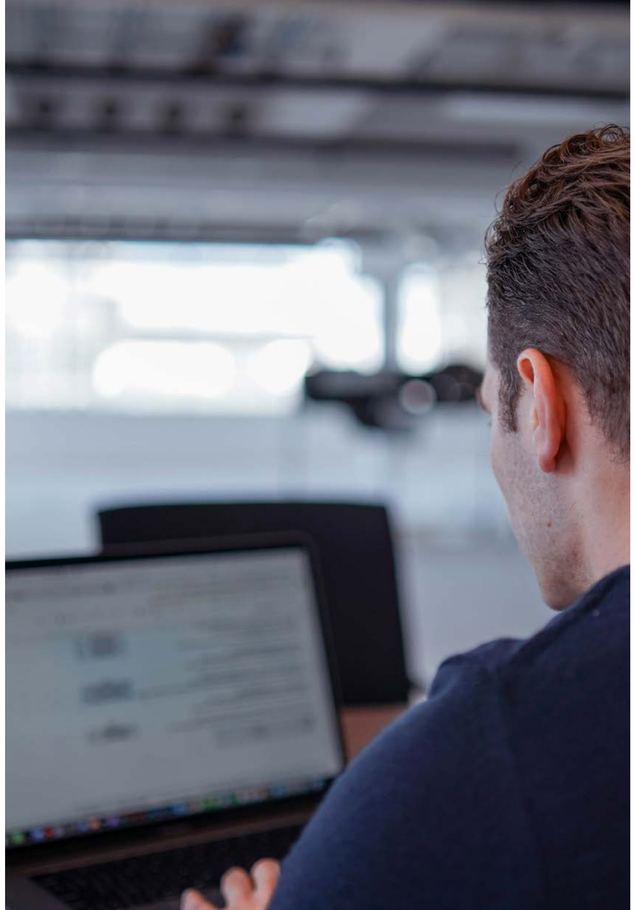
An archetype allocator will be used to identify the user types and cluster participants into user archetypes developed by Lightyear. These will later help to form a more in depth results analysis that also describes the user in relation to cars in a way that is segmenting them into so-called user archetypes.

See Appendix 15 for the allocator that is used to segment users into archtypes

FUTURE SCENARIOS

By envisioning a future context the future scenarios will be explained and shown in order to immerse them as much as possible into the future context before showing the prototype and performing the user test.

See Part 8.1 for the future scenarios and its specifications



Part B - User test with prototype (15 min.)

Before the test, an user scenario is explained in order to give the participant an idea of the context of use and its task. This is done on an abstract level to not give away too much before the test and first let them experience the prototype themselves.

The scenarios will be used as the starting scenario alternately for each test to avoid any learning effects.

Task Scenario 1: Everyday Rides **Task Scenario 2: Adventure**

See Appendix 16 for the exact information provided during the test

MODERATING

The moderating technique used during the tests is called Concurrent Think Aloud (CTA). By using this technique the participant's way of thought can be understood by speaking out loud while making use of the prototype without any interference of the moderator (usability. gov, 2016).

The way of providing information during the test about the final concept in general, its context and working principles is always given through this gradual way from less to more information as support if needed. Ideally the moderator should only have to give limited information in order to let the participant perform the correct tasks (Wichanskly, 2000).

1. What?
Showing the concept by briefly telling what parts the concept principle consists of

2. How?
Explaining how the concept works and what is needed from the user in order to let it work that way

3. Why?
Explaining the reason why this concept needs to be used and its relevance in the future

Figure 36 - Participants taking part in the user test

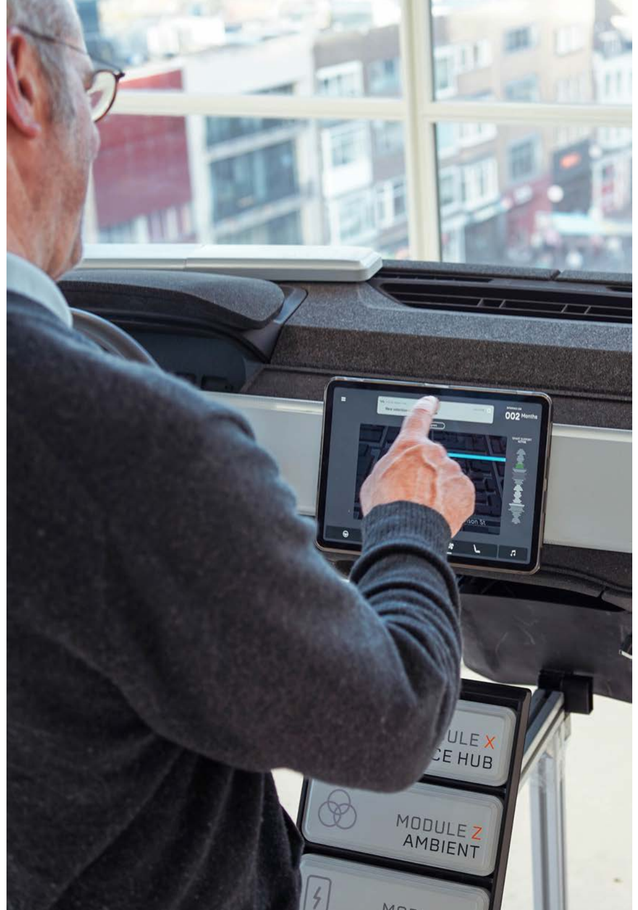
Part C - Collecting feedback (20 min.)

After the completed session questions will be asked through Retrospective Probing (RP), which mainly focus on the thoughts and actions performed during the test as noted by the moderator during the test (usability. gov, 2016).

1. Usability evaluation of the final concept (SUS evaluation), System Usability Scale (SUS)

2. A semi-structured post test interview will be conducted

See Appendix 16 for the exact questions asked after the test



12.3 PROTOTYPE

The prototype is designed in a way that the principles on which the final concept is based, can be tested with participants by interacting with the prototype. In this way the participants are able to get to know how to use the system and to observe what implications their behavior within the digital interface would have on the physical interface. The prototype not only serves as a means to use for testing, but also simulates how a system like this could look like in real life on a 1:1 scale. So the prototype could also be seen as a conversation starter that helps the participant to immerse within a future context and imagine how a system like this would work in real life.

So the functionalities of each individual element and/ or look & feel of elements in detail is not the focus for this test and serve as conversation starters and tools to illustrate the process of updating the in-car interface.

PHYSICAL INTERFACE

The physical interface is a 1:1 scale dashboard with detachable panels and modules to simulate how a modular system like this could potentially work in future real life. The layout of the modules and panels exactly matches with what is being presented on the digital interface, so in this way the implications based on choices made within the digital interface, demonstrate the working principle of how it would affect the physical interface.

Figure 37 - Final Prototype used for testing

Scan QR code to try out the digital interface

PHYSICAL MODULES & PANELS

Figure 38 - Detachable (functional) modules used for prototype

Figure 39 - Detachable (look & feel) panels used for prototype

Modules - Functional

The functional modules are located in the center console to give them a designated clustered area within the interface. The modules all simulate secondary functionalities and add-ons that might improve the overall user experience depending on the given task scenarios. These fictional modules include functions such as: in-car ambient lighting, in-car fast charger for all your devices, and a device hub to connect all your devices to the in-car interfaces and use for entertainment for example. The modules themselves are not functional but are created to demonstrate its modular principles, its location and relation with the digital interface.

Panels - Look & Feel

The panels serve the purpose of illustrating how an user is able to change the look & feel of their in-car interfaces based on certain stimuli retrieved from the digital interface. The look & feel itself is not the focus for this project but is there to demonstrate the working principle of such a system. The panels themselves are created to demonstrate its modular principles, its location and relation with the digital interface.

DIGITAL INTERFACE

Figure 37a - Digital interface displayed on center screen

The digital part of the prototype will be displayed on the IVI screen (main center screen) of the overall interface. Within this digital part the user interacts with it through a touch screen based interface that simulates a regular navigation and infotainment structure by default.

During the test after a randomized period of time, interactive elements will appear that might be inviting as 'calls to action' for the user to dive deeper into the system and discover what it has to offer. If this is not preferred by the user, it always has the option to press 'ignore' or 'decline' certain notifications.

Two types of notifications are used as stimuli during the test to see whether users liked or disliked them or what notifications had the most impact and invited the user wanting to find out more.

Mock ups of the digital interface can be found in Appendix 21

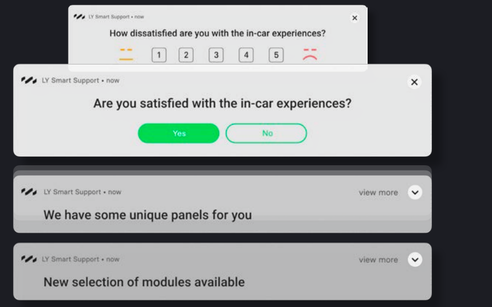


Figure 37b - Digital interface notifications displayed on center screen

Feedback notifications

These notifications appear on the screen at random moments to invite the user to give feedback about their current interfaces. In this way an analysis of the overall user satisfaction is simulated by the prototype to give them an idea of getting provided with tailor made updates afterwards. This element was also used to test whether people liked the principle of giving user input (feedback) to the system to indicate their overall satisfaction with their current interface.

Update notifications

The notifications about updates were provided at random moments as well, but always after the user made the decision to give feedback to the system. The notifications included multiple ways of communicating when a new update was available.

User flows for each task scenario to structure the digital prototype, see Appendix 17

AESTHETICS & STYLING

For the aesthetics and styling of the digital and physical interface, I took an utilitarian and minimal approach that demonstrates the functionalities but is not too apparent. The shapes and color of the modules and panels are kept as basic as possible but just refined so that it is inviting to use by participants. The overall style, text and iconography of the physical modules and panels matches the style presented on the digital interface to avoid misunderstandings. Aesthetics could be of influence to the user experience., but it is not of importance at this stage of the project.

BUILDING PROCESS

The black base consists of a dashboard assembly that is fixated on a movable rig. The system that simulates the revisability of the modules and panels and the detachable IVI center display are attached with magnets. The modules and panels, center parts of the steering wheel and center holder for modules are all 3D-printed.

For images showing the building process, see Appendix 18

> “Designing products that can adapt to changes over time is crucial for managing product related business risks in circular business models.”
>
> - (Nyström et al., 2021)

13. RESULTS

In this section the results from the user test will be analysed. The retrieved user data will also partly be evaluated in a quantative way in order to create more insights that might support qualitative findings. In addition to the qualitative data, the results of the SUS (System Usability Scale) scores will also be analysed.

After the analysis and evaluation of all test results and feedback, an evaulation of the results itself will be done in the form of a discussion about the results and conslusive part.

MAIN TAKEAWAYS PART 13

- The system providing Smart Support was seen as a positive principle by most participants
- Most participants prefered functional modules over stylistic panels because they want added value by having clear benefits
- Self-installation involved too much risk and arised safety concerns, so an installation service is prefered
- Single purchase is the most chosen payment method for the final concept over having to subscribe to a membership

13.1 TEST RESULTS

This part focuses on the results of the user tests and should form a concluding answer on the question what concept principles should be implemented within the final concept in order to be satisfactory while making use of the interfaces over time.

The main focus is on the overall use during the transitioning period from use to reuse, as described in part 10.2. So the main results will be about the process of updating the interfaces of your car over time and how the user experienced the way of updating the in-car interfaces. This overall user experience is evaluated with a qualitative method and the related highlights of the results will be presented in the following section.

As stated in part 12.2, the usability of the overall concept is also evaluated after the test and assessed by means of a SUS (System Usability Scale) evaluation, in order to form a reliable perspective on usability.

A total of 11 participants were used for the final user test which are being further described in figure 38b. All participants can be considered as general users.

RESULT TYPE	RESULTS
TECHNOLOGY	**Smart Support** Positive about use analysis and related personal updates
DESIGN	**Modular system** Positive about the princple of having revisable interfaces
FUNCTION	**Functionality over style** Focus on functionality within the user experience
SERVICE	**Installation service** Physical updates should be executed by Lightyear
ECONOMIC	**Single purchase** Prefered by users to make well considered choices

Figure 38a - Main qualitative results of the user tests

PARTICIPANT TYPE	AGE	CAR OWNERSHIP	USER ARCHETYPE	PROFESSIONS OF PARTICIPANTS
General Users (n=11)	25-60 years (41 average)	0-36 years (13 average)	Enthusiast (54,5% /11)	Marketing and Sales, Own Business UI/UX, Product Owner (Digital education) Entrepeneur, Owner (Digital education) Social Geography MSc Student Project Manager Infrastructure Pulmonologist , Medical Business Advisor
			A to B (9,1% /11)	Interaction Designer
			Green Planner (19,2% /11)	Project Manager, Green Energy CTO, Printing Company
			Non-Environmental (19,2% /11)	Marketing and Sales, Own Business Servant, Ministry of Economics

Figure 38b - Table presenting the participant types that were involved in the evaluation sessions

Qualitative Analysis of the qualitative data can be found in Appendix 19 & 20 (p. 146-149)

SMART SUPPORT

Principle indicated as positive by:

10/11 Participants

Smart support as a system that analyzes the users rides and behavior during rides and provides updates accordingly, was received positively in general. A total of 10/11 participants indicated that they liked the feeling of a system trying to improve their experience based on personal use and the context of use. The principle of having a system that tries to optimize your rides and overall user experience was something positive as well.

"I think based on the data, new features could be introduced that help me further, because my use has been analyzed first. So this comes across as a suggestion that is based on something." - Participant A, Enthusiast

"I think it's good for a system to analyze my use if it can ultimately benefit me as a user."
- Participant J, Green Planner

FEEDBACK

Several comments could still improve the user experience of having a supportive system:

- **Users still want to get notified but not guided towards updated their car, it still should feel like their own decision**
- **The personal notifications should be clear right away what the update has to offer**
- **The user should have to option to first improve by changing their behavior to improve their experience**

  "First I would like behaviour-driven feedback from the system to see if it is due to my behaviour/use and then I want to know if I can order something that helps me with that, that feels much more sustainable and fair." - Participant E, Enthusiast

MODULARITY

Principle indicated as positive by:

9/11 Participants

An in-car interface that is built with modularity as a functional principle and thereby facilitates the user in changing the elements over time is found to be positive by 9/11 participants. The overall result was the fact that people did not want their interface to be fixed, since they figured it could be adapted after a certain period of use. By doing so they could imagine they would know how their preferable interface should be after this period.

"I think it's a liberating feeling to know that not everything is immediately fixed in a car you buy, but an interior that is adaptable over time and can potentially get better."
- Participant E, Enthusiast

"It has only been designed for a certain moment for x number of years, while you only know what you are and are not missing in use." - Participant H, Green Planner

FEEDBACK

The following comments/improvements from participants to take into account:

- **The user benefits compared to current setup should be clearly communicated**

  "But it really needs to become clear to me after use what benefit I get in an insightful way, then I want to know and possibly change it, otherwise I will drop out early."
  - Participant K, Non-environmental

- **Modular elements should express clearly what function it has**

  "A plug and play system feels a bit fake to me, this makes it seem like the function is already there when I have to buy something. This makes me a bit suspicious."
  - Participant F, Enthusiast

Qualitative Analysis of the qualitative data can be found in Appendix 19 & 20 (p. 146-149)

LIGHTYEAR SERVICE
OVER SELF-INSTALLATION

Principle indicated as positive by:

10/11 Participants

The choice between service provided by Lightyear in comparison to the users installing the modules themselves, was asked. The preference among participants lies at the option of the installation service by Lightyear, since 10/11 participants choose for this option. The most proposed way of doing this is by driving to a mobile service hub that is closeby, because that feels most efficient for users. Only 6/11 participants would like to try to do it by self-installation, but it was not prefered.

"It seems to me that all this can happen without you being at home because the mechanics just have to be able to enter the car in a digital way and you as a user are informed of the status."- Participant D, Enthusiast

"I would never actually choose self-installation, even if I think I would like it or could do it, because of simple safety principles. I think that installation should always have a certain guarantee and therefore the responsibility should also lie with the company for this."
- Participant H, Green Planner

FEEDBACK

The following comments/improvements from participants to take into account:

- **A monthly service program on fixed locations might be another solution, since it requires less resources and feels more sustainable**

  "I would expect that in standard places, where you have fixed times and locations where you can have the installation done. To make it more efficient for myself and also for the company. So don't unnecessarily hire people who go to the customer one by one. " - Participant G, Enthusiast

SINGLE PURCHASE
OVER MEMBERSHIP

Principle indicated as positive by:

7/11 Participants

Participants liked to have the possibility to purchase new physical interface elements themselves over a membership. A good 7/11 participants chose this method, mostly because it would potentially make them purchase updates more consciously and it gave them a sense of control. A membership was only wanted by 3/11 people if it would start after a certain period of use, so that the user knows what to subscribe to.

"I would go for a one-time purchase and when I notice that a membership is more profitable, I would only switch to it."
- Participant C, A to B user

"I think the one-time purchase and price should be part of the consideration of buying a module." - Participant J, Green Planner

"Single purchase, a membership seems as if it is needed to update although I think it's still fine..." - Participant G, Enthusiast

FEEDBACK

The following comments/improvements from participants to take into account:

- **Membership feels too much like a marketing model that implies that it is needed to update regularly**
- **Single purchase could raise the threshold for users to update interfaces as well, so of benefits and improvements should be made clearly communicated**
- **Modules should not be too expensive since participants were hesitant to pay large amounts all at once, but didn't want to be stuck with payment in installments either**

Qualitative Analysis of the qualitative data can be found in Appendix 19 & 20 (p. 146-149)

FUNCTIONAL MODULES

Principle indicated as positive by:

The concept principle of functional modules adding a new functionality to your in-car interface was clear and understood by most users directly. Because participants could see them adding or changing new functional modules within their interface according to their personal use or context was easy to imagine. For this reason the functional modules were also highly favorable in comparison to the modular look & feel panels.

"Yes, if it really helps the car in terms of efficiency in terms of performance, ecologically and economically, then I would definitely like it." - Participant H, Green Planner

"Yes, I can see myself using it if the function really adds something to my use and it really clearly improves my use." - Participant K, Non-Environmental

FEEDBACK

Several comments could still improve the user experience of having a supportive system:

- **Should not feel too much as an luxury option (like functional add ons), but rather as needed functional modules that improve efficiency for example**
- **Modules should express its functionality and should feel like it has value otherwise it could feel too much like an software update or unlocking device**
- **Showing why a new module has sustainability benefit could be an trigger for people**

  "If you get what you spend on it, then the whole thing should sound more like functionality to update your usage, then it sounds better." - Participant I, Enthusiast

LOOK & FEEL PANELS

Principle indicated as positive by:

To change interfaces in terms of Look & Feel seemed too abstract for most people and therefore hard to judge whether they would use it or not. 7/11 participants found the communication unclear about why materials corresponded with their experiences (e.g. milestone rides). To 3/11 participants it seemd to much marketing like and not too convincing in terms of extending the in-car interface longevity by this principle.

"I didn't really understand the second part of the scenario, how those materials are linked to your experiences. That still feels too abstract." - Participant D, Enthusiast

"Experiences can certainly add to a positive user experience. I think providing insight into highlights and achievements can contribute positively to that." - Participant C, A to B user

FEEDBACK

The following comments/improvements from participants to take into account:

- **A material must add functionality if it is to replace current interfaces**
- **If materials have clear sustainability benefits it could work and contributes to the overall purpose**
- **Experiences and milestones with your car could be interesting highlight to show but hard to connect to functionalities of materials**

Qualitative Analysis of the qualitative data can be found in Appendix 19 & 20 (p. 146-149)

ADDITIONAL FEEDBACK

Some feedback was given during the test, after the test or within a casual conversation, some of this feedback will be taken into account for the design proposal and further recommendations.

