THE ALL-NEW

BASE

Redesigning an Electric Vehicle charging station by incorporating a modular design.

MSc. Graduation Project
Kevin Schouwenaar

TU Delft | revolt

Graduation project
Kevin Schouwenaar
Revolt BASE Concept

Supervisory team:
Nicole van Nes (C.N.)
Gianni Orsini (G.A.)

Master Integrated Product Design
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Delft University of Technology

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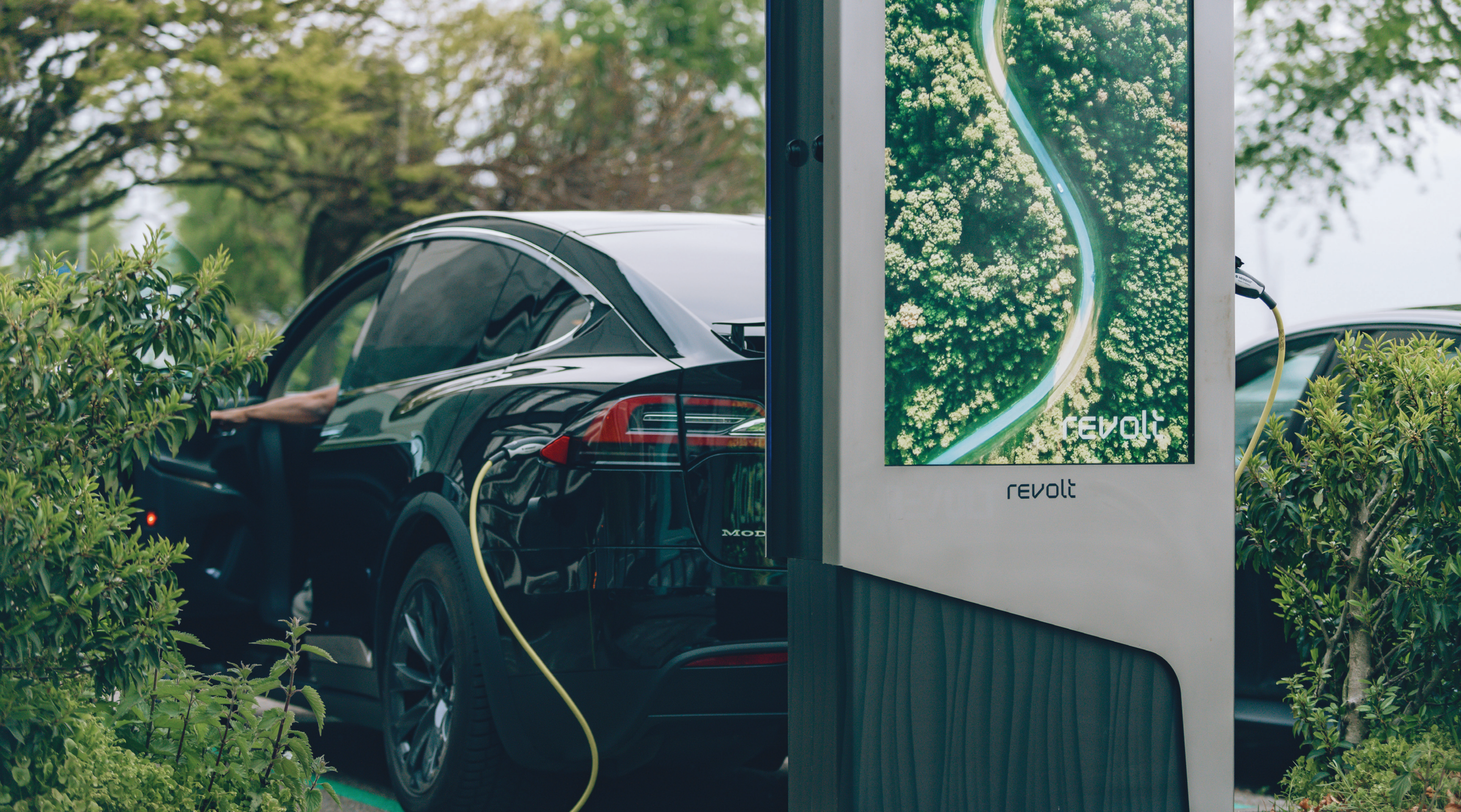
This Graduation Project
is a cooperation between: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Preface

In front of you is my graduation project; the project I have been waiting for since the beginning of my studies. The research aligns with my main interests: sustainability and user interaction, in the profession I would most like to work in: transport and mobility. Getting the chance to do a graduation project for my MSc. Integrated Product Design, this way, gives me an incredible amount of satisfaction.

As a child, I loved designing cars with big exhausts, but nowadays, that is no longer part of our standard. The electric metamorphosis of transferring people and objects from A to B has far-reaching consequences. More and more new regulations ensure these consequences can also be felt in people's homes. All due to global climate change and the replacement of fossil fuels.

Something Desiderius Erasmus already wrote at the end of the 16th century is that prevention is better than cure. I do not think this should be the credo only in healthcare but also, for example, in product design, sustainability, and facilitating the transition to sustainable mobility. A linear business model is no longer appropriate, but how can this work for a company like Revolt?

The ultimate goal of this project is not to argue that redesign should come to market but to create awareness of the aspects of which people are not yet aware. An enormous conscious process precedes the many daily unconscious choices people make. A process from an idea to a product is not usually as self-evident as one would think and involves many steps, both forward and backward. Awareness will ultimately lead to making the right choices.

I wish you much pleasure in reading this thesis and that it may interest you.

Kevin Schouwenaar
Amsterdam, August 18th 2022

Acknowledgement

I would like to thank some people who made sure that I achieved the desired result during an intensive period. First, I would like to thank my chair, Nicole van Nes, and mentor, Gianni Orisini, for their compassionate support. I appreciate how you reacted and activated me thoughout this project. I experienced our meetings as pleasant and personal but with a practical and professional undertone. I would also like to thank Jan-Willem Hoftijzer for the time he has devoted to my Project. Although Jan-Willem had to resign as Chair since the Supervisory Team did not meet the requirements of heteronomy, he still made a decisive impact on the project.

In addition, doing this project the preferred way would never have been possible without the two co-founders of Revolt, Rutger Bosch and Jeroen van de Ven. The possibility of being able to create any impact at a start-up with my project was an absolute stimulus. The personal development I have been able to go through has clarified my future plans. Furthermore, thanks to all employees of Revolt for their active participation during the project, with special thanks to Olga Wallet, Jasper Post, and Floris Loeffen for their enthusiastic involvement and insightful conversations.