SUSTAINABILITY

- **Most participants could see a deposit system or a discount, when handing in old physical modules/panels, seems to works well within the final concept**

DIGITAL INTERFACES

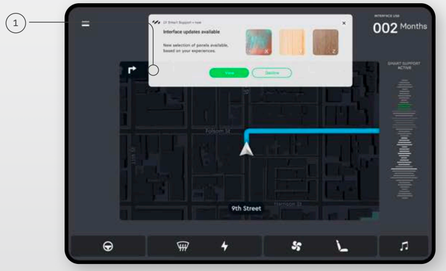
- **The digital interface should have a minimal yet acceptable step by step approach, so that the user exactly knows what it takes to complete the process and knows its current phase**

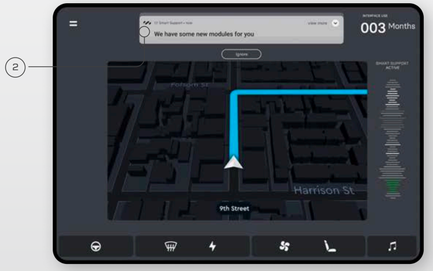
MOMENT AND TIME

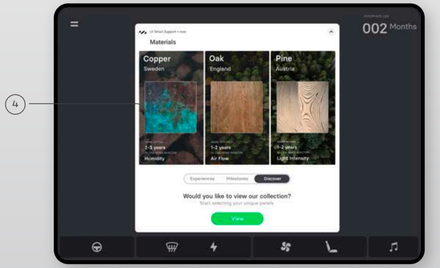
- **The location of the interactions should not necessarily be inside the car, but could also take place at home for example**
- **The moment of entering this process should not be while driving for safety reasons, but it should be adviced to do after the ride or at the beginning of a ride**
- **Users also should be able to continue the process on other devices if they want to**
- **The frequency of notifications about new updates, highlights or summaries was prefered to be once a month**

Qualitative Analysis of the qualitative data can be found in Appendix 19 & 20 (p. 146-149)

1. Users should be able to click on the material thumbnails and experience widgets to find out more about them
2. Users like to always have access to the library or purchasing platform, not access only through notifications
3. Small fonts should be easier to read from 1,5 meter viewing distance when sitting inside the car, which requires minimum of 20pt in font size
4. No abstract terminology and descriptions, communication should have an utilitarian approach that clearly expresses its functionality







Mock ups of the digital interface can be found in Appendix 21

Scan QR code to try out the digital interface used for the user tests

RESULTS SYSTEM USABILITY SCALE [SUS]

This score was the result of users rating the usability of the final concept after use. The score gives an indication of the overall ease of use and can form a quick overview of the feedback for each individual element within the final concept in terms of usability. In this way further iterations can be done with these usability results taken into account.

From the user test (n=11), the overall SUS score resulted in an average of 69,1 which means that the overall usability of the final concept lies between the adjectives 'ok' and 'good' (Bangor, 2008). In terms of user acceptability it falls in between the sections described as 'marginal' and 'acceptable' (see figure 39).

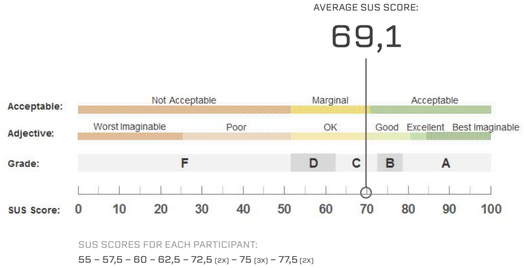


Figure 39 - System Usability Scale (Bangor, 2008)

SCORES PER STATEMENT

Evaluating the ratings per statement as visualised in the box-plots below can also be reviewed indivudually to see if there are pain points and or parts within the final concept that are already sufficient.

The following statements scored best (also considering outliers):
- 1: 'I think that I would like to use this in-car interface frequently 'and 3: 'I thought the in-car interface was easy to use'

The following statements scored worst (also considering outliers):
- 9: 'I felt very confident using the in-car interface'

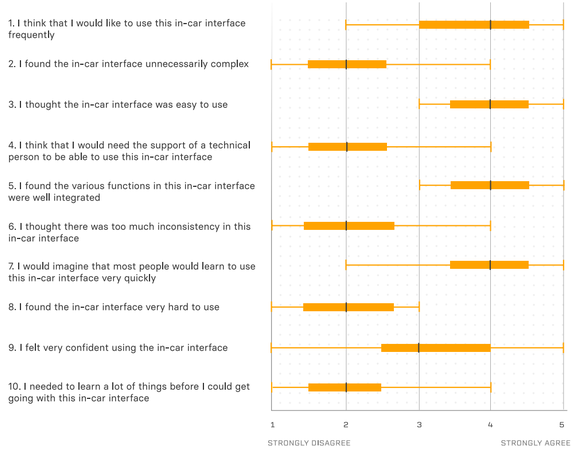


Figure 40 - Box-plots of the SUS scores given by participants after the user test

13.2 RESULTS EVALUATION

DISCUSSION

The results of the user tests (see figure 38a) form an insightful view on how users behave and would act in a future with a final concept like this. However the validity of the results can be argued in some ways.

Future imagination

This prototype was developed to demonstrate the overall process of updating interfaces. So I deliberately developed the prototype in a way, so that all principles to be tested during the user test were embedded. Since the focus was more on the step by step process rather than a real life representation of their own car they had to imagine how such a concept would visually be represented within a future context.

No previous experiences

Participants were not the owner, so estimating emotional value and making decisions based on value by actually owning the car, was hard to simulate during the test. Therefore answers and feedback given about user satisfaction with their current setup should be considered doubtful. Although it demonstrates the principle of users giving feedback to the system.

Possible biases

A total of 9/11 participants (general users) were not affiliated with Lightyear whatsoever, but there potentially could still be biases among participants. Mostly related to their expertises and fields of work in relation to the imagination capabilities about a future context.

Relative small group of participants

This could be seen as an explorative user test with a fairly small group of participants. Therefore it is needed to test this concept on at least 20 participants (Alroobaea et al., 2014) for statistically significant studies and analysis of the performance metrics.

System Usability Score (SUS)

Although the average SUS score (69,1) was between 'OK' an 'good', it is still not a representation of the overall usability of the final concept, since it is still a prototype that focussed on the process of updating rather than the visual design. However, the average system usability scores can be compared to some industry benchmarks and used as usability evaluation for each following design iteration.

CONCLUSION

Participants could see how this concept would work within the given future context and task scenarios. They understood why a concept like this would be relevant and even necessary in the future.

Main principles positive

The concept of having a revisable in-car interface that is not fixed due to its modularity was seen as something positive. It appeared that participants really liked the principle of a system analyzing their interface use and rides over time and then giving personalized recommendations to improve their in-car experience.

Efficient communication

Smaller elements of the digital design in the way of communicating analysis overviews and notifications should have incremental improvements to get the right messages across. Abstract expressions and wording should be avoided within the digital interface.

Bold and Utilitarian

The digital interface design needs to be bolder in communication by expressing its functions directly. A more utilitarian approach for the recommendations to communicate the benefits over the user's current interface setup is also needed.

Single Purchase and Lightyear Service

Most participants would like to have the option to purchase new physical updates individually and would like to have Lightyear taking care of the installation process due to safety and foreseen risk factors.

EVALUATION OF DESIGN CRITERIA

The stated design criteria (see part 10.1) on which the final concept is based in addition to the the test results, need to be evaluated to see if the overall challenge (see part 1.4) is achieved at this stage. Any needed improvements can then be described and further explored within the design proposal and recommendations section.

1. Versatile

The criterion of versatility was understood and used as intended by all participants through the modular features of the prototype. However not all modular features were found to be nessecary because the benefits for the 'look & feel' panels to be changed was not always clear. So versatility as a product quality should be carefully implemented into specific parts of the interface in order to seem/be effective and inviting to use.

2. Open

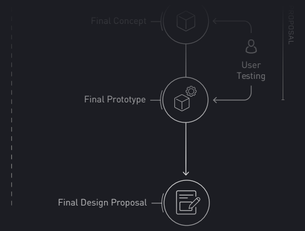
The interface prototype scored between 'ok' and 'good' so the usability can be seen as marginal and acceptable. So the final concept was found to be fairly easy to use and the overall concept was clear to most users. However there are still incrementel design optimisations (see part 14.1) needed within the digital inteface and communication in order to improve the user's sense of intuitiveness and confidence during use.

3. Serving

The prototype supporting the user by doing personalized suggestions is considered to be helpful. The sense of personalized support was found to be very positive only if it had clear benefits for the user. So once the user benefits are clear, the system has a serving quality to the user.

Interaction Qualities

The intended interaction was previously compared to the analogy of ***wave surfing*** (see part 9.1) which includes the same interaction qualities; Assertive, Intuitive, and Supportive. The product qualities mentioned above were mostly refered to during the user test but could be partly translated into these interaction qualities as well by means of the SUS scores. However, further usability testing is needed to justify and evaluate the presence of these qualities more specifically by means of a more advanced prototype.



PHASE F

DESIGN PROPOSAL

14 FINAL PROPOSAL

Based on the conclusion of the results in part 13.1 & 13.2, a final design proposal is visualized and expained in this section. Both a design proposal for the digital as well as for the physical interface is presented in this section.

This premilinary design can be regarded as a design that forms a next stepping stone into the next design and testing phase. This implies that visualisations represent how the principles possibly could be implemented into a design.

MAIN TAKEAWAYS PART 14

- **The final design should include the following elements:**

Physical Interface

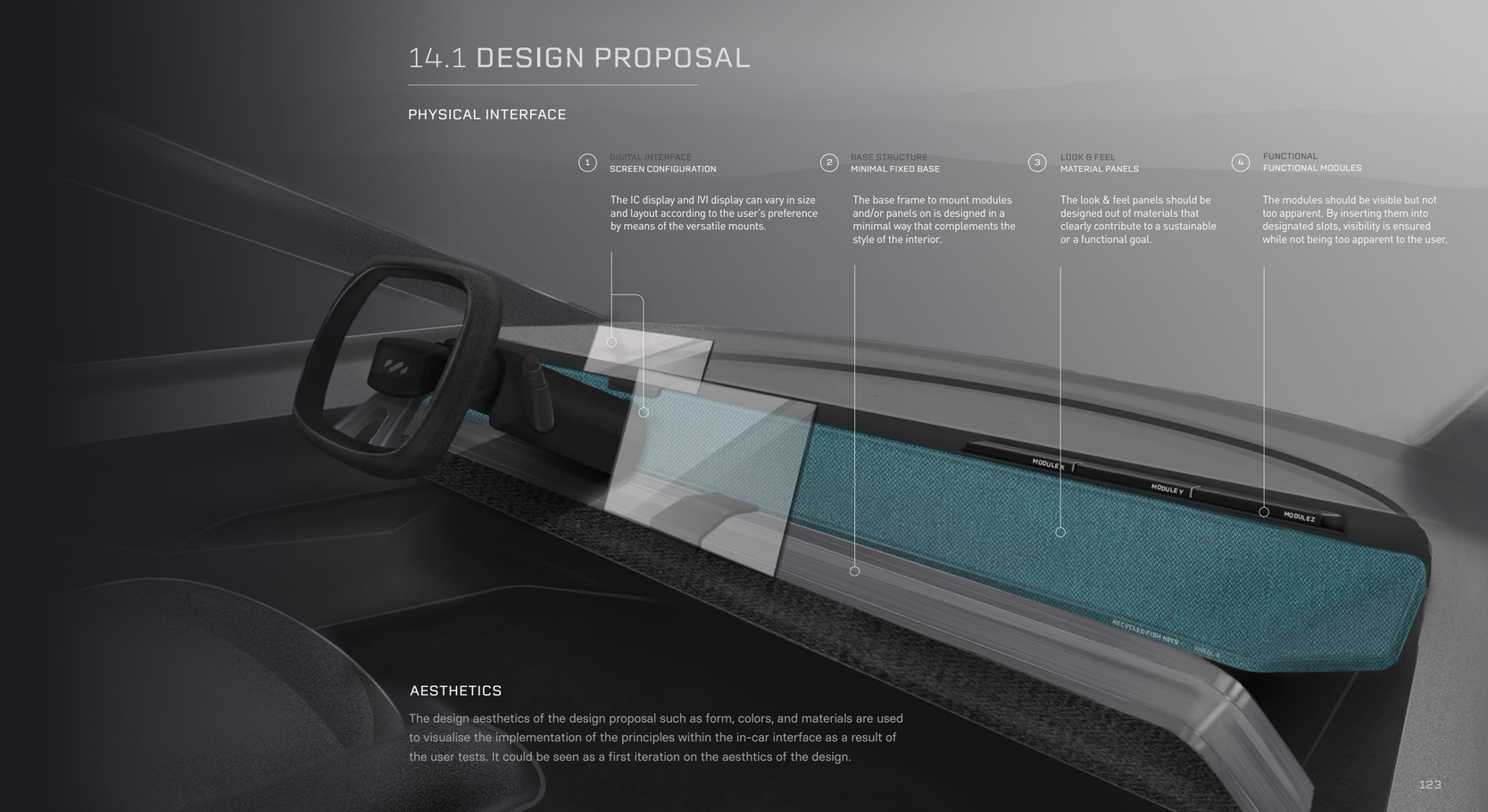
1. **Users should be able to change the size and layout of screens**
2. **A minimal fixed base in complemeting the interior style**
3. **Material panels should have clear functional benefits**
4. **Functional modules should be visisble but not too apparent**

Digital Interface

1. **Subtle pop-up notifications**
2. **Clickable visual elements**
3. **Clear module beneftis specified**
4. **Continue proces on other devices**

14.1 DESIGN PROPOSAL

PHYSICAL INTERFACE

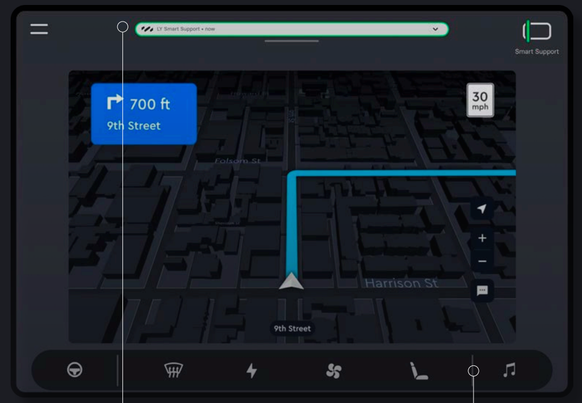


AESTHETICS

The design aesthetics of the design proposal such as form, colors, and materials are used to visualise the implementation of the principles within the in-car interface as a result of the user tests. It could be seen as a first iteration on the aesthtics of the design.

DIGITAL INTERFACE

NAVIGATION SCREEN (EXAMPLE)



MODULE SELECTION SCREEN (EXAMPLE)

1 SUPPORT NOTIFICATION
SUBTLE AND RECOGNISABLE

The initial notifiaction pop up is redesigned in a way that it notifies but is not distracting the user in any way.

2 MAIN NAVIGATION BAR
COMPACT MENU

The main navigation bar has been redesigned in a more compact way without having too much separate elements that might confuse the user.

3 MODULE SELECTOR
CLICKABLE MODULES FOR MORE INFO

The modules and panels on the digital interface should be clickable to find out more about it, since that felt most intuitive to most users.

COMMUNICATING USER BENEFITS (EXAMPLE)

CONTINUE ON OTHER DEVICES (EXAMPLE)

4 MODULE SPECIFICATIONS
CLEAR USE BENEFITS

Once a modules/panel is selected, the user gets an overview of the corresponding benefits over their current interface.

5 SUPPORT STATUS ANIMATION
SUBTLE BUT RECOGNISABLE

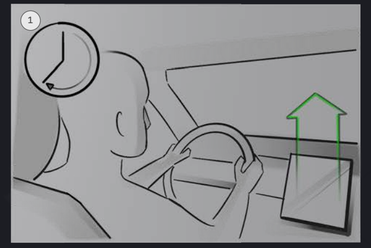
The animation of the interface analysis status (active/non-active) has been redesigned in a more subtle but clear way. that complements the overall design.

6 CONFIGURE & ORDER PROCESS
CONTINUE ON OTHER DEVICES

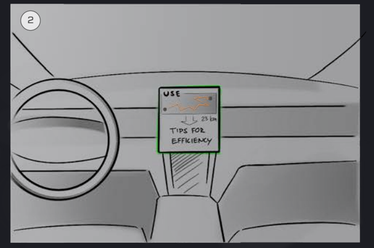
Once the user opts for a specific module/ panel, he/she can choose to continue the process on other devices as well or save their picked selection for later.

14.2 FINAL USER SCENARIO

This user scenario represents the way the user should interact with the product and visualises the intended scenario of use as a result of the user tests.

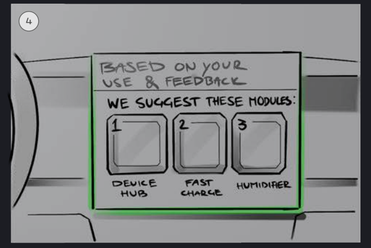


Vehicle owners use the car for X months while the smart support system analyses the everyday use of in-car interfaces and the user's rides during this period of time.

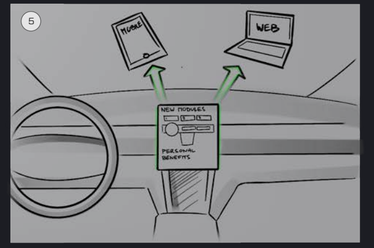


Based on the use analysis, the system supports the user with an use overview and provides improvements to the user experience by first suggesting behaviour changes.

After a certain period the user experience starts to feel obsolete, so gives feeback about this type of obsolescence to the system as input for further analysis.



Based on the use analysis and user feedback, the system suggests the latest physical modules to improve the in-car experience customized to the user needs.

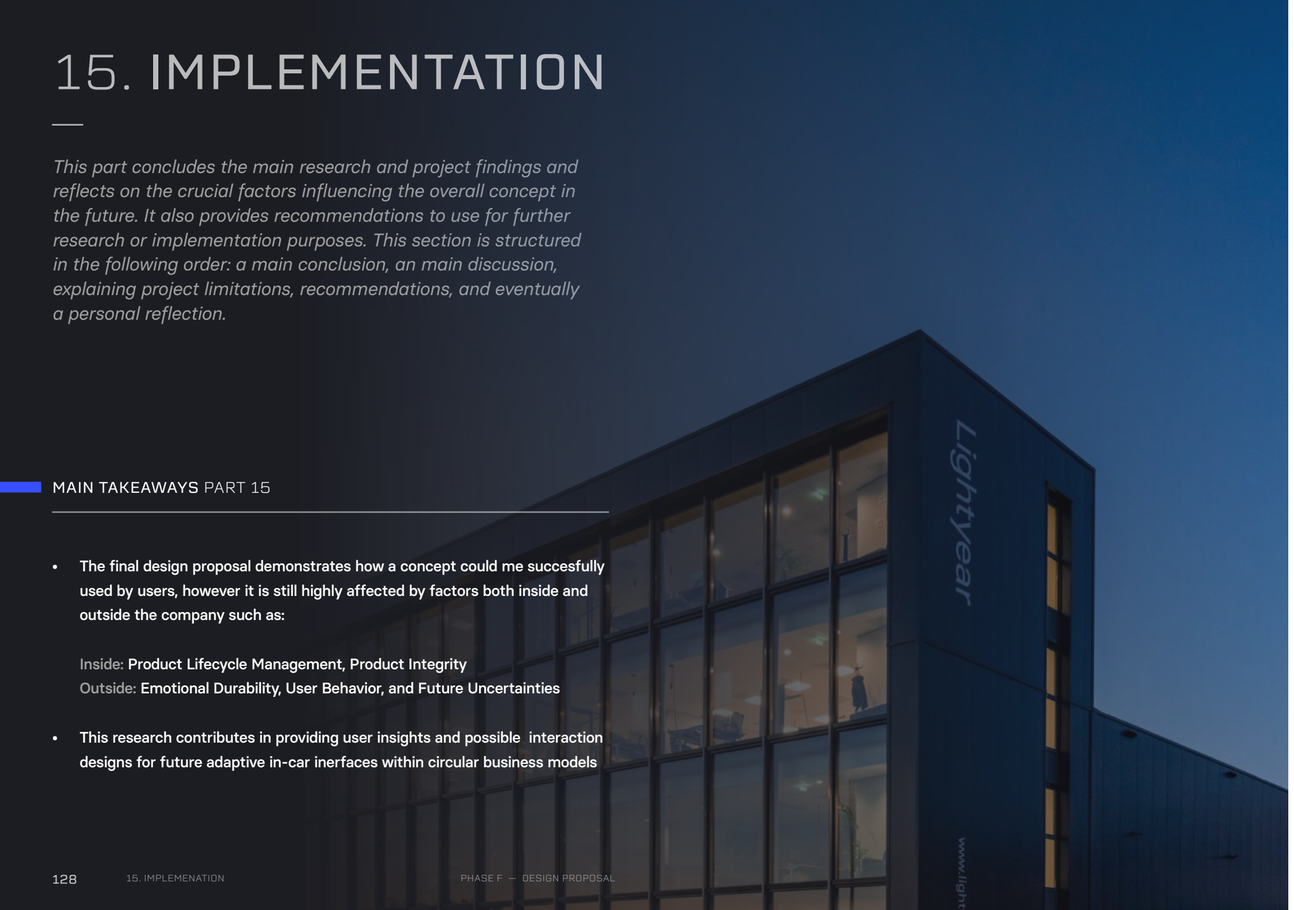


The user starts the configuration and ordering process inside the car and could proceed the process on other devices as well if needed.