Apart from the support from TU Delft and Revolt, I would like to sincerely thank employees from Streetplug, PIA Automation, Verborg Engineering, Windside Digital for their cooperation in this project and access to all documents that were needed. In particular, I would like to thank Kevin Delhez and Jaap Verborg. The discussions about technical validity proved to be invaluable. Further validation has also occurred through contact with NPSP, Made of Air, Dytos B.V., Johan Molenbroek, and Ianus Keller. Thanks for your time!

Finally, besides project-related contacts, my family, roommates, and friends see the flip side of the coin. I thank my parents for their sympathetic conversations and support throughout the project. Not everyone is lucky enough to live in such a domestic environment. My roommates had to put up with hearing unnecessary facts and asking for opinions on my ‘pictures to colour in’. And my friends, whom I did not meet enough, but who provided the perfect distraction whenever possible. Sorry guys, but I was too busy studying ‘drawing’.

It makes me feel fortunate that I have to thank so many people for achieving my personal goal. It will not be for nothing!

Executive summary

The world is currently trying to adopt a sustainable transformation process to counteract the negative effects of climate change. Part of this sustainability process is the electrification of the transport sector. However, a network of charging solutions is needed to provide the transition to sustainable mobility with the desired power. One of these solutions is the Revolt HUB, which alongside a charging solution, also serves as an outdoor advertising platform.

This project aims to find out where improvements can be made to the Revolt HUB. The starting points that have been used to define the scope are the improvement of the interaction and the embodiment of the brand values, particularly the combination of the product and sustainability. Therefore, the title of the project states: Redesigning the Revolt HUB while challenging a future-proof modular user interface and association with brand values.

In order to find possible areas of improvement, multidisciplinary research was performed. Through this research, an analysis was made of the company, the current product, the current and desired interaction and the context. The findings showed that making small adjustments led to a chain reaction of other adjustments. This resulted in a consensus with all stakeholders to rebuild the HUB from scratch. All this was accomplished through a vision formulated according to trends and developments in both the technological and social fields.

Based on this, recommendations were presented as a complete redesign of the HUB. The interaction is leading and serves as a starting point for further elaboration of the complete product portfolio. In addition, the concept also lends itself to the implementation of future technological developments, as a separate single charging station is incorporated into the design; the new ONE. Further elaboration could focus on testing the concept and concretising the technical assumptions made.

Abbreviations

All used abbreviations within my graduation project.

ATEX = ATmosphères EXplosibles
DD = Double Diamond
DOOH = Digital out of Home
EV = Electric Vehicle
IR = Infrared
LCA = Life Cycle Assessment
MoA = Made of Air
MVP = Minimum Viable Product
SME = Small and Medium Entreprises
UV = Ultraviolet
ViP = Vision in Design
VHB = Very High Bonding

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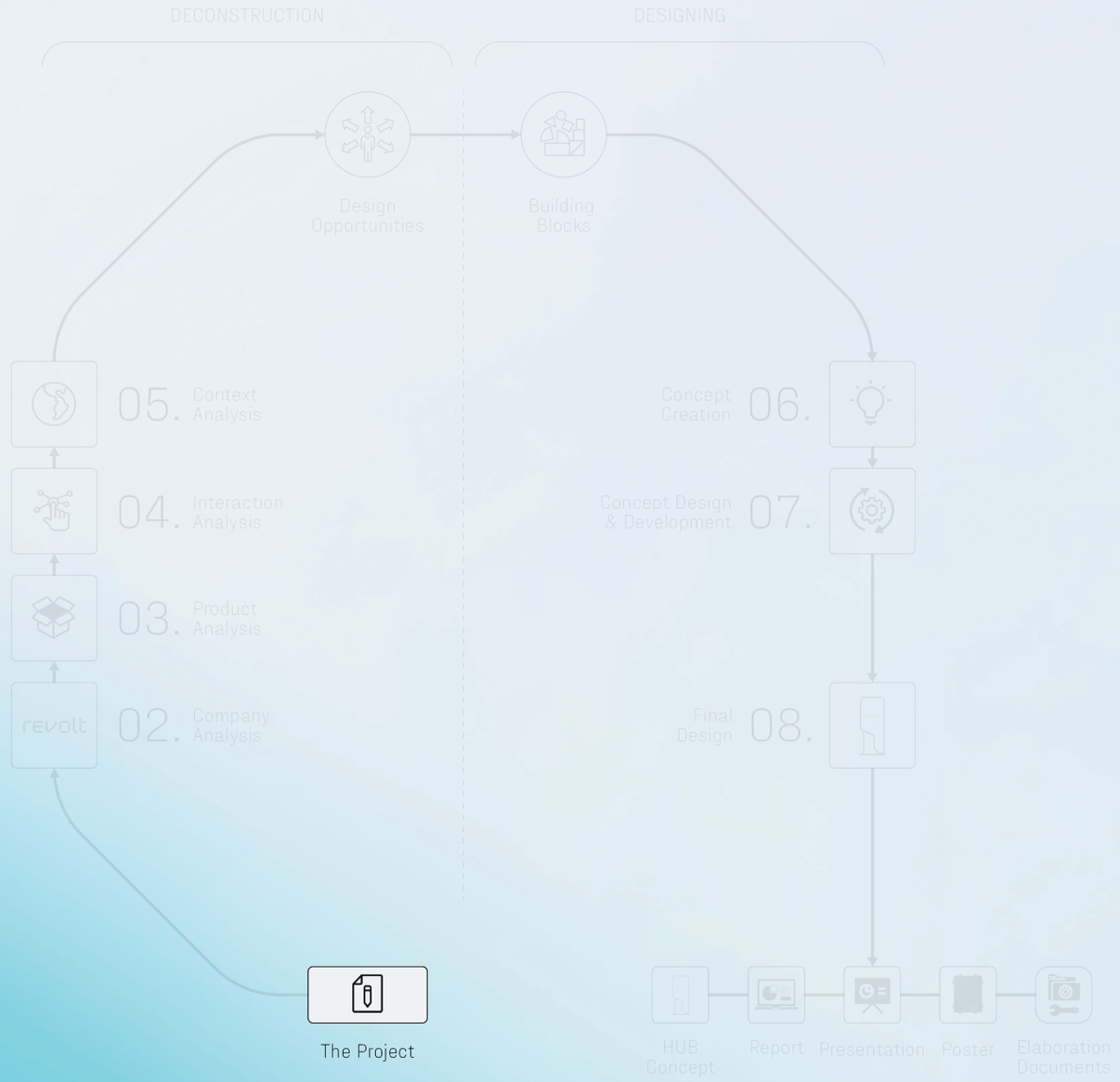
01. The project

The first chapter introduces this project and provides guidance while reading. It will explain how this project was established and the motivations for doing this project at Revolt. In addition, it will also be explained what the ultimate goal is to finish this project and how it will be structured to achieve this goal. Finally, a reader's guide is established, providing supportive guidance throughout this project.



01.1 Introduction

A graduation project can be done in two ways; you can start an independent project on the faculty, or you can choose to connect your project to an existing company or start-up. For this project, the second applies, which did not come entirely out of the blue.

More than a year and a half ago, Revolt came on the radar due to a course-related workshop at the faculty of Industrial Design Engineering at the Delft University of Technology. Several students were asked to work out a sustainable electric charging station concept, including two advertisement screens. In the end, it turned out I was in the group that best completed this challenge, which led to a four-week design assignment to develop the concept into a feasible product, the Revolt HUB (figure 1). A conceptual framework and component layout, together with the overall design were created during this assignment. Based on these outcomes, the current manufacturer of the HUB further elaborated on the concept.

However, any designer will have to admit that the period of four weeks is too short for developing a concept into a well-thought-out and tested product. During these four weeks, an incredible number of ideas were generated, but unfortunately, not all of them were fully developed. There was quite a lot of pressure behind bringing the first functioning version of the Revolt HUB to market. Since then, there has always been an internal motivation to re-examine the chances of this promising concept. In this case, more time will be available to test and develop certain options to their full potential.

Figure 1. Revolt HUB

01.2 Purpose

Today, there is almost no greater theme within the field of designers than sustainability. Besides the governmental pressure, this topic greatly impacts how I approach and develop projects. Besides sustainability, there is another interesting part of designing: User experience. In my eyes, this is the most important part of designing since a product stands or falls when it comes to this element. After all, users always have to buy or get access to a product to use it. Of course, these are not the only aspects, but I find it important to clarify my intrinsic motivation regarding the design project.

The electricity demand is growing and forces prices to unimaginable heights. The transition to an all-electric mobility network is under stress, which has severe consequences for consumers and puts pressure on companies and property owners. However, it is up to the companies and grid operators who facilitate this transition to ensure sufficient charging infrastructure remains available. This can be done in all forms, but why not how this is all meant to be done? Which is environmentally friendly.

There is a lack of clarity among people about what sustainability exactly is. Sustainable materials often give the impression that they are environmentally friendly, but this is not always the case. Sustainability concerning the environment is mainly about ‘not depleting resources and maintaining the ecology’, and when concerning products, it is often about ‘the lifespan’ (Products that lasts, 2014). A product is only environmentally friendly if it does not harm the environment in the production process, the use, and the waste phase.

I believe that a green mobility transition also includes green charging solutions. After all, is it not odd that the transition to sustainable mobility is not only facilitated by environmentally friendly products? In addition to making the Revolt HUB more sustainable, I will also aim to improve the user experience. This will make the product differentiate itself physically and mentally. In this case, the appearance and interaction will convince the user to use Revolt HUB over its competitors.

Personal
The project’s ultimate goal demands an embodiment that offers the possibility of actually being integrated. This embodiment can be realised in many forms; therefore, it is important to adjust this to my learning goals and the client’s wishes. In this, the learning goals are considered to be leading. The excitement of adding potential value to a company makes it more exhilarating and enjoyable. It also provides feedback on my work by opinions from employees and stakeholders. Finding the right balance between users’ interests, business, and societal challenges is the core of the Integrated Product Design (IPD) Master’s program. Therefore, I would like to catch it in this project’s deliverables.

The personal learning objectives, intended deliverables, and additional explanations relating to this project can be found in Appendix 2.

01.3 Methodology

Creating a clear plan to approach this project is crucial to achieving the goal. Two components are essential: the physical product itself and the interaction. This will need to be examined to get a clear picture of the current state. One method that does this correctly and is structured is the Vision in Design (ViP) method (figure 2) by Hekkert and van Dijk (2011). The method uses two distinct phases: the 'Deconstruction' phase and the 'Designing' phase. In other words, the Research-phase and Design-phase. During this project, the structure of the deconstruction phase will be used to structure the investigation of the current state of the Revolt HUB.

Visual Support

However, the ViP-method does not provide personally preferred visual support. For the support, I started to delve into Design Management (Kathryn Best, 2006) at the suggestion of Jan-Willem Hoftijzer. Delving into this topic led to the necessary support being found using the evolved Double Diamond model (DD) (Design Councel, 2019). The DD-model (figure 3) is a clear, comprehensive, and visual description of the design process, helping visually and structurally guide you through the project. The dichotomy between 'Research' and 'Design and Development' can be easily understood and reflected in the ViP-model. However, there is no clear distinction between 'diverging' and 'converging'. By visualising these phases, the need for summarising and concluding findings becomes clear, which is desirable due to the project's extensive size.

Implementation

Now that the structure for this project's two major and essential phases is clear, it is time to flesh out these two phases. The step-by-step chronological approach of the ViP-model represents three layers of description that are fundamental and characteristic: the context level, the interaction level, and the product level. They emphasise that a product - or any design solution - is always a reflection of, or is reflected in, the interaction people have with it (Hekkert & van Dijk, 2011). The aspect of sustainability will mainly fall within the product level and the interaction within the interaction level. The final structure of the project with the interpretation of these three levels can be seen in figure 4. Please note that this section about the methodology only serves as background information to the structure of this report. A reader's guide is presented in the next section.