The module gets installed by the professional at a Lightyear Service center. The in-car interface is up to date agian and improved the in-car experience to the user needs.

15. IMPLEMENTATION

This part concludes the main research and project findings and reflects on the crucial factors influencing the overall concept in the future. It also provides recommendations to use for further research or implementation purposes. This section is structured in the following order: a main conclusion, an main discussion, explaining project limitations, recommendations, and eventually a personal reflection.



MAIN TAKEAWAYS PART 15

- **The final design proposal demonstrates how a concept could me succesfully used by users, however it is still highly affected by factors both inside and outside the company such as:**

  Inside: **Product Lifecycle Management, Product Integrity**
  Outside: **Emotional Durability, User Behavior, and Future Uncertainties**

- **This research contributes in providing user insights and possible interaction designs for future adaptive in-car inerfaces within circular business models**

15.1 CONCLUSION

The goal of this graduation project was to design a future adaptive in-car interface which focuses on durability by extending the overall user experience over time (Design Brief, part 10). As described in part 1.3, this design is intended to form a solution to the problem that the user experience of in-car interfaces becomes functionally and psychologically obsolete at a much faster pace over time compared to the actual lifespan of a car itself. The main benefit for increased longevity is the reduction in total waste (Cooper, 2010). As this project focuses mainly on users and their in-car experiences it can be regarded as a user-centered approach focussing on the interaction levels of the design solution.

THEORY INTO PRACTICE

After having done extensive research on existing theories about managing obsolescence for design and future design context, and how users would behave, it appeared that the principles described by den Hollander (2014), which state that the principles of designing for Long Use, Recovery and Extended Use are also principles that can be applied within in-car interfaces to a certain extent. As explained in part 11.1, these principles could also be described on a more tangible level e.g. Repairability, Upgradeability, Emotional Durability etc. In order to explore whether these principles could be applicable within in-car interfaces, I discovered the solution space by creating artifacts ranging from visuals all the way to functional prototypes.

VALUE OF RESULTS

As a result of the user/expert evaluation and user tests, it appeared that an in-car interface is future adaptive by (physical) upgradeability was seen as very positive and most users would like to have such functionalities (partly) integrated into their own vehicles. Most users positively valued the principle of an interface system analyzing their everyday use and providing custom support. Modularity was mostly chosen to be suitable for secondary in-car functionalities and controls to have a positive impact on the in-car user experience. However users did not opt for any self-installation method and memberships connected to the concept. So these main results form clear insights on the overall use and in-car implementation side of the concept of creating a future adaptive design for in-car interfaces.

FUTURE RESEARCH

By including the design principles for managing obsolescence into in-car interfaces, these results could form design guidelines to use for future designers of in-car interfaces. Because this user-centered research gave clear insights in the fact that not all theoretical principles as proposed by den Hollander (2014), could be implemented in a successful way to have a positive impact on the user experience. So generally speaking for this reason designers and decision-makers within the automotive industry that want to design/manufacture a future adaptive in-car interface, should always first evaluate concepts with users to be sure about further development or production.

RESEARCH CONTRIBUTION

The contribution of this research project and final design proposal to the industry and scientific community can be described as 'a translation from bringing design theories for managing obsolescence into practice within in-car interfaces'. Therefore the results as presented in part 13.1, can be seen as a contribution to the knowledge about implementing these design principles into in-car interfaces and an analysis of its use context. By creating so-called artifacts in the form of concept directions and a final concept that was testable by means of a working prototype, I managed to break the barrier of theory and practice (see figure 41 on next page).

PROJECT CHALLENGE

The main challenge for this project was to iteratively find out, test, and learn how to apply design principles within the in-car interface as a method for managing obsolescence of the in-car user experience. The following questions were stated that should be answered after completion of the project:

1. **How can we utilize the expected product lifetime of the car as long as possible?**
2. **How do we ensure that the interface is kept up to date during the vehicle lifespan?**

Looking back at the overall process and the end result, I think these questions can be answered by means of the research and analysis phase, design proposal that shows that it is possible to keep the interface up to date from a user perspective as long as the design and interaction criteria are met as described. However the first question could be partly answered by the results of this project, because it depends on further research that needs to be done over a longer period of time in order to confirm that the design proposal is sufficient in achieving this challenge. The next step to continue this project would be to start on interaction explorations and design iterations for further development and research.

RESEARCH POSITIONING
POSITION WITHIN RESEARCH COMMUNITY AND DESIGN INDUSTRY

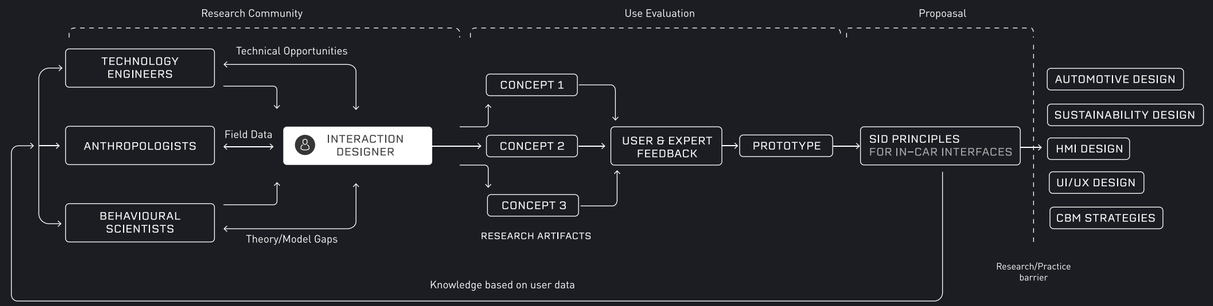


Figure 41 - Research positioning and its contribution to the industry based on the theory of Zimmerman (2007)

"An illustration of the pathways and deliverables between and among Interaction Design Researchers and other HCI Researchers. The model emphasizes the production of artifacts as vehicles for embodying what "ought to be" and that influence both the research and practice communities." (Zimmerman, 2007)

15.2 DISCUSSION

CRITICAL MINDSET

As described in the previous concluding part which covers the results of this project and explains its relevance within the industry, the success of this concept is highly dependable on other factors and therefore in itself not a guaranteed solution to the problem of an obsolete in-car user experience over time. The final design based on the underlying interaction principles could only work well if its context is also organized and executed in the right way. This includes, business strategies, human resources, new business channels, company mindset and product integrity all attributing to the determination whether this concept will succeed within society or its likely to (partly) not sustain over a longer period of time or even not succeed in its initial state.

DETERMINING FACTORS

According to den Hollander (2018) product design with circularity as underlying principle is affected by multiple factors, namely: A suitable circular business model strategy, Design for extended use, Service design for intended user behavior etc. So only if all these factors are being taken into account by the designer, company and other parties affiliated with the final product and/or life cycle, it is likely to succeed as intended. Below, the essential factors that determine the success rate of a sustainable in-car interface.

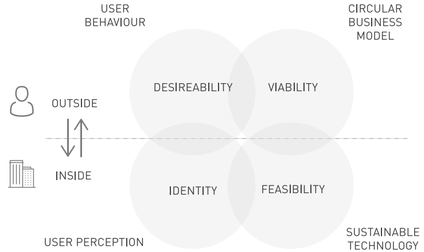


Figure 42 - Related factors to the value proposition, design, implementation, and business model

SUSTAINABILITY

An apparent benefit from extending a product's lifespan is the reduction in waste as a result of produced products at a given time. But another take on it is the decreased carbon emissions by the usage of fossil fuels of their production: all produced products include embedded carbon. However, extending a product's lifespan, does not automatically imply that it will be used as intended in order to be a more sustainable solution, because once the following crucial elements are not met, the product is not a viable solution in terms of sustainability (Cooper, 2010).

Product Lifecycle Management

A circular business model which is further defined as Access Model (Bakker, 2014) to use as a basis on which this concept potentially could work, it is still dependable on another structural plan to ensure the over goal of sustainability is realistic. Because without proper product lifecycle management the flow of obsolete products at their end of life or end of use periods can be controlled and/or estimated properly. Only when product life cycle management is executed properly, it could drastically reduce environmental loads, resource consumption and waste generation (Fukushige et al., 2012).

Emotional Durability

Designers should design for extended use all the way from the beginning of the developing process of new products. This means designing products that are easy to maintain and/or upgrade. However the influence of emotional value affecting the decision-making to update or upgrade something is hard to depict, since it depends on a lot of personal and contextual elements that might be of influence. It is not something that is easy to predict or measure so this is an uncertainty. Although there are tools that could help in designing for positive emotions (Yoon et al., 2020), that could result in the user having an emotionally durable relationship with the product.

NO FULL CONTROL ON USER BEHAVIORS

An upgradeable product design is not only an engineering quality that can be designed into products but is also affected by intangible factors like user behavior and wider socio-cultural influences (Cooper, 2010). Therefore Lightyear is also not able to have full control on their customers. which is something to take into account and could form a reason to get in close contact with behavioral scientists as well as anthropologists that have a clear view on how society and humans in general develop.

Intended Use

It is unsure whether users will behave consistently and if products are used properly. However the amount of control a product has with regards to its intended use it was initially designed for, can be (partly) guided in a way that users will be nudged positively by designing stimuli within the product/service that result in the intended use.

Misuse

If the concept over time or Lightyear as a company/manufacturer is not able to demonstrate and exploit the concept as intended among users, some users might be tempted to misuse this. A possible effect could be that users see it as a service to keep modules/panels as spare parts to store themselves or maybe even resell through other channels.

Misuse could also be the case with installation processes by users taking matters into their own hands by installing modules/panels themselves which can later result in high risk of material/product failure, no safety guarantee, and maybe even (fatal) accidents.

USER PERCEPTION

The overall message is that a positive in-car user experience can be extended by making use of the concept that enables users to personally set up their in-car interfaces based on their context and use. Whether this idea behind the concept comes across as intended is also doubtful. Because users eventually still have to pay for modules/panels for example, it could also feel like a marketing model that just tries to sell you new products, which is unwanted since sustainability is the overall end goal. It is also highly contradictory with Lightyear's vision and intended brand image to have accelerated the sustainability transition in mobility and to have positive impact.

However delivering a message like "this is the only suitable option to be truly sustainable", is also not necessarily what is needed to get the right message across. The overall value proposition should be that products could could improve and/or update the user-experience over time, so that the user benefits positively while having a positive impact on sustainability. A principle that is also stated by Cooper (2010) which entails that consumers appear to be more attracted to personal benefits such as economic gain and added value through functionalities, rather than the greater environmental benefits.

UNCERTAIN FUTURE

Within the context phase of this project an extensive futurescaping process made it possible to shape a future context that is based on existing data, research, and expert views and predictions on the future ahead. Although this is a good attempt at setting possible future context, it is still a rough estimation how the future will be shaped and more importantly, how users will behave in it.

So for this project the future is taken to shape a possible future that opens enough creative solution space and still be close to reality because of Lightyear's company vision and mission. However, applying methods such as Future Adaptive Design which takes into account that circular business models and its product always should be adaptive to its ever changing contexts (Nyström, 2021), could help prevent designs/services from becoming obsolete due to changing contexts of use.

15.3 LIMITATIONS

INDIVIDUAL PROJECT

Considering the time frame of this project which had a duration of about six months and the fact that it was an individual project, it was not possible to cover all aspects that might have an influence on the concept. Therefore the technological feasibility and business aspects are mentioned but not researched in a detailed way.

NO REAL USER DATA YET

As Lightyear is just about to deliver their first model (Lightyear 0) to customers in the coming months, no real user data was available yet. So for the analysis I could just rely on potential user groups based on internal customer research and marketing research.

MISUSE

The context was taken into account in the form of user scenarios and by a scenario based user test, though it was not developed any further due to time constraints. This resulted in the fact that participants had to imagine how the product would be used in the future with relation to the business model, product support, and service for example.

PARTICIPANTS

With two tests being taken that consisted of one concept direction evaluation session and one more advanced user test, for this project the amount of participants (respectively 16 and 11) that took part can be considered sufficient. However, for future research within this topic, it is advised to use a larger group of participants to also be able to include quantitative data and form a well funded median based on qualitative data.

BUILDING TOOLS FOR PROTOTYPE

I built the final prototype in the proto lab at Lightyear and their tools. I also got the support from prototype engineers during the building process to get to build the prototype within a timespan of about 2,5 weeks. Because of this short timespan and the availability of both the tools and materials as well as the prototype engineers, I had to accommodate to their schedule and way of working sometimes.

15.4 RECOMMENDATIONS

VALUE PROPOSITION

Clear communication is key in getting the right concept of updateability and its benefits across to users. Once the communication is clear to users they are likely to interpret the concept as intended and assumingly will use it appropriately. The overall goal of sustainability should be made very clear by Lightyear through a dedicated value proposition and all the well thought considerations should be expressed in order to create the right product.

360º ARGUMENTATION

Since this project has a user centered approach the technological part and business part has only been researched through the use perspectives. Although this forms a clear vision on how users would prefer a business model and expect its use of technological features, these parts need to be further researched and tested on feasibility and viability in relation to the final concept.

PHYSICAL DESIGN

The physical design needs to be designed with a style that matches the Lightyear form language, colors and materials which also have an influence of the possibilities and limitations regarding the final design proposal for further development. It also contributes to form a more realistc view on how this product would fit within future Lightyear models and eventually its product portfolio consisting of more products.

CIRCULAR BUSINESS MODEL

The circular business model should be a combination between one time purchase business model and the access business model. This will ensure the company is in full control of the limited amount of products being produced and products will be used in turns (Bakker, 2014). While users will have full ownership after purchasing it, the company should work with a deposit system and set up refurbishment channels for repairment facilitation leading to reuse.

SUSTAINABILITY

The final design should be designed with sustainability as its main objective. This means that durability of the physical components of the design should be thoroughly stress and failure tested in order to come up with a high quality durable and long lasting solution preferably made out of eco-friendly materials. Once the design is decided upon, a Life Cycle Analysis needs to be done in order to determine the total impact per product plus its potential impact during the time of use. Once this is done properly, the honest and factual environmental benefits can be valued.

FUTURE DESIGN RESEARCH

Behavioral studies among (potential) users in relation to potential use and misuse should be done in order to gain knowledge about essential communicative design elements that need to be implemented to make the product work. Once a preliminary design is finished it should be tested with a 1:1 scale prototype as close to the real context of use as possible. This should be done by extensive pilot tests, preferable over a longer period of time. Additionally a detailed service should also be designed around it to give the users the full experience of how the concept could work and what services are connected to it. Once this is done properly, a well funded view can be achieved on what principles or design. elements work and which ones should be adapted.

PERSONAL REFLECTION

It was a real pleasure to follow one of my greatest passions and to get the chance to do this for my graduation project, namely car design. Lightyear is a company that I admire a lot and the design team provided me with an inspiring working environment which sometimes even made it hard in deciding my own role by having your own graduation project next to all the inspiring things that you simply want to know all about. For this reason I decided to prioritize my own project as much as possible, although this did not always match my initial intuition. Because I had the opportunity to work within the Lightyear design team, I was also able to work a lot with experts from all kinds of fields. Thanks to this, I have been able to build a network of colleagues who supported me in making this project a success!

Looking back now, I am very satisfied with how the overall process went and with the result. I think, given the time frame, I was able to get the most out of it. However, there have been steps that in my opinion could have been more efficient, such as finding a ‘method’ and the activities done for the ‘future framing’ phase. I think if this would have been shorter, it would have given me more time to test multiple concepts supported by an advanced prototype for example. However, I don’t think this would have changed the result very much after all.

The project has been brought to a succesful completion, although I think the overall problem is still far from solved. I look back on a very valueable and energetic period that has improved me both personally but also professionally in the field of UX design, especially within the automotive industry, which I look back to with virtue!

THANK YOU FOR READING!

For more information, feel free to contact me

ADDITIONAL MATERIALS

REFERENCES & APPENDICES

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APPENDIX 1

OTHER TYPES OF OBSOLESCENCE

Economic obsolescence

This category of obsolescence can be seen as indirect and external factors that have an influence on the replacement and lifecycle reduction of products. Based on economic reasons, the consumer decides to replace its current product. This can be explained by two different types.

Cost of Repair

When the cost of repair is too high or too close to the (original) price of purchasing a brand new product, it is no longer reasonable to repair it because of economic motives.

Purchase subsidy mechanisms for consumers

The replacement rate of products could increase because of subscription business models that invite people to replace their products by only having to pay a little extra next to their subscription in order to receive a new model. Usually this extra fee for a new product is significantly lower compared to the original price of a product.

Subsidy mechanism by policies

Consumers receive subsidies from local institutions by the use/purchase of new products because of their new technologies (e.g. more environmentally friendly technologies). The step towards replacement of products now becomes much more attractive due to the financial benefits it has to offer.

Ecological obsolescence

Environmental concerns push the consumer to buy new products because they are more environmentally friendly – either more energy-efficient or more recyclable. As environmental concerns are growing, companies are trying to increase the consumption of their products by attracting consumers with ecological arguments (Centre Européen de la Consommation, 2013).

APPENDIX 2

VISION | LIGHTYEAR 0

Change of mindset

Lightyear emphasizes that the conventional perception of cars and mobility in general is likely to change by its innovative solar technology. It will change due to the way the car is able to charge itself by solar energy without the need of a power supply for an extra 12km per hour. With an average Daily Driving Distance of 32,9km in Europe and 25-50km on average globally (Solarnev, 2021), the need to charge is of less importance for the user. So the user's mindset changes by not having to check the remaining battery percentage until a new charging session is needed, but instead it

A car that never sleeps

The bi-directional charging technology implemented in the Lightyear One enables the car to deliver solar generated energy back to the grid. This means that the car itself could not only generate but also store energy and transfer it (in)directly back to the grid or to a house. By doing so the car not only consumes its generated energy but could also function as an extra power source when parked outside.