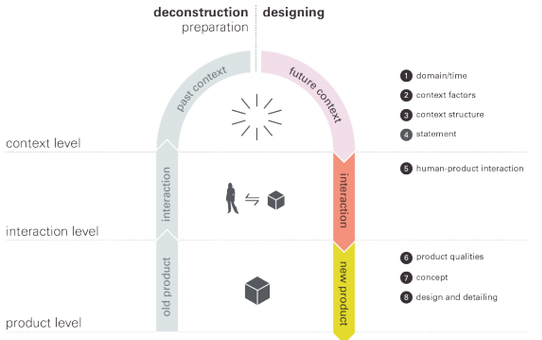


Figure 2. Structure of Vision in Design method

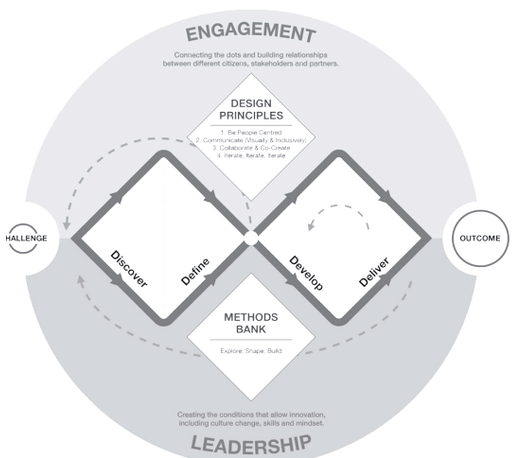


Figure 3. Structure of the Double Diamond model

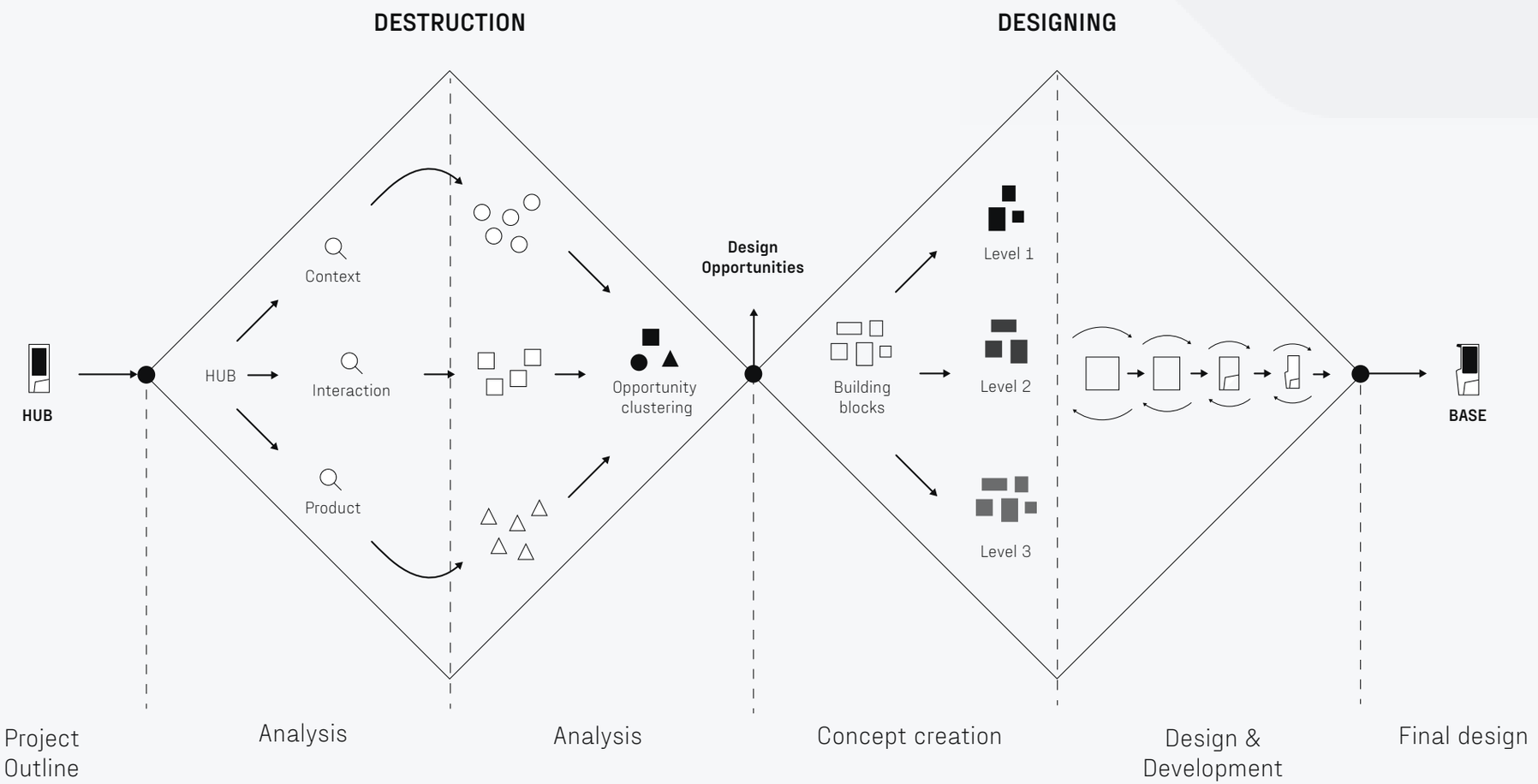


Figure 4. Structure of the Double Diamond model

01.4 Readers Guide

This section offers a visual representation of the method to serve as a reader's guide (figure 5). It provides a complete overview of all chapters and sections that shaped the project to the final design. The overview will be shown at the beginning of each chapter as a helpful indication.

Deconstruction

To understand the current situation regarding the redesign of the HUB, a thorough research phase is essential. By understanding the company and the product, areas for improvement can be sought and used to create design opportunities. A section is added to understand the foundation of Revolt properly. The company is young, so keeping a close eye on the philosophy and core values is essential to establishing a solid foundation for the future. In addition, a brand refresh took place during the project period, which has to be integrated into the redesign. Therefore, the deconstruction phase consists of the following four topics:

Company - Defining essential core values and understanding its nature.

Product - Analysing the technical elaboration and market positioning.

Interaction - Analysing the interaction and user concerns regarding charging stations.

Context - Defining the future context and preferences of EV driving.