EXTERIOR STYLE | LIGHTYEAR 0

Exterior

While still having the starting point from the archetype of a car that we are all familiar with, this car is clearly something new with its tear drop shaped shell that is covered by a 5m2 solar panel embedded in the roof. It transmits a futuristic future while still staying close to nature as we know it by its hyper aerodynamic shell shape. This expression of freedom is in line with Lightyear's 'Go Free' branding, by seeming slightly elevated, achieved by its dark underparts. Next to the overall design language, efficiency is also intensively implemented within other stylistic elements such as the side mirrors that are transformed in tiny cameras, the rear wheel covers, and the clear low bonnet at the front, all to increase efficiency by improving its aerodynamics. (GranStudio, 2019)

APPENDIX 3

RUBRIC FOR INTERACTIVE SYSTEMS EVALUATION ON SUSTAINABILITY

This rubric provides an understanding and assessing method of interaction design in forms of use, reuse and disposal from the perspective of sustainability, ordered very approximately from greatest to least negative environmental impact (Blevis, 2007):

1. disposal—does the design cause the disposal of physical material, directly or indirectly and even if the primary is the material of the design digital material?

2. salvage—does the design enable the recovery of previously discarded physical material, directly or indirectly and even if the primary material of the design is it digital material?

3. recycling—does the design make use of recycled physical materials or provide for the future recycling of physical materials, directly or indirectly and even if the the primary material of the design is digital material?

4. remanufacturing for reuse—does the design provide for the renewal of physical material for reuse or updated use, directly or indirectly and even if the primary is the material of the design digital material?

5. reuse as is—does the design provide for transfer of ownership, directly or indirectly and even if the primary is the material of the design digital material?

6. achieving longevity of use—does the design allow for long term use of physical materials by a single owner without transfer of ownership, directly or indirectly and even if the primary material of the design is digital material?

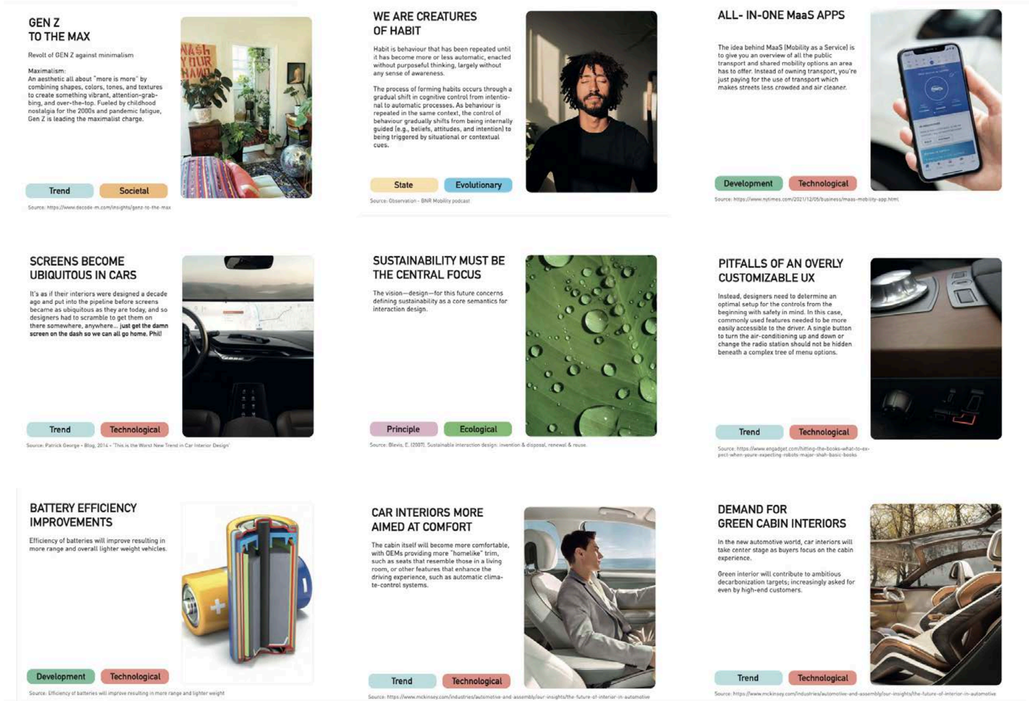
7. sharing for maximal use—does the design allow for use of physical materials by many people as a construct of dynamic ownership, directly or indirectly and even if the primary material of the design is digital material?

8. achieving heirloom status—does the design create artifice of long-lived appeal that motivates preservation such that transfer of ownership preserves quality of experience, directly or indirectly and even if the primary is the material of the design digital material? This notion of heirloom status is similar to Nelson & Stolterman [30] description of “ensoulment”.

9. finding wholesome alternatives to use—does the design eliminate the need for the use of physical resources, while still preserving or even ameliorating qualities of life in a manner that is sensitive to and

APPENDIX 4

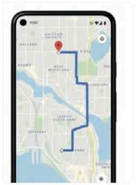
CONTEXT FACTORS



CONTEXT FACTORS

PEOPLE STRIVE FOR EFFICIENCY

People focus on having the most efficient and shortest journey possible



Principle | Societal

Source: Observation + BNR Mobility podcast

MOBILITY HUBS ROLL OUT

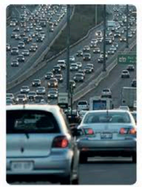
Mobility as a Service (MaaS) replaces car ownership with a combination of multiple modes of mobility on demand. Mobility hubs are essential for the safe and convenient switch between modes of transport but they can be much more than just locations to switch modes. Best practices show that they can close supply gaps, enhance traveler experience and the quality of life in their areas.

Development | Technological

Source: https://mobility-as-a-service.blog/mobility-hubs/

55% OF THE CITY DEDICATED TO CARS

55% of the city is dedicated to car real estate in NL

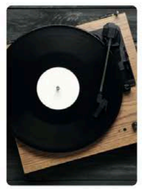


State | Economic

Source: Milieudefensie (Recht van de Sneltrein)

AFTER EVERY TREND COMES NOSTALGIA

For every trend (like installment of screens) there is a counter trend, people just want to go back. Which could be related to bringing back the essence or nostalgia principles.

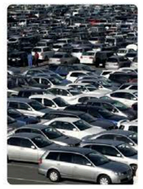


Principle | Psychological

Source: Interview Carlo Brantsen (Expert)

AVERAGE LIFESPAN OF A CAR IS 8 YEARS

An average life span of a car is 8 years.



State | Economic

Source: An average life span of a car is 8 years.

FUNCTIONALITY OVER GIMMMICKS

The majority of people simply in the end would choose functionalities over nice techy gimmicks.

Principle | Technological

Source: Carlo Brantsen (Expert) and Bram Bos (Expert)

SCREEN-HYPE REVERSED

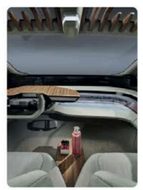
Trend towards huge displays could be reversed (eg, through holographic displays.)

Trend | Technological

Source: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-future-of-interior-in-automotive

CAR AS 3RD LIVING SPACE

The interior of an automated vehicle may be of particular importance, as it contributes largely to creating a living space.



Trend | Evolutionary

Source: Charlie Bos (Expert)

PURPOSE-BUILT VEHICLES

The purpose-built vehicle (PBV) market is a new business model in the automotive industry that involves original equipment manufacturers (OEMs) designing, manufacturing, and selling highly customized vehicles according to customers' application needs.

Trend | Technological

Source: A new breed of cars – Purpose Built electric vehicles, Roland Berger (2018)

CONTEXT FACTORS

HIGH ACCEPTANCE WHEN PART OF COMMUNICTY

Citizens are 'engaged' when they play a meaningful role in the deliberations, discussions, decision-making and/or implementation of projects or programs affecting them. Accordingly, organizational and government leaders need to broaden the way they see their responsibilities to include roles as facilitator, supporter, collaborator, and empower of citizens and stakeholders.

Principle | Societal

Source: https://www.gsu.edu/research/centers/ccel/engagement-tool-box/engagement/why-community-engagement-matters

YOUNG PEOPLE (20- 35) OWN LESS AND LESS CARS

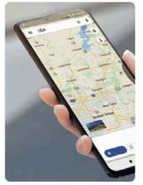
Om maar meteen met de deur in huis te vallen: in de leeftijdsklasse 18- tot 30-jarigen is het aantal bezitters van een auto laag, en het loopt zelfs gestaag terug, blijkt uit CBS-cijfers. Minder dan drie op de tien jongeren heeft nog een eigen auto en dat staat in schril contrast met oudere gebruikers. Want onder 65-plussers is het autobezit zelfs gestegen naar meer dan zes op de tien. Wat is er aan de hand? Is de auto geen statussymbool meer of doet de auto er überhaupt niet meer toe?

Trend | Economic

Source: https://fd.nl/fd-persoonlijk/1271737/waarom-kopen-jongeren-minder-auto-s

PEOPLE USE NAV APPS NOW FOR DISCOVERY

Google redesigned Google Maps to make it better for discovery and exploration. In doing so, it's taking some cues from social media companies, such as Snapchat and Instagram, which have used maps or location tags to help users discover and explore locally relevant posts.



Trend | Technological

Source: https://www.smartester.com/content/people-continue-to-rely-on-maps-and-navigatio

TECHNOLOGY EVOLVES WHILE INTERACTION STAYS

Interactions will partly be turned back like the feeling it had when every knob and button was still physical, while the technology will still evolve behind it.

Trend | Technological

Source: Interview Carlo Brantsen (Expert)

LIGHTWEIGHT CARS

I think the biggest design trend in cars the coming 10 years will be to make more lightweight cars.

Trend | Technological

Source: Interview Carlo Brantsen (Expert)

BATERRY PRICES WILL DECREASE

Battery prices will fall in the near future resulting in lower priced EV's.

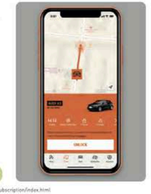
With rising production and technological improvements, batteries are becoming cheaper to produce, making EVs increasingly competitive with gas-powered cars.

Development | Economic

Source: https://www.visualcapitalist.com/electric-vehicle-battery-prices-fall/

PAY PER USE LEADS TO DECREASE IN OWNERSHIP

Why buy and own something if there is an easier way to get the same or even better outcome? In other words, "why own when you can subscribe?" is the new mindset amongst consumers.

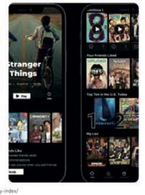


Trend | Economic

Source: https://money.cnn.com/2018/09/01/technology/car-subscription/index.html

SaaS BUSINESS MODELS ARE POPULAR

SaaS business models are becoming more popular amongst users and the industrie of subscription models is growing rapidly.

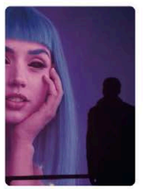


Trend | Economic

Source: https://www.zuora.com/resources/subscription-economy-index/

HIDDEN SCI-TECH

Sci-Tech is becoming more a thing within interior designs. Technology that is hidden and only appears when needed. Smart use of technology within interfaces.



Trend | Technology

Source: Interview Charlie Bos (Expert)

CONTEXT FACTORS

CARS MONITORING OCCUPANT

The interaction from human to machine will revert via smart monitoring within cars from car to occupants. Car monitors occupants and acts according to their needs, feelings, emotions, behavior etc.

Trend | Technology

Source: Interview Charlie Bee (Expert)

AIR QUALITY WILL BE OF IMPORTANCE

The air quality inside vehicle interiors can be a serious health concern, for causes ranging from elevated heart rate and blood pressure to increased risk of driver drowsiness.

Development | Biological

Source: https://www.iqair.com/blog/air-quality/in-car-pollution

SUSTAINABLE MATERIALS IN CAR INTERIORS

In recent years, the trend has moved towards using more sustainable and natural materials. The automotive industry is leading the charge on innovation with new materials that can replace harmful ones and which also benefit agriculture and other industries. One example is the synthetic leather, SofTex, which weighs far less than genuine leather, produces fewer carbon emissions and fewer Volatile Organic Compounds.

Trend | Technology

Source: https://www.continental-tires.com/car/stories/technology-and-innovation/material-car-world

MOVEMENT WITH INTENTION

Mobility can be seen as movement with intention.

Principle | Demographic

Source: https://www.linkedin.com/pulse/how-mobility-can-shape-sustainable-future-claus-andy-cahen/

DESIGN WITH TRANSPARENCY

The shift from closed to open paradigms in new product develop- ment is seen as an emergence of new forms of production, innova- tion, and design.

Development | Societal

Source: Ikhsamurto et al., 2015)

COVID-19 LEADS TO ENVIRONMENTAL AWARENESS

The COVID-19 pandemic continues to shape and shift consumption and lifestyle behaviour across the globe. A new study across 24 countries reveals 58% of adults are more mindful of their impact on the environment, and 85% said they're willing to take personal action to combat environmental and sustainability challenges in 2021.

Development | Societal

Source: https://www.mastercard.com/news/media/pfcnaedh/consumer-attitudes-to-the-environment-2021.pdf

MINIMZING COMPLEXITY IN UX

Larry Tesler argues that, an extra week should be spent by the engineer to reduce the complexity from the system rather than making millions of users spend an extra minute using the program because of the extra complexity.

Principle | Technology

Source: https://uxdesign.cc/complexity-for-the-system-or-the-user-that-is-the-question-af6a29056aad

IT'S ALL ABOUT THE NARRATIVE

The fact that humans react to storytelling is not news. Stories have been with us since our existence, as evidenced by cave paintings, fairy tales, all the words and images that time travel seamlessly and join us together in common narratives. It's a social activity that helps people relate to what's being narrated. These stories and experiences are at their core emotive, they evoke curiosity and are immersive.

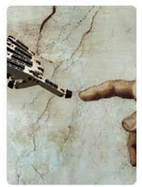
Principle | Psychological

Source: https://99designs.nl/blog/trends/ux-design-trends/#1

DIGITAL HUMANISM

In a world that is rapidly evolving due to technology and its advances, it is important to maintain the human connection.

While technology solutions allow us to automate solutions and make our everyday lives simpler, real people and authentic interactions are critical to maintaining positive communication and ensuring that digital processes run smoothly.



Principle | Psychological

Source: https://www.trackmind.com/digital-humanism/

CONTEXT FACTORS

OEM'S BECOME SOFTWARE PROVIDERS

While OEMs continue pushing their ambitious transition from car manufacturers to mobility providers, in-vehicle infotainment systems and digital dashboards have emerged as a new profit opportunity, with over-the-air updates and platform innovations that are contributing to change OEMs' business models.

Trend | Economic

Source: https://www.inverse.com/article/10947-as-urban-populations-explode-personal-space-will-become-a-rare-luxury

BEING DIGITAL NOMAD BECOMES EASIER

The New Trend Of Wanderlust, Work-From-Anywhere Digital Nomads
The rise of "remote work" and a more and flexible workforce, drives a trend in more flexible "nomadic" lifestyle. No fixed address but still a highly disposable income.

Trend | Demographic

Source: https://www.forbes.com/sites/jacklori/2020/06/20/the-new-trend-of-wanderlust-work-from-anywhere-digital-nomads/?sh=2a1163f78b81

FROM CONSUMER TO PROSUMER

Simply put, a prosumer is someone who both produces and consumes energy – a shift made possible, in part, due to the rise of new connected technologies and the steady increase of more renewable power like solar and wind onto our electric grid.

Development | Technology

Source: https://www.energy.gov/eere/articles/consumer-vs-prosumer-whats-difference

INCREASING SCREEN SIZE CAUSES SAFETY CONCERNS

Cars, trucks and SUVs have grown in size in recent years; so too have the infotainment screens inside of them. With the increased size and additional landscape the screens are taking up, concern from safety experts is on the rise regarding how the technology contributes to distracted driving.

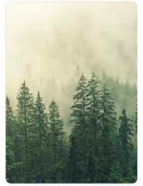
Development | Technology

Source: https://www.nonewsweek.com/infotainment-screens-getting-bigger-little-no-safety-regulations-place-1602197

NEED FOR TRANSPARENT BUSINESSES

To make true progress towards a more sustainable future, businesses need to be transparent about their environmental impacts.

This means reporting not only on corporate impacts, such as greenhouse gas emissions, waste and water usage, but also on the environmental impact of their products, throughout their lifecycle.



Development | Societal

Source: https://www.theguardian.com/sustainable-business/blog/waste-and-recycling

DISPLAY-CENTERED WORLD

"We're living in a display-centred world," said Brian Rhodes, Connected Car Research Lead at IHS Markit. "I don't think it's coincidental we have a lot of screens in vehicles that look just like tablets. That's clearly the trend."

Trend | Technology

Source: Brian Rhodes, Connected Car Research Lead at IHS Markit. – 2019 https://www.cbc.ca/news/science/ces-trends-8-tech-screen-can-1.4972574

TIMELESS DESIGN

Timeless design specifically can be defined as design that will never go out of style, it has a staying power and it is created not to be temporary.

A timeless design, in fact, will last for years and can be brought up to date with changes in accessories and accents.

Principle | Cultural

Source: https://moremidcenturydesign.com/blog/home-interior-design/how-to-create-a-timeless-design/

ZERO SCREEN UI BECOMES THE NEXT BIG THING

We shall soon approach the era of screenless interaction, often known as Zero UI.

Humans will be able to connect with machines through natural methods like as speech, movement, looks, and even thoughts, thanks to zero UI technology.

Zero UI is already in use on a variety of devices, including smart speakers and IoT devices.

As of 2018, 16 percent of Americans (about 39 million) own a smart speaker, with 11% owning an Amazon Alexa device and 4% owning a Google Home device.

Development | Technology

Source: https://medium.com/visual-side/zero-ui-the-end-of-screen-based-interfaces-visual-side-ltc-829990667f5c

HONEST DESIGN

Conversely, when a product team is willing to put in the time to understand its users, the end product doesn't need to hide anything. It not only provides value, but continues to adapt and develop with the user's input.

Now more than ever, audiences are extremely resourceful and active in searching for products they can trust. Ones that can provide them with value and can display a penchant for honesty and empathy in their design. As a designer (or really as just a person), you should be reflecting constantly on how you can be a better advocate for your audience and how you can improve your honesty with the work you do.

Trend | Evolutionary

Source: https://medium.com/swlh/good-ux-design-is-honest-9fb501d0e697

CONTEXT FACTORS

FREEDOM WITHIN COLLECTIVE

The freedom of all individuals, within the accepted norms of societal restrictions, feeds the stream of collective freedom. Thus, freedom at the levels of both individual and collective is necessary to allow a creative outflow at both levels.

Principle | Societal

Source: https://www.thenews.com.pk/tns/detail/717165-individual-freedom-in-a-collective-context#:~:text=In theory%2C the collective society,their%20stream%20of%20collective%20freedom.

EV'S HAVE HIGH IMPACT ON THE GRID

Rising interference of EV in grid causes decrease in life cycle of the transformer. The mining of lithium (which is used in batteries of EV's) result in production of greenhouse gases, environmental pollution and affects the human health.

State | Technology

Source: https://eeexplore.ieee.org/document/9567587

SUSTAINABLE MOBILITY HAS STILL IMPACT

Sustainable mobility has impact on all kinds of systems. The future of personal mobility systems will likely consist of a mix of new technologies and changes in the present infrastructure, as well as new services and social arrangements.

Principle | Technology

Source: Thaller, A., Posch, A., Dugan, A., & Steininger, K. (2021). How to design policy packages for sustainable transport: Balancing disruptiveness and implementability. Transportation Research

SOFTWARE AS DIGITAL SOUL OF THE CAR

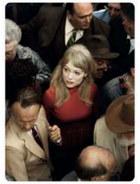
"Of course we want to own the real estate in our own car," newly appointed Daimler AG CEO Ola Kaellenius told a small group of journalists on Tuesday. "You need to own your own digital soul of your car."

Principle | Technology

Source: Daimler AG CEO Ola Kaellenius - 2019 https://www.cbc.ca/news/science/ces-trend-48-inch-screen-car-1.4972574

PEOPLE NEED SOCIAL INTERACTION

Our brain and bodies need human interaction because it helps us to understand what is going on around us. Thereby, human connections are key to the promotion of health and prevention of illness. Moreover illness can cause deterioration of human connections.



Principle | Psychological

Source: https://www.newsweek.com/infotainment-screens-getting-bigger-little-no-safety-regulations-place-1402197

NO DISTRACTIONS WHILE DRIVING

Driver distraction would decline, not rise, with a larger screen, they say, as drivers would no longer need to struggle through a myriad of options cluttered on a small screen.

"There are things we will lock out while driving," she said, adding that customers will be encouraged to use voice commands.

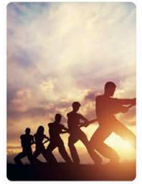
Principle | Technology

Source: https://www.cbc.ca/news/science/ces-trend-48-inch-screen-car-1.4972574
Ruth Vann - Ford UX supervisor

SENSE OF BEING PART OF SOMETHING GREAT

Having a sense of community embraces spirit, character, image and pride and is a vital element of a healthy community.

It is a feeling that people within the community matter to one another with a shared faith that their needs will be met through commitment and togetherness. Being a part of a community can make us feel as though we are a part of something greater than ourselves.



Principle | Psychological

Source: https://www.wellbeingpeople.com/2020/07/23/the-importance-of-an-engaging-community/

PEOPLE OPTING FOR SMART HOMES

Households have experienced an unprecedented change in the smart home field in recent months.

Figures from the recently published GfK Smart Home Monitor 2020 show that the awareness of Smart Home has more than doubled in 5 years. Dutch households currently own an average of 5 smart devices and no less than a fifth expects to have a complete Smart home within 2 years.

Trend | Technology

Source: https://insights.gfk.com/nl-nl/smart-home-monitor-2020#:~:text=Uit cijfers van de recent,uitgelig Smart huis te hebben.

PANDEMIC LED TO MORE SMART WEARABLES

When consumers started spending more time at home during the pandemic, many started using wearable devices as a means to monitor their health and seek medical treatment.

According to Insider Intelligence, US consumers' use of wearables increased from 9% to 33% in just four years.

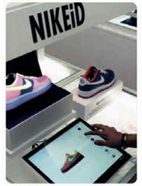
Trend | Technology

Source: https://www.insiderintelligence.com/insights/top-healthcare-wearable-technology-trends/

CONTEXT FACTORS

PERSONALISED EXPERIENCES

While businesses should benefit from increased conversion levels, consumers trading up and increased loyalty, the consumer receiving a personalised experience will feel more valued and recognised.



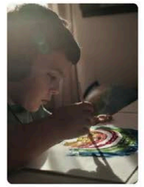
Principle | Psychological

Source: The Deloitte Consumer Review | Made-to-order: The rise of mass personalisation

STATE OF FLOW GIVES A FEELING OF SATISFACTION

When you're giving your fullest attention to an activity or task that you are incredibly passionate about, singularly focused on, and totally immersed in, you may find yourself creating the conditions necessary to experience a flow state of mind.

If the activity at hand happens to be something we enjoy and we're good at, we achieve a flow mental state — and it can leave us feeling ecstatic, motivated and fulfilled.



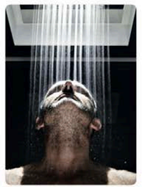
Principle | Psychological

Source: https://www.headspace.com/articles/flow-state

WE ARE SENSORY BEINGS

A multi-sensory learning experience with combinations of visual, auditory and other sensory functions exploits the natural connectivity of the brain.

As each sense holds a proprietary memory location within the brain, the effective orchestration of multiple sensory inputs ensures a wider degree of neural stimulation - Wolfe, 2021



State | Biological

Source: https://www.sensorytrust.org.uk/about/sensory

EV CONSIDERED TO BE TOO EXPENSIVE

The average driver still considers electric cars as too expensive so decides to choose for a combustion engine car.

State | Economic

Source: https://www.weforum.org/agenda/2021/01/electric-cars-batteries-fossil-fuel/

ESCAPING FROM REALITY

The American Psychology Association defines escapism as the tendency to escape from the real world to the safety and comfort of a fantasy world.

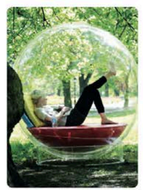
Since life is innately stressful, coping strategies are essential to making it through each day.

Principle | Psychological

Source: Fort Behavioral Health - August, 2021

PERSONAL SPACE WILL BECOME A LUXURY

Personal space will become a luxury
On a crowded subway car, finding a pair of empty seats is like spotting a crisp 20 on the floor: It's rare; it's fortuitous; and it makes us savagely possessive. In the era of overpopulation, personal space is a coveted luxury.



Trend | Psychological

Source: https://www.inverse.com/article/10947-as-urban-populations-explode-personal-space-will-become-a-rare-luxury

APPENDIX 5

CLUSTERS

1. Rising environmental awareness

As a result of environmental changes as the effects of global warming and earth pollution become apparent. There is an increasing amount of people being aware of these issues. Although this group of people is aware of the facts and changes that are necessary by taking appropriate actions, the group of people taking action by making conscious decisions and adapt behaviors is still minimal.

2. Green Living by Prosumer

The group of conscious people that take behavioral action by adopting a green way of living can be seen is prosumers. They no longer make use of energy provided by others but generate it themselves or they would like to transform their products and/or environments into so called green products and/or environments.

3. Shy-Tech based on MAYA principles

The screen less designs that makes use of the newest innovative technologies that still are widely accepted by their ease of use. Interactions might be new but all have human-like principles that make interaction feel natural and only apparent when the interaction takes place.

4. Accessible design (No nonsense)

Design that is aimed at functionality first and designed around that. (Almost) every element has a purpose. It is often characterized by utilitarian aesthetics. It is designed in a way that it is easy to understand and use by its users and thereby an accessible character.

5. Need for personal space

The need for personal space became relevant more than ever during times of a pandemic, but also considering the ever increasing urbanization trend and overcrowded places lead to a demand for personal space. It is expected that in the future personal space will be seen as a luxurious perk to have.

6. A software centered car

The importance of software is the central focus point of most EV's nowadays. The technical information, performance features and live data are all being displayed through software. The use of multi-media through the infotainment system is also something built on software that has become one of the most wanted dashboard features of a car.

7. On Demand (Service based) culture

The product as service use is ever growing. People want to subscribe to memberships and plans by not owning stuff and but making use of it whenever they want. And so is selling software as a service, also a popular business model these days.

A trend in the mobility industry now is to sell services that include all kinds of (micro) mobility within urban areas, so your now longer dependent on one provider.

8. A screen based world

We are living in a digital age with mobile services and software services being used more than ever, the screen plays a big role in our everyday life as well.

We use it every hour whether it is a laptop, phone or tv screen. It is everywhere. Same goes for the latest in car development that is simply using screens to minimize costs and offer limitless interface possibilities.

9. Personalized Experiences

The demand for customization and personalization is also an factor that plays a big role in our lives. With systems and services becoming more general and more used everyday, we still would like to express our own identity or have a custom option specially developed for an individual.

10. Living on the go

Living and working remote is becoming easier due to our innovative mobile technologies and its also a widely social accepted principle. The same thing goes for occupants of inside cars while driving or standing still. The car not only becomes an transportation space but also a place to relax, work or spend time in for other activities. The car becomes an extension of your house and office and could be interpreted as a third living space.

11. Car as a living object

The car becomes redundant while parked, but solar technologies make it possible to let the car still be functional while it is parked. Next to this a lot of other possibilities lie in this cluster e.g. the abilities of the car to interact with its environment. This is a change in perception of the car could be truly revolutionary and make the overall image of cars (specially within urban areas) of greater importance instead of an unwanted object.

13. Freedom within collective

The power of the collective is a well known principle. But next to that people are also more likely to accept new innovations when they feel to be part of a greater whole that all have the samen intentional believes.

The acceptance rate of something new as a product or a new behavior is also more likely to be high when an individual feel to be part of a community.

The need for freedom within a collective is still highly valued by most individuals and so there should be enough room for individuals to feel free for personal experiences and growth.

14. We are multi-sensory beings

We as human beings are multi-sensory beings that are highly influenced by stimuli all around us in order to interact with our environment. Whether it is sound, smell, vision, haptics or taste, they all contribute to an experience that could add value in someway.

A combination of multiple senses is even more wanted in order to generate valuable experiences, and therefore are also more likely to attach to and to remember.

15. Contra movements

Trends, hypes and era's all go by and fluctuate highly and so whenever something comes...something goes. Apparently when something is very much in demand and very popular among people or cultures after a while there is often a group of people who are consciously seeking for something completely different or opposed.

These continuous tensions create circles or peaks that lead to a dynamic structure of trends and developments that will stay, leave or come back over time within societies.

METHOD OF FORMING CLUSTERS

Common-quality cluster:
Combination of factors that all point to the same (underlying) direction and together from a 'metafactor'.

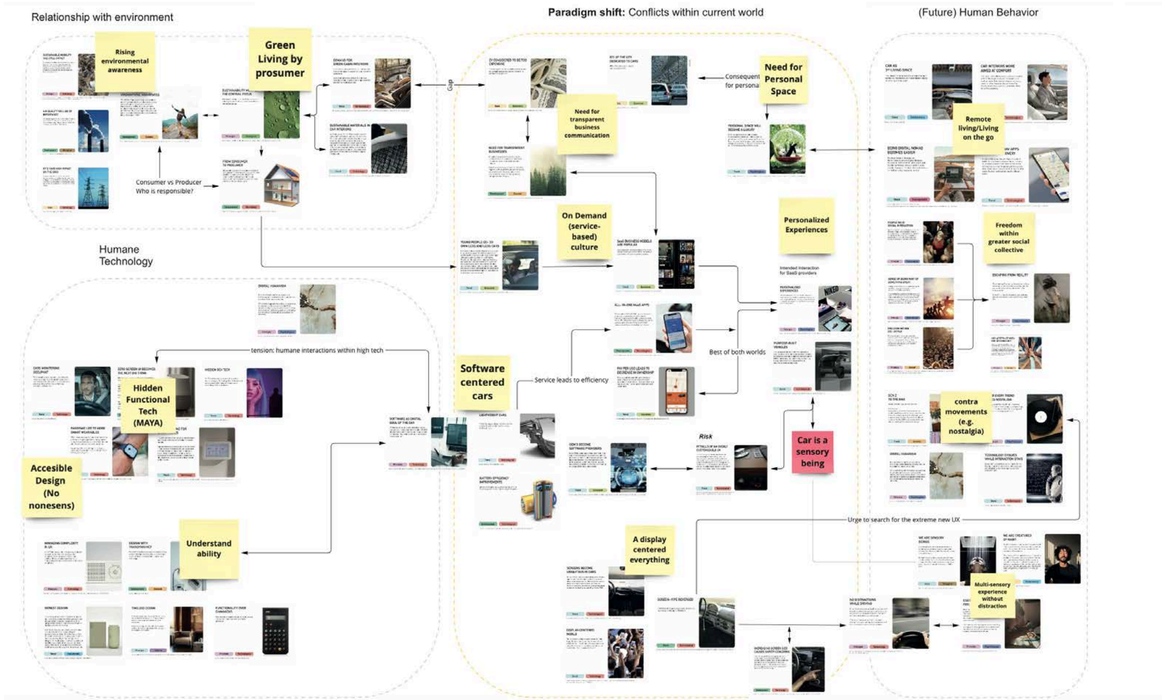
Example:
"people go to the gym more often" + "there is an increasing demand for vitamin supplements"

Emergent-quality cluster
By bringing together various factors, a new factor might emerge that is not represented by the two factors separately.

Example:
"teenagers spend two hours per day on gaming"+ "employees increasingly work extra hours" could be combined into one emerging factor "disintegration of family life"

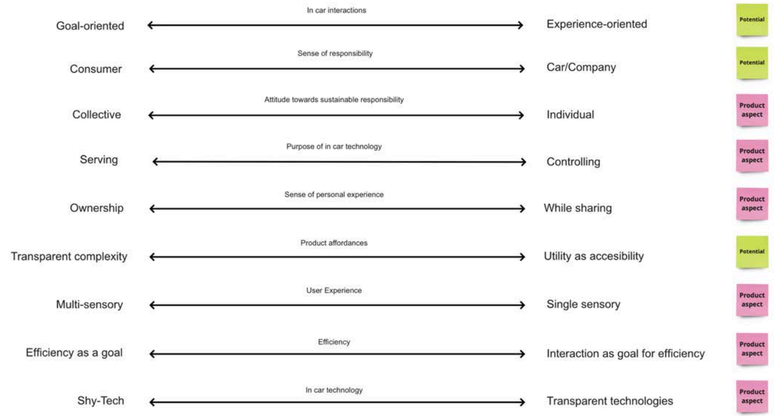
APPENDIX 6

CLUSTER RELATIONS MAP



APPENDIX 7

CLUSTER DIMENSIONS (DERIVED FROM RELATIONS)



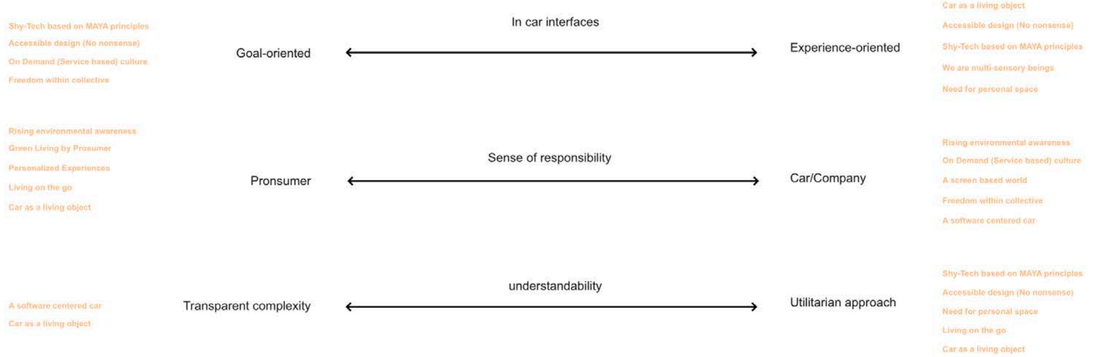
METHOD OF FORMING CLUSTERS

Pattern/storyline
Look at your clusters from a distance, a pattern or thread may appear that unites the clusters into a sort of narrative.

Dimension
When clusters seem to conflict or refer to opposing forces

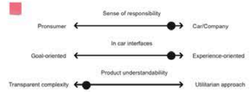
APPENDIX 8

FINAL CLUSTER DIMENSIONS FOR FUTURE FRAMEWORK



APPENDIX 9

FINAL FUTURE FRAMEWORKS EVALUATION

Dimension relations	Interaction view **Narrative**
	**Prosumer, Goal-oriented, Transparent complexity** In this interior scenario, users feel environmental responsibility and are therefore willing to take action by being a prosumer. The interfaces inside the car are all goal-oriented and therefore the purpose of interactions is always clear. The user understands the interfaces by its transparency in design.
	**Car/company, Experience-oriented, Utilitarian approach** In this interior scenario, people feel not responsible since they make use of a technologically advanced product that is doing it all. The interfaces inside the car are experience based and the endgoal of the interaction is not immediately clear. The user understands the interfaces by making use of its utilitarian design approach.
	**Car/company, Experience-oriented, Transparent complexity** In this interior scenario, people feel not responsible since they make use of a technologically advanced product that is doing it all. The interfaces inside the car are all experience based and the goal of the interaction is sometimes not immediately clear. The user understands the interfaces by its transparency in design.
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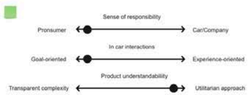
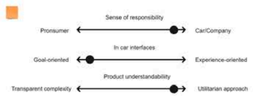
Dimension relations	Interaction view **Narrative**
	**Prosumer, Goal-oriented, Utilitarian approach** In this interior scenario, users feel environmental responsibility and are therefore willing to take action by being a prosumer. The interfaces inside the car are all goal-oriented and therefore the purpose of interactions is always clear. The user understands the interfaces by making use of its utilitarian design approach.
	**Car/company, Goal-oriented, Utilitarian approach** In this interior scenario, people feel not responsible since they make use of a technologically advanced product that is doing it all. The interfaces inside the car are all goal-oriented and therefore the purpose of interactions is always clear.The user understands the car by making use of its utilitarian design approach.
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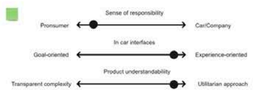
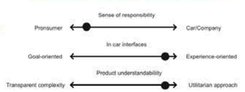
	**Prosumer, Experience-oriented, Utilitarian approach** In this interior scenario, users feel environmental responsibility and are therefore willing to take action by being a prosumer. The interfaces inside the car are all experience based and the goal of the interaction is sometimes not immediately clear. The user understands the car by making use of its utilitarian design philosophy.

APPENDIX 10

FINAL FUTURE FRAMEWORKS

Dimension relations	Interaction **Description**	Future scenarios **Clusters**	Future scenarios **Characteristics**
1. 	**Advanced in-car interfaces serve the user to understand its sustainable goals** **Car/company, Goal-oriented, Transparent complexity** In this interior scenario, people feel not sustainably responsible since they make use of a technologically advanced product that is doing it all. The interfaces inside the car are all goal-oriented and therefore the purpose of interactions is always clear. The user understands the interfaces and technologies by its transparency in design.	Related clusters **Shy-Tech based on MAYA principles** **Accessible design (No nonsense)** **On Demand (Service based) culture** **Freedom within collective** **Rising environmental awareness** **On Demand (Service based) culture** **A screen based world** **Car as a living object** **A software centered car**	• Environmental aware users • Car will try to maximize efficiency • User can monitor the car (One-way interaction) • On demand (service based) culture • Screen based world • Clear goals and benefits • Process towards efficiency is understandable
2. 	**Responsible use of function-based interfaces towards clear sustainability goals** **Prosumer, Goal-oriented, Utilitarian approach** In this interior scenario, users feel environmental responsibility and are therefore willing to take action by being a prosumer. The interfaces inside the car are all goal-oriented and therefore the purpose of interactions is always clear. The user understands the interfaces by making use of its utilitarian design approach.	Related clusters **Rising environmental awareness** **Green Living by Prosumer** **Personalized Experiences** **Living on the go** **Car as a living object** **Shy-Tech based on MAYA principles** **Accessible design (No nonsense)** **Freedom within collective** **Need for personal space**	• Environmental aware users • The user feels responsible for the environment • The user has the know how to act sustainable • The user understands the product and its functions • Zero redundancy, everything is function-based • Effective interactions that enable sustainable goals and behavior • The car is a living object (Also when parked) • The car as 3rd living space • Green living is key of life • They collaborate within collectives when needed
3. 	**Responsible use of experience-based interfaces while understanding its sustainable character** **Prosumer, Experience-oriented, Transparent complexity** In this interior scenario, users feel environmental responsibility and are therefore willing to take action by being a prosumer. The interfaces inside the car are all experience based while the goal of the interaction is sometimes not immediately clear. The user understands the interfaces and technologies by its transparency in design.	Related clusters **Rising environmental awareness** **Green Living by Prosumer** **Personalized Experiences** **Living on the go** **Car as a living object** **Shy-Tech based on MAYA principles** **We are multi-sensory beings** **Need for personal space** **A software centered car**	• Environmental aware users • Curiosity of the user how the car behaves • The in-car interfaces as experiences • The experience is the way towards sustainability • People inside the car are being amused by having experiences • Experiencing the transition to sustainability themselves • Interfaces as experience facilitators • Experience will change behavior with regards to sustainability
Interaction features of scenario 4 do not match or form a logic connection, and at the same time is not distinctive enough for later comparison and rating of the future scenarios. **4.** 	**Responsible use of function-based experience interfaces while understanding its sustainable character** **Prosumer, Experience-oriented, Utilitarian approach** In this interior scenario, users feel environmental responsibility and are therefore willing to take action by being a prosumer. The interfaces inside the car are all experience based and the goal of the interaction is sometimes not immediately clear. The user understands the car by making use of its utilitarian design approach.	Related clusters **Rising environmental awareness** **Green Living by Prosumer** **Personalized Experiences** **Living on the go** **Car as a living object** **Accessible design (No nonsense)** **Shy-Tech based on MAYA principles** **We are multi-sensory beings** **Need for personal space**	

APPENDIX 11

FULL SIZE VISUALS OF SCENARIOS

FAITH IN TECH – NARRATIVE

In this future scenario the world has slowly gone warmer and climate change is a main concern. People are confronted with the change of the environment and are starting a new movement in which environment is first priority. To reach these environmental goals people have accepted that advanced technologies are the great hope that can solve these problems. The use of Artificial Intelligence, Meta verse, Artificial food production etc. has increased. Consumers have accepted that technology has out-smarted them. To still understand what technology can do, designers have created systems that are able to explain its complexity. The main-goal of designers, is to explain what technology is doing to the "normal people".