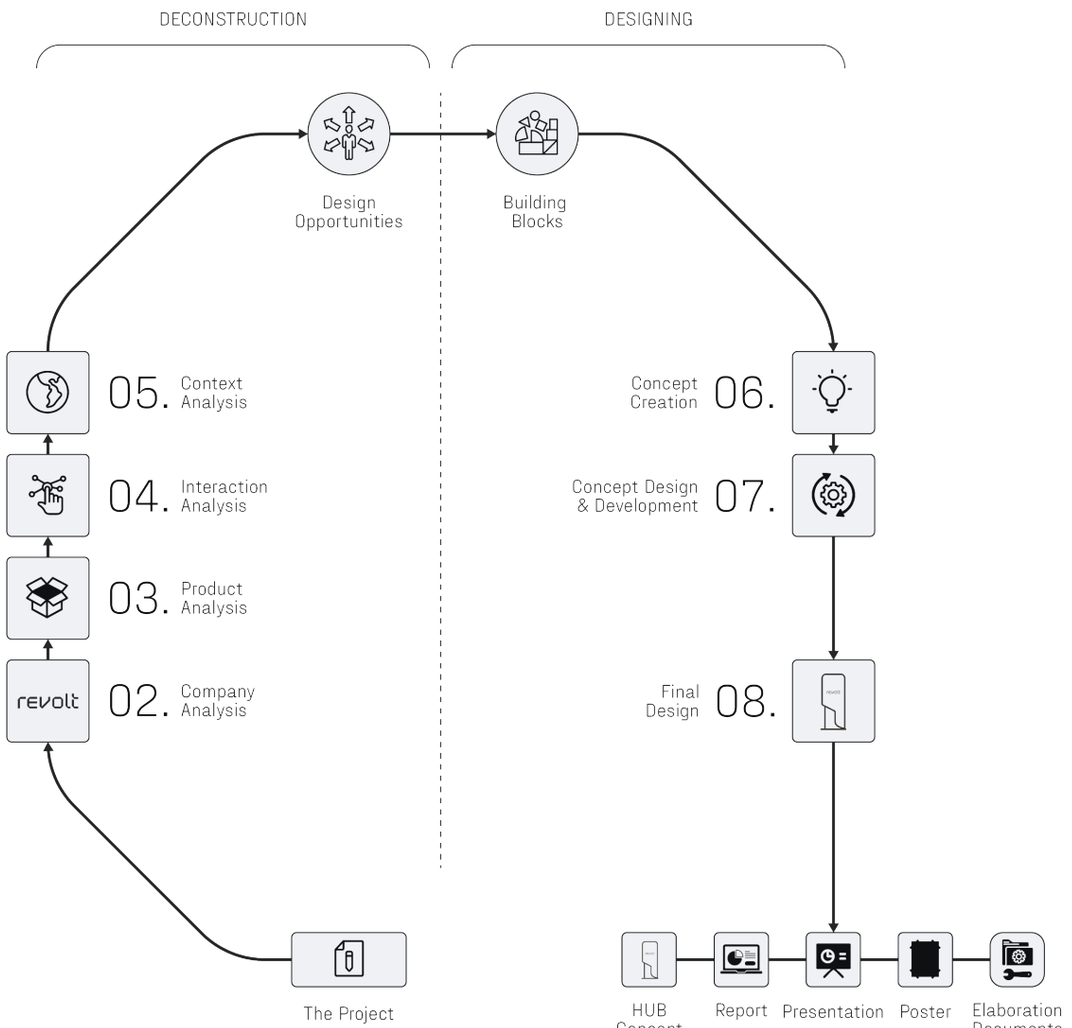


Figure 5. Readers guide

Company
The company research aims to get a complete picture of why they exist and how the company wants to bring this to the market. In addition, it is also important to know which potential consumers they want to address and which products they use. It is essential to understand Revolt's brand identity to put this theory into practice. These components will be explored in this chapter, resulting in design opportunities.

Product
The examination of the product is divided into several phases. First of all, technical analysis will determine the current state of the product. This will be done by observing the product and investigating all internal parts. Conversations with the manufacturers and the analysis of the documentation present will provide a comprehensive overview. When the physical product has been analysed, the activities of the stakeholders in this process will be examined. Together with an investigation of other market providers, this will create possibilities for technological improvements.

Interaction
The value of interaction in a product is evident, so in this chapter, the HUB's interaction will be investigated. This interaction will be evaluated by an in-field investigation of popular charging stations' interactions. Since also consumers interact with the HUB without charging (outdoor advertisement), the product's appearance will also have to be examined. In order to convert these facts into usable design opportunities, it is desirable to understand the nature of an interaction. This will be investigated through a literature review. By having a clear picture of the underlying principles of the interaction, an intended interaction can be designed during the concept creation.

Context
In addition to the philosophy guiding the company, it is also valuable to understand the product's establishment. Conversations with the HUB's manufacturers result in understanding the decisions made. Today's situation, trends, and developments are incomparable while the market is developing rapidly. Literature research will show the current market developments, what consumers are encountering, what decisions they make, and where they are based on. The design opportunities resulting from this research will be essential in the foundation of the design direction.

Designing

Useful findings from the deconstruction phase will be used for concept creation in the design phase. The design opportunities will lead to a design direction during the chapter about Concept creation. This design direction will be forged into a concept during the design and development phase. The concept will eventually be concretised into a validated concept that can serve as a basis for further development. The structure of these chapters is based on the project's requirements, according to the methodology in section 01.3.

Concept creation - Converting design opportunities into a substantiated design direction.

Concept design & development - Designing a desired and validated interaction and appearance.

Final design - Developing the concept into a detailed proposal.