A group of people called the "inventors" are constantly developing new technologies for the better cause while the average user simply follows and adopt these products into their everyday-life.

Mobility is a necessity that is automatically a sustainable solution of transportation.

FULL SIZE VISUALS OF SCENARIOS

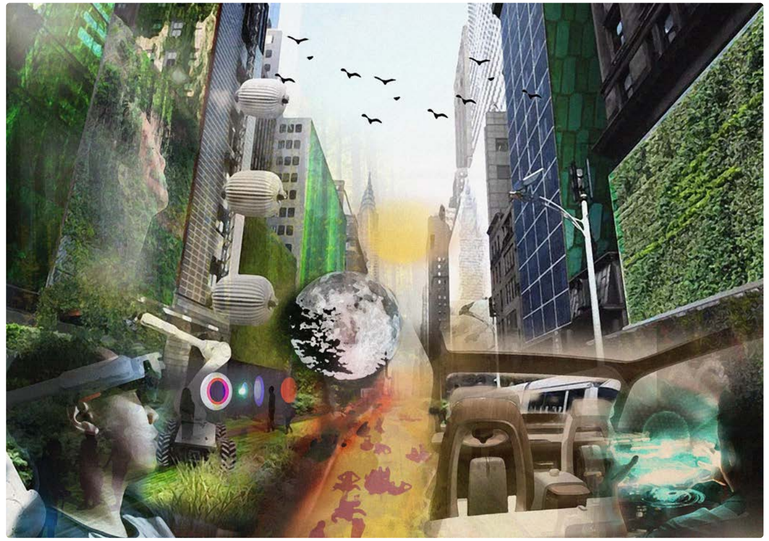
THE NEW BAUHAUS – NARRATIVE

In this future scenario the consequences of the global warming and overconsumption become apparent and therefore people are willing to take action. People are the only resource to rely on in order to solve these greater world problems. "Prosuming" rather than consuming becomes the norm amongst society. Efficiency by only designing function-based products that are as effective as possible in order to reach sustainability goals form the world wherein people operate. Green living is not a new innovative way of living anymore but a standard that people feel obligated to live by. Collaboration within greater systems as a collective is also something that happens on a regular basis. The car is not longer just a method of transportation but also a self generating source of energy that is also able to provide energy back to the grid and other facilities.

The common thread within this world is that people try to get back to the essence of existence as much as possible by not only adapting their way of living but also within all products around them that are aimed at sustainability.

Mobility is a necessity to go form point A to point B and an opportunity for proactively pursuing sustainability goals while this movement with intention takes place.

FULL SIZE VISUALS OF SCENARIOS



SENSING SUSTAINABILITY– NARRATIVE

In this future scenario the consequences of the global warming and overconsumption become apparent and therefore people are willing to take action while having pleasurable experiences. Contributing the the greater ideal of having a sustainable future becomes the norm but is more a hidden endgoal rather than a direct goal that has clear effective steps to follow. While making the future world a better place people get to experience these changes themselves in a positive way while they contribute to this greater ideal. The experience process towards a sustainable future is understandable by the user. In this world it is still about the journey as well besides the positive end goals that are attached to them. By experiencing things people get familiar with principles that drives a better future and are more likely to adopt or change a certain behavior in order to live more sustainable.

By experiencing the process of a understandable sustainable outcome, people have a clear view of their impact on their environment.

Mobility has become a movement that creates new experiences and eventually will contribute to a better sustainable future.

APPENDIX 12

DESTEP ANALYSIS

A DESTEP Analysis is a framework used to understand the external environmental factors and the issues that may impact you. DESTEP stands for Demographic, Economic, Sociocultural, Technological, Ecological and Political/Legal. These are the six categories you use to list factors that could impact your business.

TYPOLOGIES FOR DESIGN APPROACHES FOR PRESERVING PRODUCT INTEGRITY IN A CIRCULAR ECONOMY.

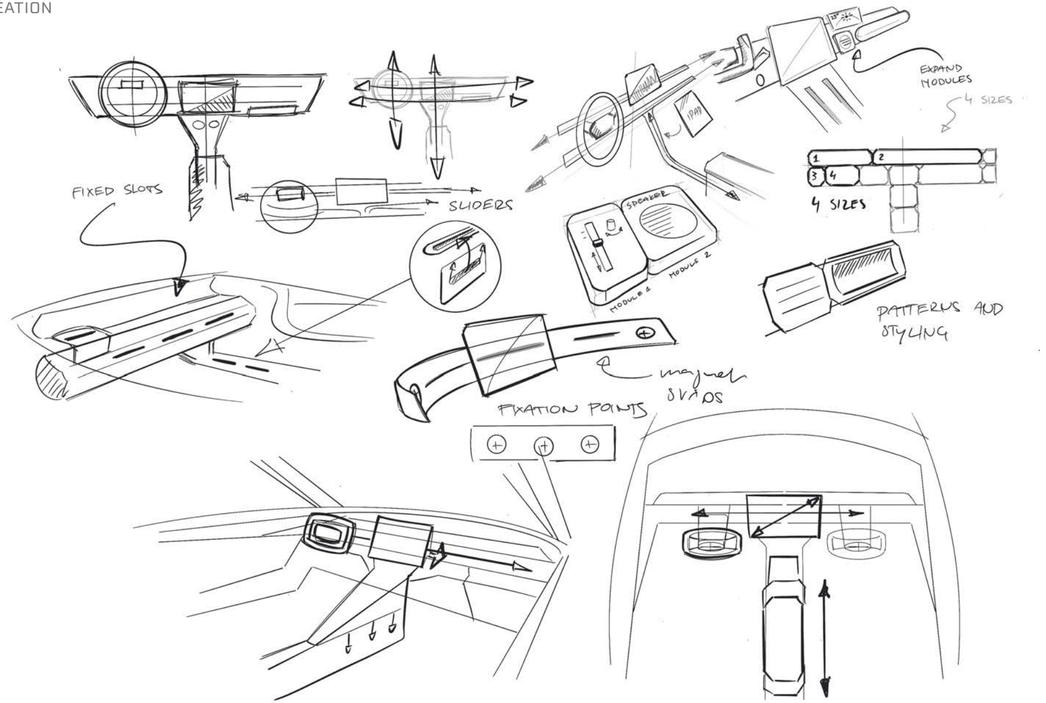
Design for Preserving Product Integrity

Long Use	Extended Use	Recovery
Resisting Obsolescence: Design approaches for long use	***Postponing Obsolescence: Design approaches for extended use***	***Reversing Obsolescence: Design approaches for recovery***
Designing for Emotional Durability	**Designing for Maintenance**	**Designing for Recontextualizing**
Designing for Physical Durability	**Designing for Repair**	**Designing for Refurbishment**
	Designing for Upgrading	**Designing for Remanufacturing**

(M. den Hollander, 2018)

APPENDIX 13

IDEATION



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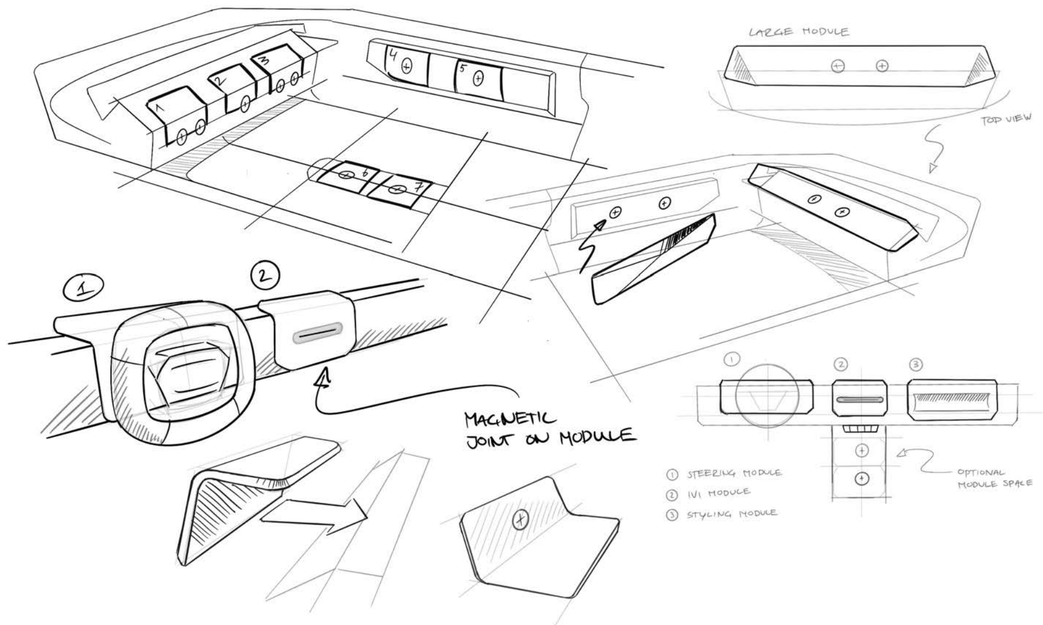


APPENDIX 14

Secondary research questions for both kinds of participants:
(potential) users and Lightyear internals

- What do participants experience as positive/negative when the in-car interfaces start to feel obsolete?
- In what parts of the interfaces do people value the implementations of the 3 principles the most? (E.g. smart support, concept of time, user as creator)
- What business model would participants expect in relation to the final concept?
- Does this principle seem to be a feasible concept now and/or in the future to you?

Extra sub questions for Lightyear internals

For Lightyear internals questions will be asked related to their field of expertise e.g. technology, production, business, sustainability, strategy etc.)

- Does this principle seem to be a feasible concept now and/or in the future?
- How should this principle be implemented in order to be feasible in the future?

APPENDIX 15

SURVEY TO ALLOCATE USERS

Lightyear Archetype Segmentation

Q18 General Driving/ Car Attitudes
To what extent do you agree or disagree with the following statements?
Please use the scale shown where 1 is "Strongly disagree" and 5 is "Strongly agree".

	Select:
Q18.3 Driving is just a means of transport: it gets me from A to B	Slightly disagree
Q18.5 My car is an expression of who I am	Slightly agree
Q18.7 I do not care what other people think about my car	Slightly disagree
Q18.8 I want my passengers to have a comfortable, enjoyable experience	Strongly agree
Q18.9 What my friends think about my car is important to me	Slightly agree
Q18.10 I am emotionally attached to my car	Slightly agree
Q18.12 I would like to easily lend the vehicle to someone else to use in my household	Strongly agree

Q23a Car Range Adadptability/ Charging Attitudes
To what extent do you agree or disagree with the following statements?
Please use the scale shown where 1 is "Strongly disagree" and 5 is "Strongly agree".

	Select:
Q23A.1 I like to reach my destination without stopping to refuel/ recharge	Neither agree nor disagree
Q23A.3 I tend to drive my car for as long as possible before refuelling/ recharging	Slightly disagree
Q23.5 I tend to plan my longer car journeys – including service station stops/ most appropriate re-fuelling & charging	Slightly disagree

Q23b Future Car Purchase Sustainability Attitudes
To what extent do you agree or disagree with the following statements?
Please use the scale shown where 1 is "Strongly disagree" and 5 is "Strongly agree".

	Select:
Q23B.1 I will consider the car brand's green credentials when choosing my next car	Slightly agree
Q23B.2 I will take into account the environmental impact of the vehicle, when choosing my next car	Strongly agree

Segment	Cluster 1
1.00	Enthusiast

Cluster 1-5 respectively :
1. Enthusiast, 2. A to B, 3. Sentimental, 4. Green Planner, 5. Non-Environmental

By filling in the scales on the right, a cluster with corresponding user archetype is being generated wihtin the frame (left bottom).

APPENDIX 16

PRE TEST QUESTIONS

1. What car do you own and/or use frequently and why do you like it or dislike it?
2. What do/did you like about the in-car interfaces (physical/digital)?
3. Did you ever feel a type of obsolescence within in-car interfaces?
   If so, what did you experience when your personal car started to feel obsolete?

TASK INFORMATION [SCENARIO BASED]

1st Task scenario (Everyday Rides)

"After years of driving the Lightyear X, your everyday commute rides during rush hours appear to be most prominent among all of your rides. As this doesn't seem the most "fun" experience, this could be improved over time, supported by Lightyear. Learn how this could be improved by unlocking the center-display."

2nd Task scenario (Adventure)

"By driving the Lightyear X for several years now, you have already collected a lot of unique experiences with it. For this reason Lightyear selected some unique products that you might like to relive these experiences and make even more memories. Learn how these memories could be relived by unlocking the center-display."

POST TEST INTERVIEW QUESTIONS

The interview should include at least the following questions:

1. How did you like/dislike the principle of the interface systems giving support to you as a user?
2. How did you like/dislike the principle of a modular part for the center console?
3. What do you think of the self-installation process of new modules/panels?
4. How did you like/dislike the principle of materials connected to experience and their graceful aging over time?
5. What do you think of lightyear providing all the service regarding installment of new modules/panels?
6. What do you think about a single purchase option vs a membership?
7. How would you see yourself making use of this final concept in the future?

For Lightyear Internals only
8. How should this concept be implemented in order to be feasible in the future regarding your field of expertise?

APPENDIX 17

WIRE FLOW

EVERYDAY RIDES

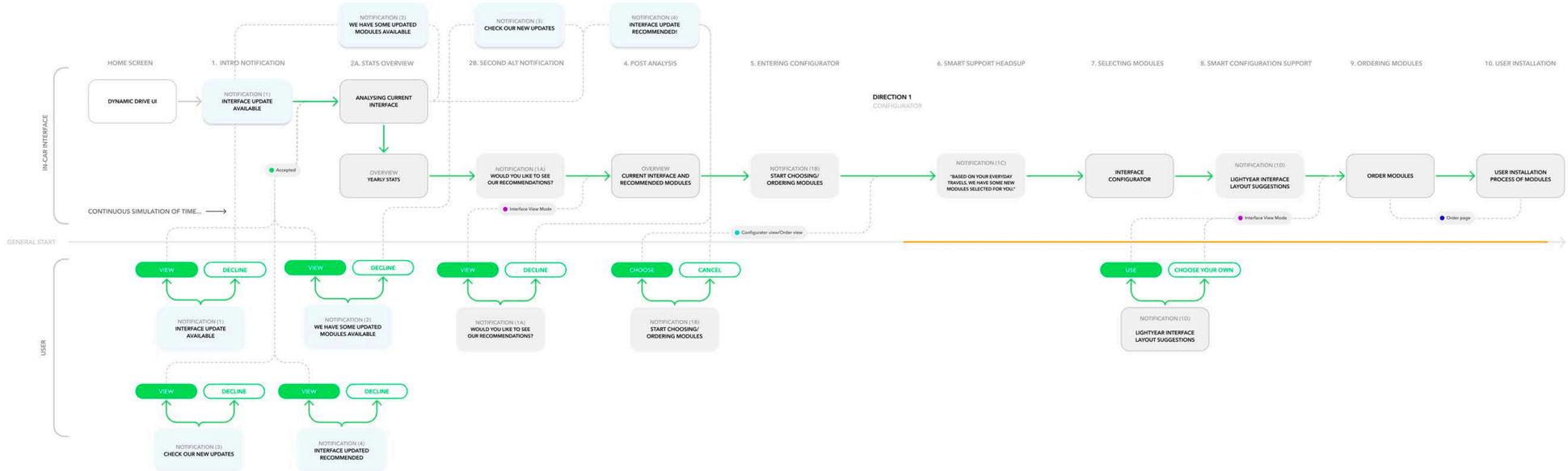
DIRECTION 1
CONFIGURATOR

SMART SUPPORT

The entire wire flow is based on the concept direction of smart support in which the system supports the user about the live status, prognoses, and possibilities.

USER AS CREATOR

This user flow is aimed towards drivers who generally use the car as a mean for everyday commuting from point A to point B.

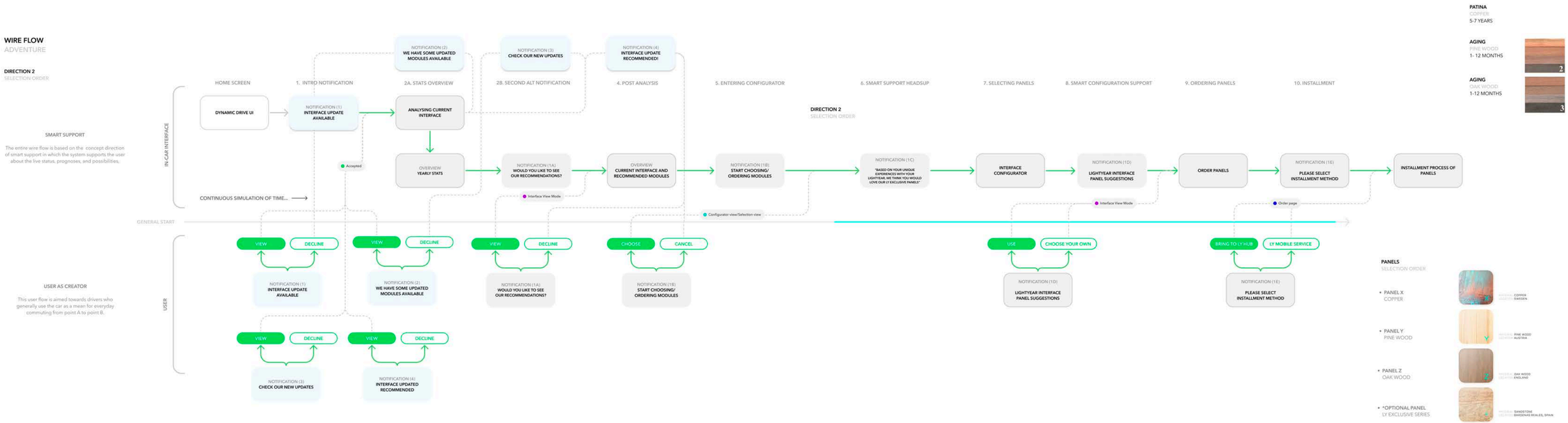


MODULES

CONFIGURATOR

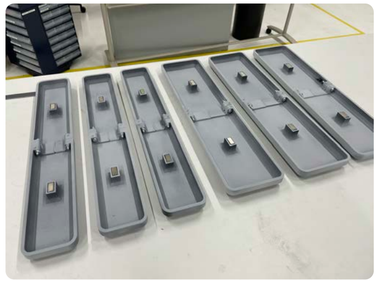
- **MODULE X**
  AMBIENT SET LIGHTING HUB FOR PHONE
- **MODULE Y**
  WIRELESS FAST CHARGER PAD
- **MODULE Z**
  HEPA FILTER FOR TRAFFIC JAMS
- ***OPTIONAL MODULE**
  AIR COMPRESSOR