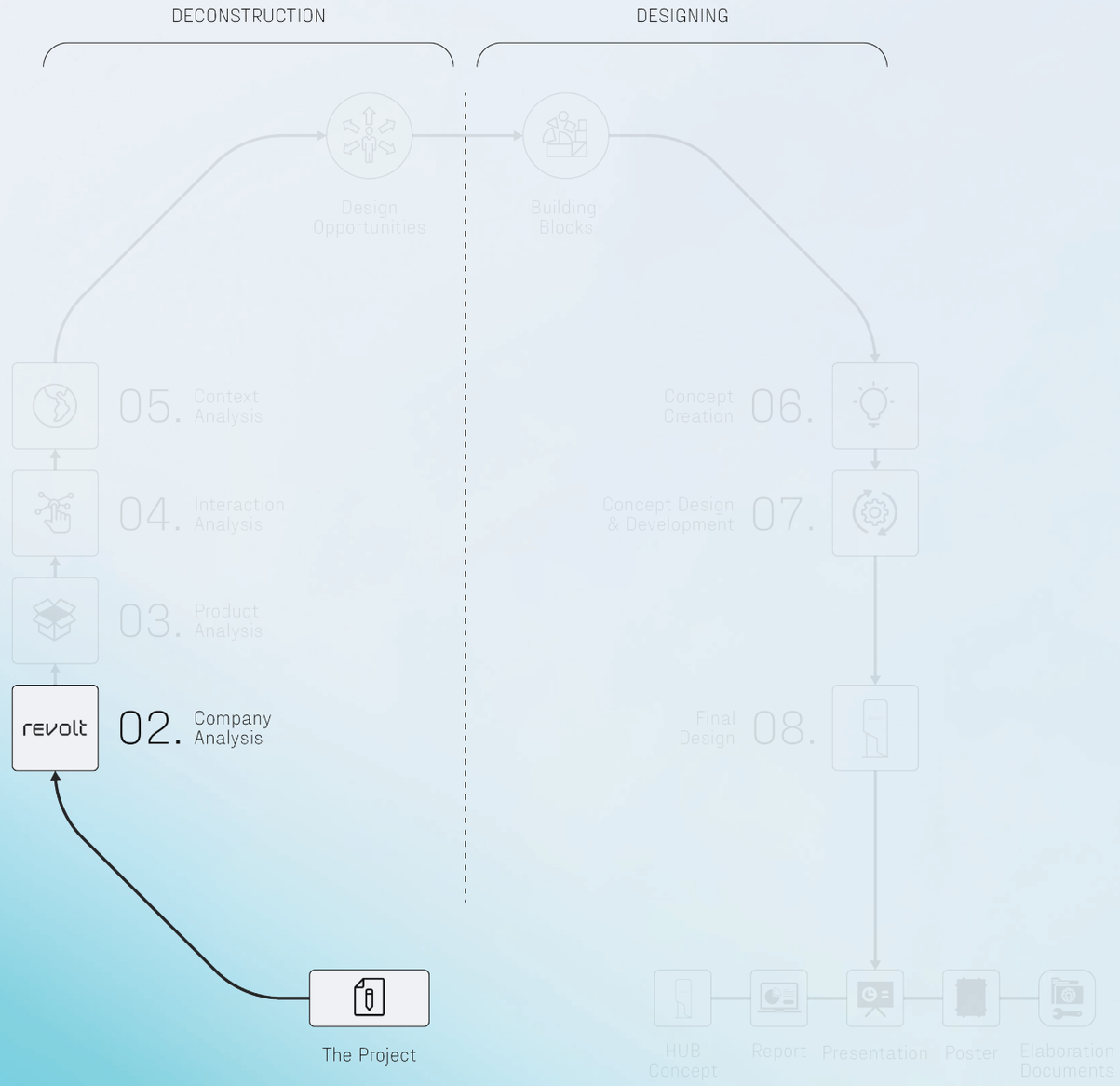
Concept creation
Within concept creation, the design opportunities that have emerged from the research will be structured into usable clusters. These clusters will be used as building blocks during the concept creation process. The concepts were designed in three levels based on impact and future-proofing. These levels were then presented to the stakeholders, from which arguments were developed to reach a final design direction.

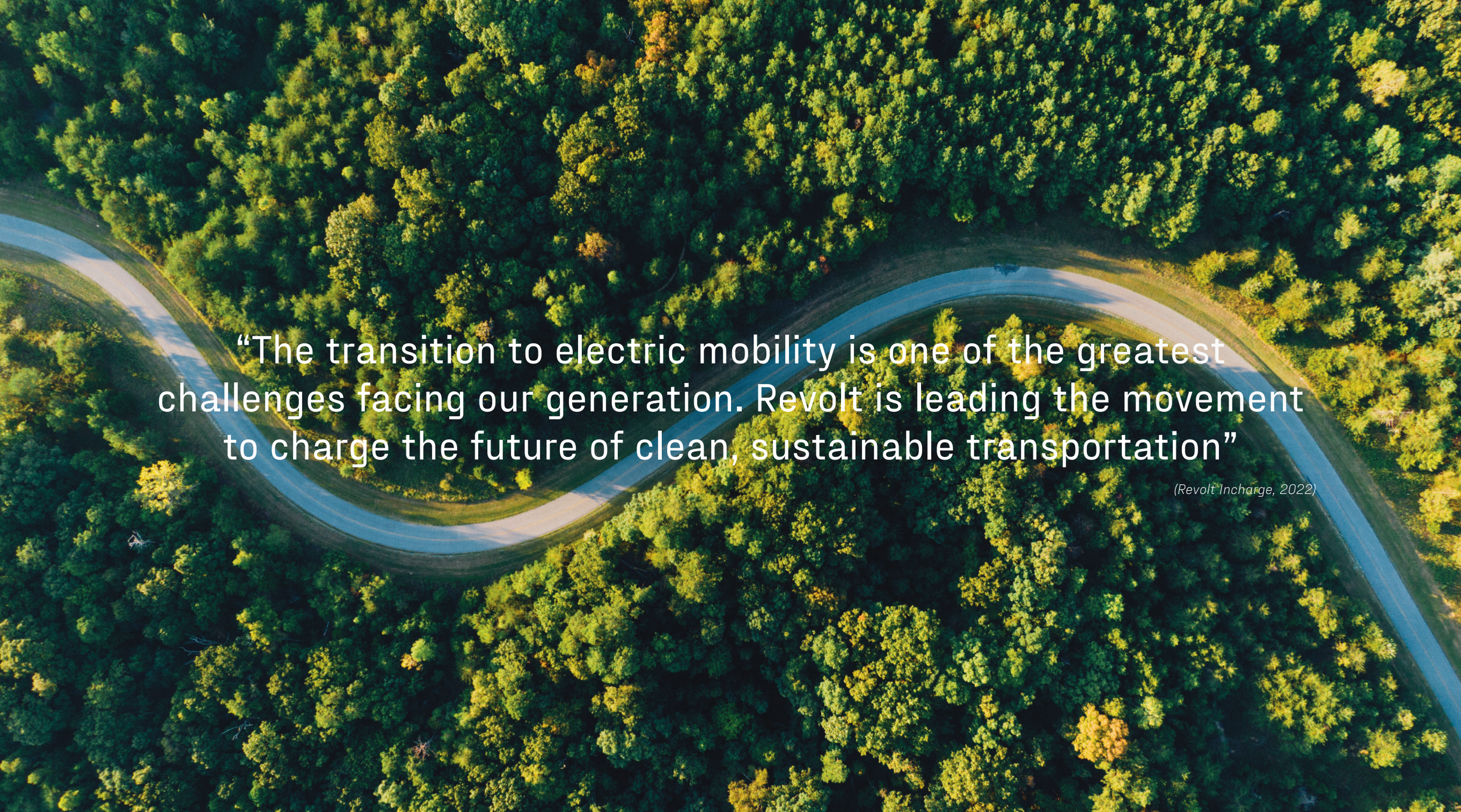
Concept design & development
In this section, the chosen design direction is further elaborated into a tangible design. This is done based on a personal vision that has emerged from an overall assessment of the knowledge acquired. Before starting with the ideation, a list of the intended interaction and appearance of the new product is compiled. This list serves as a helpful tool during the ideation phase. The outcome of the ideation sessions will be further detailed in Chapter 08.