APPENDIX 17


WIRE FLOW
ADVENTURE
DIRECTION 2
SELECTION ORDER
SMART SUPPORT
The entire wire flow is based on the concept direction of smart support in which the system supports the user about the live status, prognoses, and possibilities.
USER AS CREATOR
This user flow is aimed towards drivers who generally use the car as a mean for everyday commuting from point A to point B.
IN-CAR INTERFACE
USER
GENERAL START
CONTINUOUS SIMULATION OF TIME...
HOME SCREEN
1. INTRO NOTIFICATION
2A. STATS OVERVIEW
2B. SECOND ALT NOTIFICATION
4. POST ANALYSIS
5. ENTERING CONFIGURATOR
6. SMART SUPPORT HEADSUP
7. SELECTING PANELS
8. SMART CONFIGURATION SUPPORT
9. ORDERING PANELS
10. INSTALLMENT
DYNAMIC DRIVE UI
NOTIFICATION (1) INTERFACE UPDATE AVAILABLE
ANALYSING CURRENT INTERFACE
OVERVIEW YEARLY STATS
NOTIFICATION (2) WE HAVE SOME UPDATED MODULES AVAILABLE
NOTIFICATION (3) CHECK OUR NEW UPDATES
NOTIFICATION (4) INTERFACE UPDATE RECOMMENDED!
NOTIFICATION (1A) WOULD YOU LIKE TO SEE OUR RECOMMENDATIONS?
OVERVIEW CURRENT INTERFACE AND RECOMMENDED MODULES
NOTIFICATION (1B) START CHOOSING/ ORDERING MODULES
NOTIFICATION (1C) "BASED ON YOUR UNIQUE EXPERIENCES WITH YOUR LIGHTYEAR, WE THINK YOU WOULD LOVE OUR LY EXCLUSIVE PANELS"
INTERFACE CONFIGURATOR
NOTIFICATION (1D) LIGHTYEAR INTERFACE PANEL SUGGESTIONS
ORDER PANELS
NOTIFICATION (1E) PLEASE SELECT INSTALLMENT METHOD
INSTALLMENT PROCESS OF PANELS
Accepted
Interface View Mode
Configurator view/Selection view
Interface View Mode
Order page
VIEW
DECLINE
CHOOSE
CANCEL
USE
CHOOSE YOUR OWN
BRING TO LY HUB
LY MOBILE SERVICE
NOTIFICATION (1) INTERFACE UPDATE AVAILABLE
NOTIFICATION (2) WE HAVE SOME UPDATED MODULES AVAILABLE
NOTIFICATION (1A) WOULD YOU LIKE TO SEE OUR RECOMMENDATIONS?
NOTIFICATION (1B) START CHOOSING/ ORDERING MODULES
NOTIFICATION (1D) LIGHTYEAR INTERFACE PANEL SUGGESTIONS
NOTIFICATION (1E) PLEASE SELECT INSTALLMENT METHOD
NOTIFICATION (3) CHECK OUR NEW UPDATES
NOTIFICATION (4) INTERFACE UPDATED RECOMMENDED
PATINA
COPPER
5-7 YEARS
AGING
PINE WOOD
1- 12 MONTHS
AGING
OAK WOOD
1-12 MONTHS
PANELS
SELECTION ORDER
• PANEL X
COPPER
• PANEL Y
PINE WOOD
• PANEL Z
OAK WOOD
• *OPTIONAL PANEL
LY EXCLUSIVE SERIES

APPENDIX 18










APPENDIX 19

QUALITATIVE QUOTES AND TAKE AWAYS FOR EACH PARTICIPANT

https://www.figma.com/file/vlLZgACnjCKdtJhOmOtcPu/User-Test-Results?node-id=0%3A1

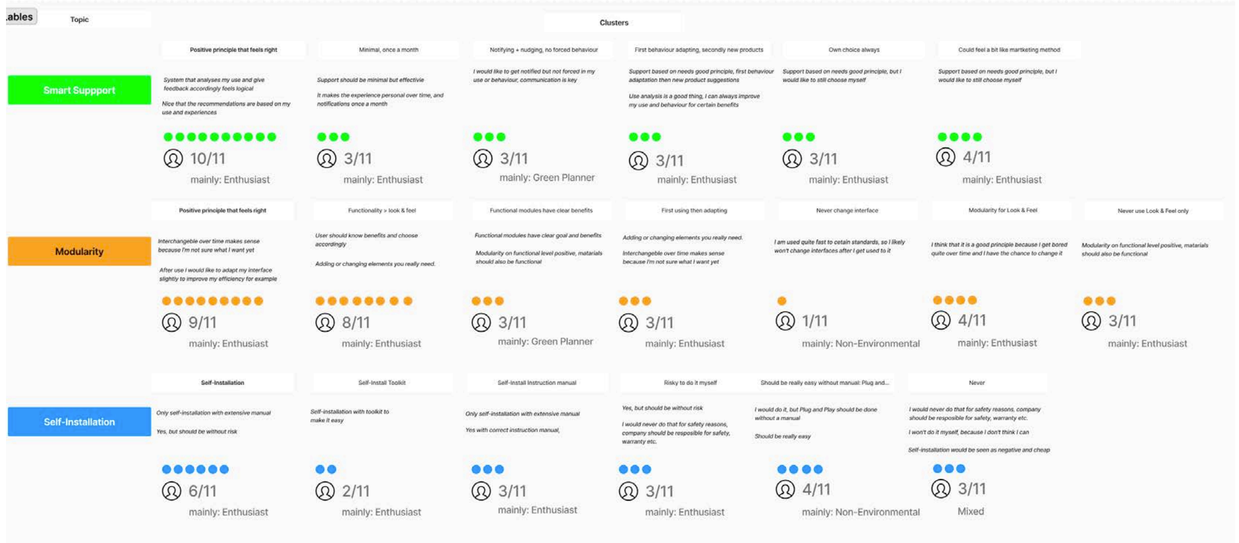
	Participant #1 - (Enthusiast)	Participant #2 (Non-Environmental)	Participant #3 - (A to B)	Participant #4 - (Enthusiast)	Participant #5 - (Enthusiast)
			Lightyear Internal - Interaction Designer		
Q1 Smart Support					
	System that analyses my use and give feedback accordingly feels logical	Nice that the recommendations are based on my use and experiences	Support should be minimal but effective	It makes the experience personal over time, and notifications once a month	Support based on needs good principle, first behaviour adaptation then new product suggestions
Q2 Modularity					
	Interchangeble over time makes sense because I'm not sure what I want yet	Nice that the in-car interfaces are not fixed	User should know benefits and choose accordingly	Functional modules have clear goal and benefits	Functional modules have clear goal and benefits
Q3 Self Installation					
	Self-installation with toolkit to make it easy	This is unwanted	Yes, but should be without risk	Only self-installation with extensive manual Self-installation would be seen as negative and cheap	Plug and Play, but if harder then service Should not take time because I want to use my car
Q4 Experience connected to panels					
	Communication of connecting personal experiences with materials should be clear	Unclear what experiences meant	Yes, experience highlight could positively contribute in a positive way	Didn't get the connection between experiences and materials	Materials should be functional in order to make sense Too much information on one page
Q5 Lightyear service expectations					
	Mobile service hub	Lightyear service center	Service point, this feels most efficient	At home Service hub	At home Service hub
Q6 One time purchase vs Membership					
	Membership that is easy to unsubscribe from	Single purchase	Single purchase, membership if it is cheaper	Single purchase, only membership after period of use	Single purchase, only membership after period of use Membership just for functional modules Materials seem to much EMO purchase
Q7 Feasible concept from your perspective					
	Yes I would treat it like my second home, which is also doesn't reamin the same all the time	Own experience as main user driver, sustainability as second	It could succeed for me, but I think that communication is key	Personalization would trigger me to update my interface	Not all interface elements are being used by me so I would like to optimize my interface
EXTRA FEEDBACK					
TAKE AWAYS	• User journey must be clear, how are these modules an improvement? • I would like to give feeback in more ways (e.g. voice, terms) • I would like to continue my process on other devices once I get home	• The user benefits must be included for the material panels • The process of ordering modules should be continued on other devices at home • Lightyear Service Center preferable	• Notifications should be subtle and should not have a warning character • Trade offs of certain modules open up transparancy next to the benefits • Self-installation seen as risky	• Personalization as trigger to choose modules • Functional modules have clear benefits, materials less • Single purchase • Service hub at home	• Material updates seen as EMO purchases • First feedback round about use and behaviour to improve my UX and after that some needed modules to help me

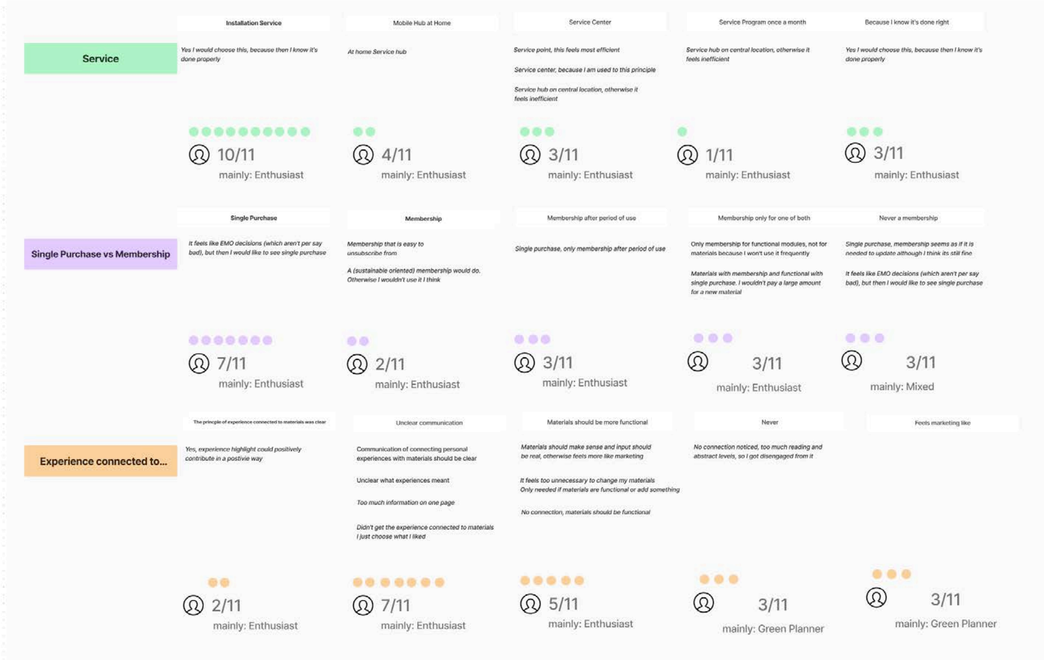
Participant #6 - (Enthusiast)	Participant #7 - (Enthusiast)	Participant #8 (Green Planner)	Participant #9 - (Enthusiast)	Participant #10 - (Green Planner)	Participant #11 - (Non-Environmentalist)
Lightyear Internal - Design Strategy					
Support based on needs good principle, but I would like to still choose myself	Only for safety or use benefits its good, if not it feels like marketing model	I would like to get notified but not forced in my use or behaviour, communication is key	That a system provides you with support is a good thing because I don't have to come up with adaptations myself	Use analysis is a good thing, I can always improve my use and behaviour for certain benefits	By analyzing user behaviour and use, the notifications make sense and feel personal
Modules should express functionality otherwise it feels too fake and feels suspicious	Adding or changing elements you really need.	After use I would like to adapt my interface slightly to improve my efficiency for example	I think that it is a good principle because I get bored quite over time and I have the chance to change it	Modularity on functional level positive, materials should also be functional	I am used quite fast to certain standards, so I likely won't change interfaces after I get used to it
Yes with correct instruction manual, modules should'nt be too apparent	Only if extensive instruction manual provided	I would never do that for safety reasons, company should be responsible for safety, warranty etc.	I won't do it myself, because I don't think I can	I would do it, but Plug and Play should be done without a manual	Should be really easy
Materials should make sense and input should be real, otherwise feels more like marketing	It feels too unnecessary to change my materials Only needed if materials are functional or add something	Not for me its too abstract, only if materials are functional	Didn't get the experience connected to materials I just choose what I liked	No connection, materials should be functional	No connection noticed, too much reading and abstract levels, so I got disengaged from it
Self installation of simple enough, otherwise service center	Service hub on central location, otherwise it feels inefficient	Service center	Yes I would choose this, because then I know it's done properly	Mobile service hub, free	Service center, because I am used to this principle
Materials with membership and functional with single purchase. I wouldn't pay a large amount for a new material	Only membership for functional modules, not for materials because I won't use it frequently	Single purchase, only membership after period of use	A (sustainable oriented) membership would do. Otherwise I wouldn't use it I think	It feels like EMO decisions (which aren't per say bad), but then I would like to see single purchase	Single purchase, membership seems as if it is needed to update although I think its still fine
Materials could work on short term but should feel functional and make sense	I really see the benefits from keeping your interface up to date functionally	I really see the benefits from keeping your interface up to date functionally, economically or efficiency wise	Yes esspecially suitable for younger generations, wouldn't use it for the look & feel options often	Users won't use their car longer but its more the guarantee of longevity. of cars that a company can guarantee through such a system	If the purpose is clear of why I should do this and I get to experience clear benefits from it
• Materials should feel functional or should make sense otherwise it would feel too much a marketing trick • Modules/panels platform should be accessible always	• It should not feel like a marketing trick to sell more modules then neccasary, so it should really feel like custom personal recommendations • Changing materials doesn't seem needed to me in the first place so that should only be recommended if it's needed	• I would like to exactly know why certain choises are better for me than others, otherwise I would just continue riding • I wouldn't install anything myself (Although I think I can), because of safety, warranty and responsibility reasons	• Showing why something is more sustainable if it will be updated • Also functionality in realion to your current setup and use should be clear, why this is a benefit over the old interface • It shouldn't feel too much like a luxury option to do so, then it does also not feel sustainable and accessible enough for all people	• EMO purchases should never be done through a membership I think because people should feel free in their choice to do so • It enables a certain barrier to purchase a new module so it makes you more consious and well considered to choose • Materials should clearly be functional in order to make it feel as an improvement to me	• Short and efficient communciation • No abstract phrasing and wording • Membership suggests the neccesarily of continuously needing to upgrade, but I don't want to experience that feeling in my own car

APPENDIX 20

LABELED CLUSTERS AND QUANTITATIVE APPROACH FOR QUALITATIVE THEMES

https://www.figma.com/file/vILZgACnjCKdtJhOmOtcPu/User-Test-Results?node-id=0%3A1





APPENDIX 21

SCREENS OF THE DIGITAL INTERFACES CREATED FOR THE PROTOTYPE

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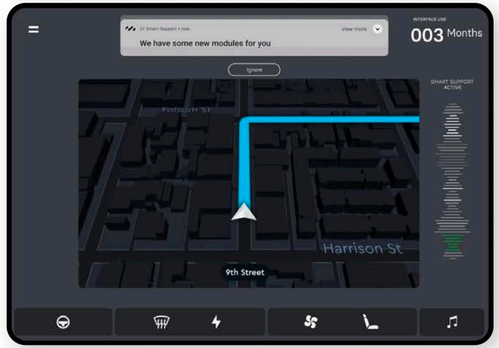

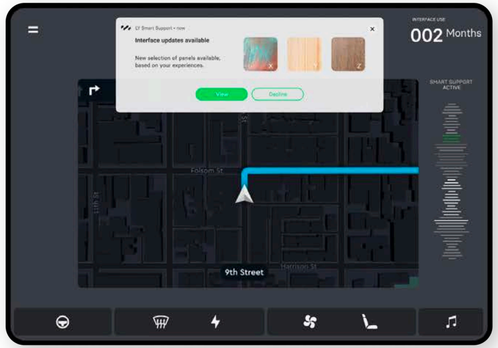

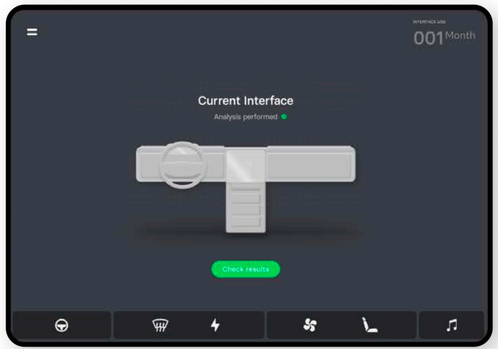

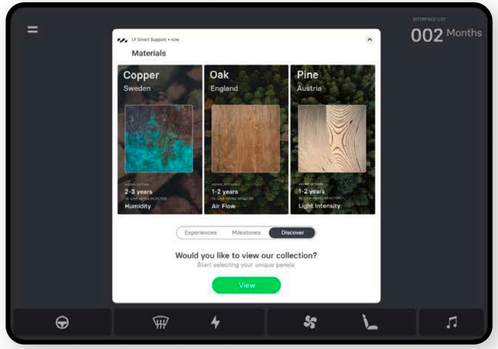

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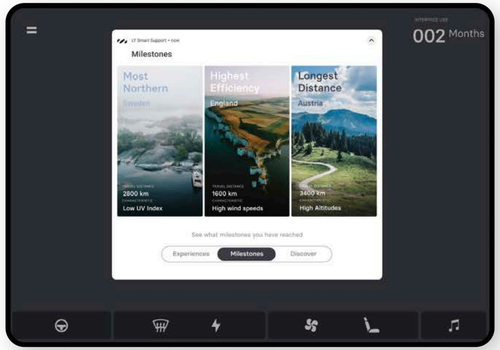
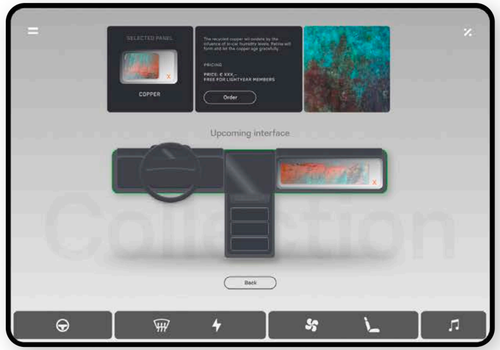
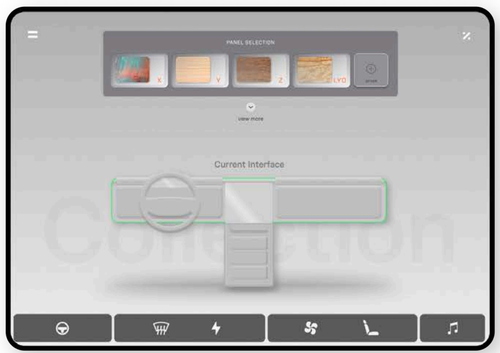
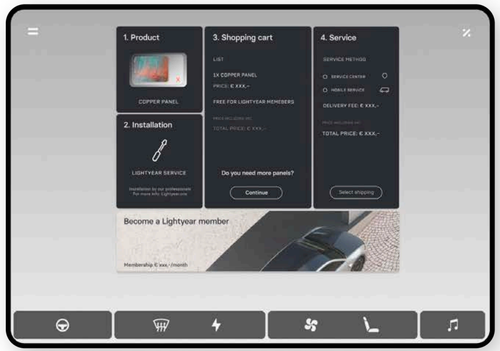