Final design
In the project's final phase, further detailing of the concept is performed. During the detailing, attention will be devoted to the technical details. With external companies, attention will be given to the detailing of the components, the frame's technical feasibility, and the sustainable enclosure. The final sketches will add the desired weight to the concept, which will be supported by documentation to further develop the concept into a real product.

02. Company analysis

The company analysis consists of six sections to understand Revolt accurately and make the reader acquainted with the company. Firstly, the brand values and operations are analysed to understand why they exist and how they want to implement this. An overview of the product portfolio will clarify which products they offer. The user groups will explain whom Revolt is targeting after the product portfolio indicates with what products they want to do this. Then, the current stakeholders are labelled to outline the distribution of tasks. Lastly, contemporary competitors are described to understand Revolt's market position.




“The transition to electric mobility is one of the greatest challenges facing our generation. Revolt is leading the movement to charge the future of clean, sustainable transportation”
(Revolt Incharge, 2022)

02.1 Revolt's existence

Revolt is a company that offers charging solutions to power all current forms of sustainable mobility, primarily focusing on Small and Medium Enterprises (SMEs), real estate, and leisure companies. SMEs account for roughly 90% of global business and more than half the employment (World Bank, 2019). They play a critical role in economic growth, innovation, and job creation. If the goals of the Paris Agreement are to be achieved, it will be crucial that SMEs reduce their carbon footprint (Carbon trust, 2019).

It can be imagined that the rapid development of technologies, complex topics, and urgent implementation make it hard for these companies to pursue. In order to this implementation of energy management or charging solutions, these companies have to make significant investments to reduce their carbon footprint. In order to play into the hands of these companies and fill the gap in the market, they have created a subscription business model, which lowers the threshold for such companies to implement sustainable innovation since no investments are needed to use their services.

Vision

The business model is supported by operating based on a vision that has been the driving force behind the company's existence. Their vision (sentenced in the blue box) has been clarified to get a good idea of what they want to achieve. The vision includes words like an ecosystem, all forms of sustainable mobility, clean energy, and some general terms like; anytime, anywhere, and everyone. Essentially, a mission statement is created to serve as the guiding light to achieve the vision (Hofstrand, 2016).

Revolt's mission will not be used for explanatory reasons since this will make it more complex and confusing. A clarification per term will help to get a useful picture of Revolt's positioning. It is important to mention that in all instances where the word 'charging' is used, this can be replaced with 'energy' if Revolt develops further as a company. If further information on the revolt's mission is required, this can be found in Appendix 4.

Explained: The vision

It is discernible that umbrella terms are often used for marketing purposes to reach potential customers. However, an explanation of the terms Revolt uses in its vision is being clarified to avoid misunderstanding. The three words, anytime, anywhere, and everyone, correlate to the discussed ecosystem that Revolt wants to build and its users. On the next page is a brief explanation of each term.

VISION:

"By 2030, Revolt's ecosystem will charge all forms of sustainable mobility, making clean energy available anytime, anywhere, and to everyone."

(Revolt Incharge, 2022)

"By 2030, Revolt's ecosystem will charge all forms of sustainable mobility, making clean energy

Building an ecosystem

Essentially, an ecosystem is a community or group of living organisms that live in and interact with each other in a specific environment (youmatter.com, 2022). In the case of Revolt, this involves charging and media solutions that can communicate with each other and vehicles connected to their energy network.

At the heart of Revolt's ecosystem is the balancing of available energy. Variables can always be supplied with energy, such as the user who needs the most. Therefore, communication between products is critical. In terms of media solutions, the HUB network offers advertisers to have their ads displayed to reach their target audience.

All forms of sustainable mobility

When mobility is combined with sustainability, things become a little more complicated. Sustainable mobility is a broad concept, so the definition is not necessarily definite. However, sustainable mobility can best be described as:

"Sustainable transportation is the capacity to support the mobility needs of a society in a manner that is the least damageable to the environment and does not impair the mobility needs of future generations." (Rodrique, J.P., 2017). Overview 1 shows all forms of sustainable mobility and which forms Revolt is currently responding to.

Electric cars | Electric vans | Electric excavators

Overview 1. Current sustainable mobility respondence

Clean energy

Different types of energy can be used for sustainable mobility; renewable energy, green energy, and clean energy (National Grid Group, 2022). These terms are often used interchangeably, but it is helpful to understand their differences. Renewable energy, also known as renewable energy, is generated by inexhaustible natural resources, such as wind power, solar energy, and hydropower. These resources are constantly and naturally renewed and are also considered the counterpart of fossil fuels (National Grid Group, 2022.

Green energy is part of renewable resources but includes only the forms of energy with the smallest environmental footprint, sunlight, wind, heat, and water (Terrapass, 2020).

Clean energy, like green and renewable energy, does not generate any greenhouse gasses during its production, but it is not always renewable. In other words, you can say that clean energy is the least environmentally friendly of the three; however, all these forms are part of the future of our energy supply.

available anytime, anywhere, and to everyone."

(Revolt Incharge, 2022)

Anytime

This term is about the availability of Revolt's energy network to customers (if any). SME's, real estate, and leisure companies should be able to access this network at all times. If they need an appropriate solution, they can contact Revolt and further steps will be taken.

Anywhere

This is not only related to the product level and to which market Revolt is currently entering. Revolt focuses on the Dutch market and wants to build a stable basis before entering the international market. In terms of products, they want to offer the customer flexibility and find a suitable solution for each customer. This also applies to difficult-to-reach areas such as construction sites, shipyards, and workplaces.

Anywhere

For now, the focus is on SME's, real estate, and leisure companies because higher adoption rate of this segment, but this may also expand to other segments in the future. If it were up to the Revolt founders, anyone who needs an energy solution should be able to turn to Revolt.

ALL OF THE ABOVE CAN BE TRANSLATED TO THE FOLLOWING ONE-LINER:

"No matter the location or the occasion, Revolt has a charging solution tailored to your infrastructure."

(Revolt Incharge, 2022)

Core values

To realise the vision, Revolt works from specific core values. In order to properly understand why a particular choice is made, knowledge of how these choices are made is indispensable. Revolt's values are divided into two different groups; Brand personality and communicative characteristics. The brand personality is about the identity and spiritual thought behind the company's core values, table 1.

Guiding principles

These core values will be used during the design thinking process in the 'designing' phase. However, it is challenging to work with abstract values since the pitfall is that people will all agree, and real depth on the issues will not be achieved. Therefore, these values are developed into guiding principles to make the values applicable for this project and possible future projects. Guiding principles are brand-related and open for personal interpretation, providing an opportunity to start a discussion. While converting the core values into guiding principles, two critical points were taken into account:

- The principle is a bit controversial.
- The principle helps decision-making.

In this case, the guiding principles (table 1) can serve as pillars for the graduation project and the employees during the design thinking and decision-making. In addition, the categories will be renamed to add conceptual power and increase creativity.

Brand personality - Tone of being

The guiding principles that will help during design thinking and decision making during this project are as follows:

Brand Personality	
Challenger	Is pioneering and boosting innovative products that contribute to a sustainable future.
Professional	Delivers quality, has the expertise, and gets things in good shape.
Confident	Is an expert in the operation and knows what she is talking about.
Inspirational	Offers perspective and works visionary to help the customer further.
Distinctive	Dares to make choices that benefit the product quality and experience.
Accessible	Is always and everywhere accessible for everyone.
Social	Focuses on building relationships with customers.

Table 1. Core values and guiding principles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02.2 Brand operations

Offering subscription-based charging stations distinguishes Revolt from its competitors. In order to get a good overview of what this means exactly, it will be explained in three main parts: customer journey, charging-as-a-service, and impact by media.

Customer journey

It is valuable to know what the customer will experience once they have chosen Revolt. An in-depth overview of the Revolt customer journey can be found in Appendix 4. The customer journey provided below outlines what a customer can expect in three concise steps.

01. *Scan*

Revolt will complete a short scan of the current fleet (if applicable) and the available loading capacity at the business premises.

02. *Technical proposal*

They will follow up with a technical proposal that combines the outcomes of the scan with the company's EV ambitions and desires.

03. *Quote*

After approving the technical proposal, the company receives a commercial proposal with transparent and affordable rate options.

How it works

Charging-as-a-service

The subscription-based charging solutions include end-to-end services - from advice and installation to regular maintenance. They offer fixed and flexible subscription options to persuade consumers to use their services, with no up-front purchase costs and maintenance fees.

What is included

01. *Hardware*

The hardware consists of the physical charging solution. This solution can be a ONE, WALLBOX or a HUB. Again, only the products that serve the consumer market are taken into account.

02. *Energy costs*

Within the subscription is also an allowance for energy costs. The compensation offered by Revolt is €0,11 per kWh.

03. *Installation*

To maximise unburdening and convenience, end-to-end service is included in the subscription. This service consists of the preparation, installation, and completion of the charging solutions on site. However, this step can only be performed if the three steps of the customer journey have also been completed.

04. *Subscription*

The subscription that the customer signs has a length of 60 months.

05. *Maintenance and check-ups*

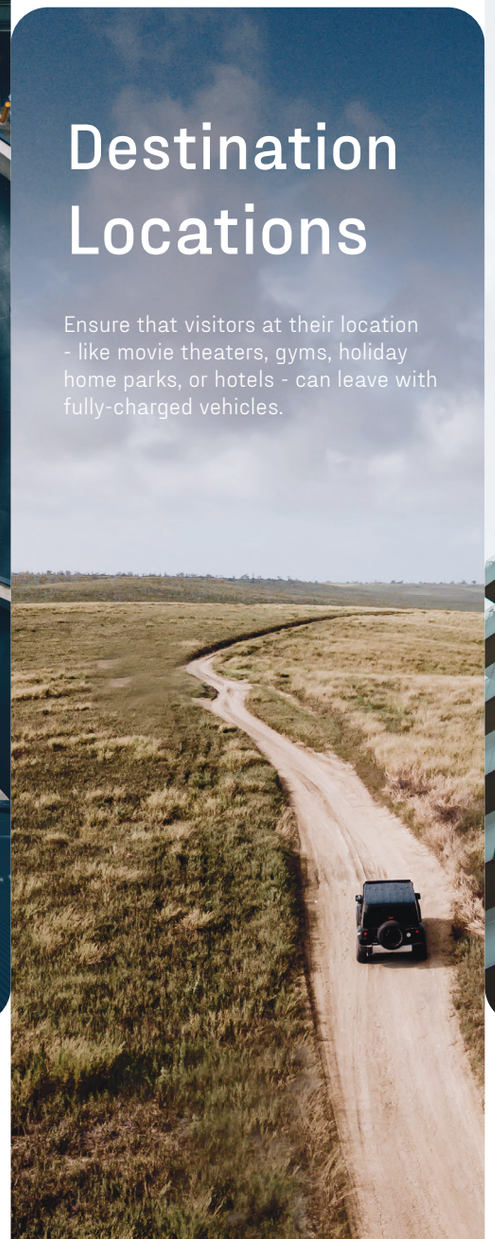
Besides taking care of the complete installation, Revolt will also do regular maintenance if needed. This could include cleaning the charging station or checking out the internal components.

Impact by media

It is also possible for companies to create media impact. This only concerns the Revolt HUB, which is accompanied by a bespoke digital advertising platform. This empowers the company to reach new and established audiences through targeted, digital communications on built-in 55” screens.

The screens can communicate with guests, customers, and employees. The screen content is always available and adaptable, so the visitor’s experience remains personal and current. Start with a welcome message, use the space to inform about events, or tap into Revolt’s media network. The opportunities offered by this option are particularly targeted at leisure companies. Effective advertising can offset their costs to as little as €0/month, i.e., a free charging station.

How to make impact