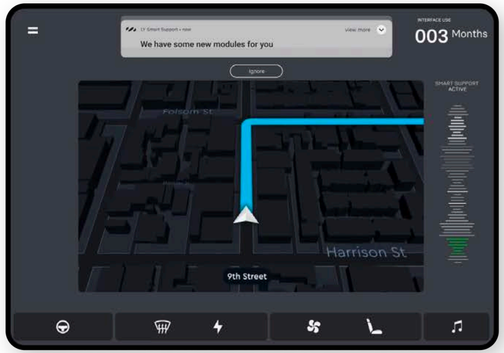


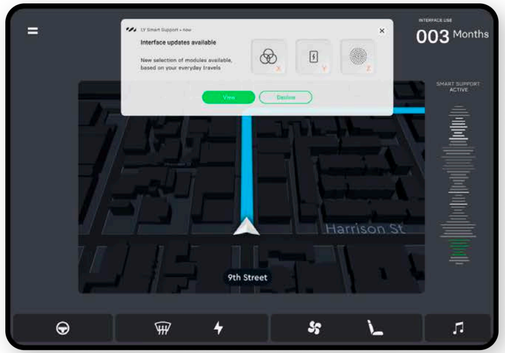


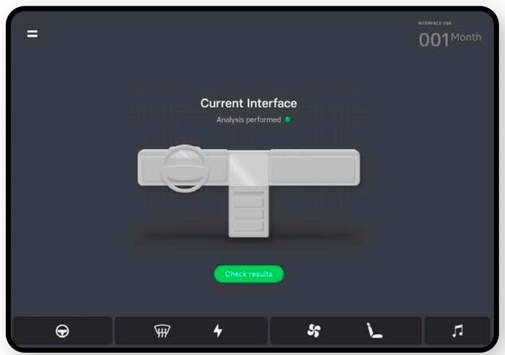


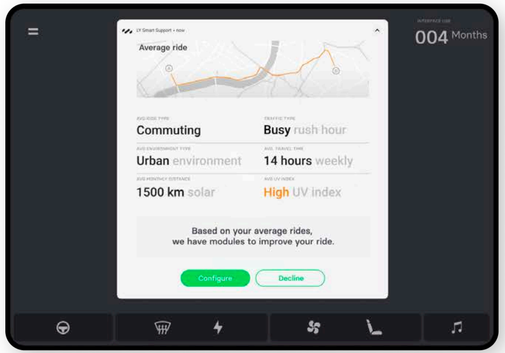
SCREENS OF THE DIGITAL INTERFACES CREATED FOR THE PROTOTYPE

https://www.figma.com/proto/BPQ2le0WEha3rgMfLWnJ9S/Virtual-Prototype?page-

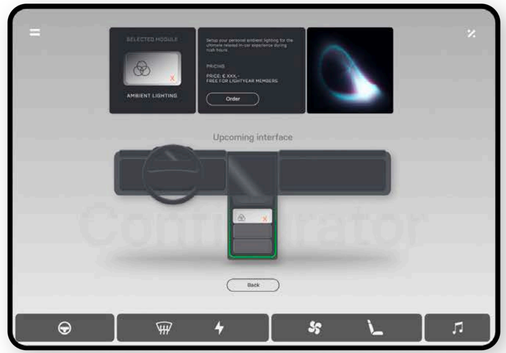


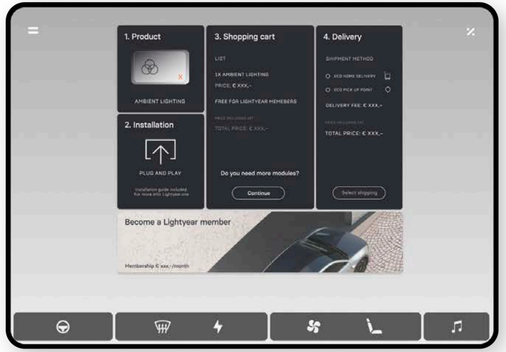






SCREENS OF THE DIGITAL INTERFACES CREATED FOR THE PROTOTYPE





APPENDIX 22

QUESTIONAIRE USED FOR THE CONCEPT DIRECTION EVALUATION

Concept Direction Evaluation

Thanks for taking the time to evaluate the concept directions by filling out this survey for my graduation project! (5 min.)

This survey will take 5 minutes of your time and will help me to collect feedback on the concept directions by general drivers as well as Lightyear internals. The feedback collected will help me formulate clear principles on which the development phase towards the final concept can be build upon.

To help immerse each participant within the future context, please check out the future scenarios by scanning the QR code next to the visuals.

Note: These concept directions are not specifically for HVS, they are more potential directions to take for future Lightyear models in general

*All participants will be kept anonymous

justus.hermans@gmail.com (niet gedeeld)
Ander account

*Vereist

Name (Optional)

Jouw antwoord

Are you a Lightyear internal? *

- Yes
- No

Driving experience and/or car ownership (in years): *

Jouw antwoord

Job Title or field of expertise: *

Jouw antwoord

1. What do you think of the (potential) concept directions in general?

(e.g. functionality, use, feasibility, potential etc.)

Keep in mind the concept will be used within a future context

Jouw antwoord

2. What concept direction would you like the most?

Keep in mind the concept will be used within a future context

- 1. User as Creator
- 2. Smart Support
- 3. Concept of Time

4. Why do you like this concept direction the most? *

Keep in mind the concept will be used within a future context

Jouw antwoord

3. What concept direction would you dislike the most?

Keep in mind the concept will be used within a future context

- 1. User as Creator
- 2. Smart Support
- 3. Concept of Time

4. Why do you dislike this concept direction the most? *

Keep in mind the concept will be used within a future context

Jouw antwoord

(To be answered by Lightyear internals only)

5. Which (mix of) directions seem to be a feasible concept principle in the future?

- 1. User as Creator
- 2. Smart Support
- 3. Concept of Time

(To be answered by Lightyear internals only)

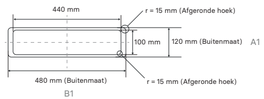
5. How do you think this principle should be implemented as a concept for Lightyear to make it work?

(Concerning your field of expertise within Lightyear)

APPENDIX 23

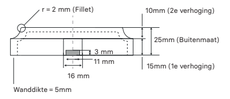
TECHNICAL DRAWINGS FOR PANELS AND MODULES USED FOR PROTOTYPING

Panelen Groot (3 stuks) Assembly voor 3D print
Boven aanzicht



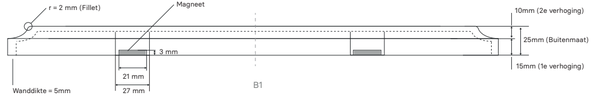
B1

Panelen Groot (3 stuks)
Zij Aanzicht



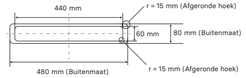
A1

Panelen Groot (3 stuks)
Vooraanzicht



B1

Panelen Middel (3 stuks) Assembly voor 3D print
Boven aanzicht



OPMERKING:

"Panelen Middel" hebben exact dezelfde specificaties en afmetingen nodig. Enkel en alleen verschilt de diepte maat van 80mm ipv 120mm diep (Zie tekening boven aanzicht).

Dus ook het iets hoger gelegen plateau is 60mm ipv 100mm.

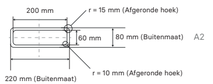
MAGNETEN

De houders voor de magneten aan de binnenzijde/onderkant van de panelen is er voor bedoeld dat de magneten op een lijn komen te liggen met de onderlijn van het ontwerp. Ook wel 'flush' met bottomline genoemd.

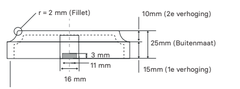
De magneet dient op zijn plaats gehouden te worden dmv opstaande wandjes a 3,5 mm dik.

Postitie van de houders op 1/4 aan weerszijden. Komt niet heel nauw als de houders maar symmetrisch ten opzichte van elkaar geplaatst zijn op een lijn.

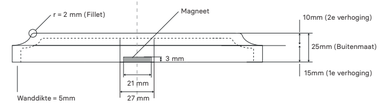
Panelen Klein (4 stuks)
Boven aanzicht



B2



A2

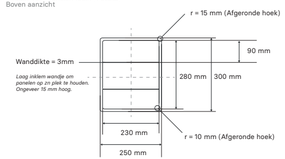


B2

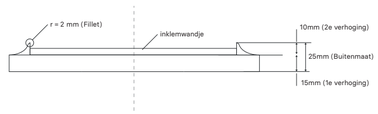
OPMERKING:

Bij "Panelen klein" hoeft er maar 1 magneetsteuntje in de binnenkant.

Houder voor Panelen Klein (1 stuks)
Boven aanzicht



B3



B3

DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

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

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

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

STUDENT DATA & MASTER PROGRAMME

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

family name: Hermans 5730
initials: J A L given name: Justus
student number: 4444817
street & no.:
zipcode & city:
country:
phone:
email:

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

SUPERVISORY TEAM **

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

** chair: Jasper van Kuijk dept. / section: HCD/AED
** mentor: Wouter Kets dept. / section: HCD/DA
2nd mentor: Bram Bos
organisation: Lightyear
city: Helmond country: The Netherlands

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

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

comments (optional): Evita Goettsch who is currently Strategic Designer at Lightyear (former IDE student) will also be involved in the project every now and then since she is also aware of the graduation process and requirements from the TU Delft.

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

TU Delft

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF

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

chair: Jasper van Kuijk date: 30 - 05 - 2022 signature: Digitally signed by Jasper van Kuijk Date: 2022.05.30 13:53:48 +02'00'

CHECK STUDY PROGRESS

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

Master electives no. of EC accumulated in total: 27 EC
Of which, taking the conditional requirements into account, can be part of the exam programme: 27 EC
List of electives obtained before the third semester without approval of the BoE:

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

name: C. van der Bunt date: 07 - 06 - 2022 signature: Digitally signed by C. van der Bunt Date: 2022.06.07 14:36:34 +02'00'

FORMAL APPROVAL GRADUATION PROJECT

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

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

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

name: Monique van Morgen date: 21 - 06 - 2022 signature:

APPENDIX 24

GRADUATION PROJECT BRIEF

TU Delft

Personal Project Brief - IDE Master Graduation

Sustainable interior interface design for future Lightyear vehicles — project title

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

start date: 23 - 05 - 2022 end date: 18 - 11 - 2022

INTRODUCTION **

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

Lightyear is an innovative and fast-growing company with a very specific product that is a car driven by unique solar powered technology and thereby clearly differentiates itself from other EV companies within the automotive industry. In a time where globalization and climate change become a major problem for both earth and humanity, it is now crucial to make environmentally driven design choices such as the use of sustainable and/or non-compostable materials, design for re-use and repair, reducing CO2 emissions etc. Same goes for the automotive industry where these design principles are of high importance nowadays.

Although there is clearly a shift from combustion engine vehicles towards driving electric it was still only 8,3 % in the year 2021 of all car sales worldwide being electrically driven cars including both BEV and PHEV sales (Irle, 2021). Carried by a decarbonisation challenge most leading nations now take seriously, 2021 is a game changer in the history of EV sales and it is expected that 6.4 million vehicles (EVs and PHEVs combined) will be sold globally by the end of the year 2022. So there is still a large gap of potential users for Lightyear to win together with its uniques solar technology while driving electric.

As these zero emission design principles start to become more and more the standard, it is of essence to take the user experience into account as well when it comes to sustainability. It is best if a company not only differentiates itself by using cutting edge technology, but in addition provides the user an unique durable user experience that adds (emotional and functional) value to the product. So by creating a sustainable experience in terms of its overall interaction quality that will last long really complements Lightyear's vision on sustainable mobility and potentially increase overall user satisfaction in product use as well in the long term (Harper, 2017).

As discussed with company stakeholders/ mentor, the focus of this project conceptualization will mostly be on the upcoming Lightyear models. Because of the many opportunities and decisions that still have to be made regarding its overall (interface) design.

The project will start with an in-depth analysis on which interfaces within the use of the Lightyear Two will be relevant to focus on for this project. This will likely be the interface that has high user visibility and includes multiple (micro) interactions that could be of importance for the long term. In later stages of the project an important element is the application of feasibility within the concepts. Therefore feasibility will be taken into account regarding technology, costs and strategic implementation which could also form possible limitations to the final concept.

References:
- Aesthetic Sustainability: Product Design and Sustainable Usage, Kristine H. Harper (2017)
- By Roland Irle, EV-volumes.com (2021)

space available for images / figures on next page

TU Delft

Personal Project Brief - IDE Master Graduation

introduction (continued): space for images

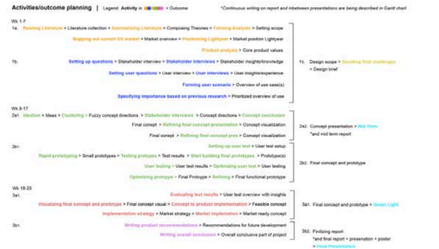


image / figure 1: Planning to structure the Gantt chart by describing order of activities needed to be performed

TO PLACE YOUR IMAGE IN THIS AREA:
- **SAVE THIS DOCUMENT TO YOUR COMPUTER AND OPEN IT IN ADOBE READER**
- **CLICK AREA TO PLACE IMAGE / FIGURE**

PLEASE NOTE:
- **IMAGE WILL SCALE TO FIT AUTOMATICALLY**
- **NATIVE IMAGE RATIO IS 16:10**
- **IF YOU EXPERIENCE PROBLEMS IN UPLOADING, COVERT IMAGE TO PDF AND TRY AGAIN**

image / figure 2:

Personal Project Brief - IDE Master Graduation

TU Delft

PROBLEM DEFINITION **

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

Lightyear's mission in general is sustainability and the focus for now is on using innovative technology, use of materials and its purposes within a new sustainable oriented user group. Although this is key in being truly the potential towards a transition into more sustainable products, the durability of the user experience and therefore the longevity of user interactions is often overlooked.

The main challenge lies in the fact that the overall interactions within interior interfaces should maintain its value and relevance by designing in a sustainable way ,to prevent the interactions from becoming obsolete, outdated and irrelevant.

The scope of this project will mainly be within EV markets with an emphasis on solar powered EVs. The focus for this project will be on the Lightyear's future vehicles interior interfaces. This will likely involve all future models that are planned to hit the market starting from the year 2024/2025. With the intention to reduce the purchase prices and the increase of production scale for these future models, they will become more accessible to a larger potential user group.

- What interaction designs within interior interfaces are of most importance to the user?
- What aspects within these interactions form its core qualities? (e.g. Physical // virtual, Trends, Aesthetics, Identity etc.)
- How to form and create new sustainable interaction qualities based on previous insights for sustainability purposes?

The final concept will be achieved by passing several phases: analysis, user research, setting the scope and design brief, synthesis (including ideation, conceptualization, and optimization through user testing), design proposal, and a recommendations section.

ASSIGNMENT **

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

With this project I will create a concept for a sustainable user experience for the future Lightyear models by conceptualizing an interface that is based on sustainable interactions (SID) principles. The purpose of this final concept is that it can be (partially) implemented in future Lightyear models and to highlight clear design principles that Lightyear can incorporate into design processes and later implement (partially) in their final designs.

1. Analysis - Literature research, Market Analysis, Product analysis/mapping,

2. User Research - User/stakeholder interviews. Context mapping, User scenarios, Conclusion of Insights, Focus point

3. Design Brief - Setting the scope, Setting the challenges, Creating design brief

4. Synthesis - (two parts) - 4A. Conceptualization: Ideation, 3-4 Concept directions, stakeholder Interviews, Final concept choice, Final concept development, Rapid prototypes and testing, Building final prototype - 4B. Optimization: Setting up user tests, testing, Test optimization, Prototype optimization, Detailing phase final concept/prototype

5. Proposal - Overview and presentation of final concept and related design principles, Feasible implementation of concept into the upcoming Lightyear models, Strategic applications, Market opportunities for Lightyear

6. Recommendations - Concluding overview, Recommendations, Next steps to be taken for future implementation

The solution I expect to deliver is a conceptual interface (physical and/or virtual) alongside (a) working prototype(s) based on the principles of sustainable interaction design principles (SID) in context of use for future Lightyear models.

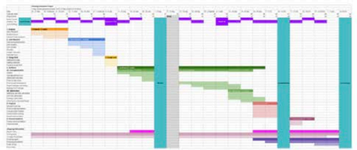
Personal Project Brief - IDE Master Graduation

TU Delft

PLANNING AND APPROACH **

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

start date 23 - 5 - 2022 18 - 11 - 2022 end date



The project is structured in seven main phases, with a preparation phase before the project's start. The project will be carried out over the duration of 25 weeks with 4 working days reserved for the graduation project. Due to freelance work, and a break-week scheduled after the midterm evaluation.

Deadlines
- Mid term meeting (Week 11):
Deliverables: Mid term Report, short presentation of the process so far

- Green Light meeting (Week 20)
Deliverables: Final Report, short presentation to present the project and outcomes

- Graduation Ceremony (Week 25)
Fine tuned report, Long presentation (30 min) about the project and outcomes, Poster.

As described in the Gantt chart, there will be the following additional interim deliverables: continuous writing on documentation and extra report hand in before mid-term, a table of contents for report in wk 2, and a dynamic ppt presentation to support the heads up meetings to support/structure these.

* See image figure 1. above on page 4 for actions/outcomes planning to structure the Gantt chart by needed activities
**For a high res image of the actions/outcomes planning and Gantt chart (Please see attached)

Personal Project Brief - IDE Master Graduation

TU Delft

MOTIVATION AND PERSONAL AMBITIONS

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

Personal Motivation

I am highly passionate about collaborating with a company like Lightyear because mobility has always aroused my interest and in recent years electric vehicles in specific. After my internship at Tesla I got more and more interested in the future of mobility and the transition to sustainability energy within the mobility industry. Especially the future perspective and the unique new user experience that this industry is constantly releasing, appeal to me very much because of my Masters in Design for Interaction. That is why I am very enthusiastic about Lightyear and their inspiring philosophy to shift the standard to solar powered driving with a zero CO2 emission target in the future. Therefore, my approach for this project is that it will not be a 5 month project only but me as a designer and/or my final results should be of significance for Lightyear in the long term as well.

Relevance

I believe that my research in UX within interfaces within the entire context of Lightyear products, can certainly add value to the vision and goals of Lightyear as well as its upcoming products in the future. It is not only performance, technology, production, and materials that can realize this mission towards zero emission mobility, but also durable user interactions and user experiences count as an important factor in the journey towards clean mobility for an ever growing potential user group.

Skills

Some soft skills that I would like to learn is to bring theory into practice by doing extensive research and eventually coming up with concepts that could really contribute to a scale up company its future vision, design processes, and designs. So dealing, involving and collaborating with different stakeholders (from the company and TU Delft) and users will be one of the skills that I would like to develop and discover more during this project.

A hard skill that I would like to develop more as a strong competence is to design working prototypes that combine virtual interfaces with physical interfaces for user testing purposes. Combining tools such as: Figma and Arduino

A second hard skill is that I would like to improve is 3D modeling and rendering through tools like Rhino and Keyshot

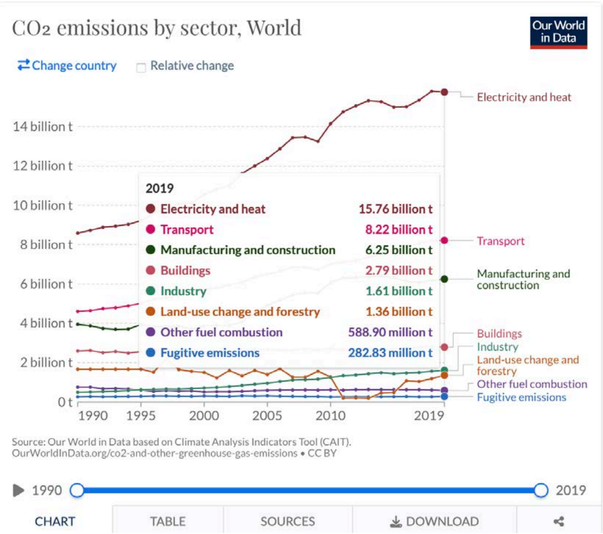
Ambitions

My ambition for this project is to work from an abstract vision through user testing towards a clear final concept that Lightyear can implement directly, adopt within their current/future design processes or use as a reference for future designs. So bringing extensive (academic) research and bringing its results into practice into existing and future designs of a fast growing company is something that I will strive for with this project.

FINAL COMMENTS

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

3 EC from the course 'Initiate to Graduate' need to be added to complete the overall needed 90 EC by adding the remaining 3 EC after this graduation brief has been approved.



Source: Our World in Data based on Climate Analysis Indicators Tool (CAIT).
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY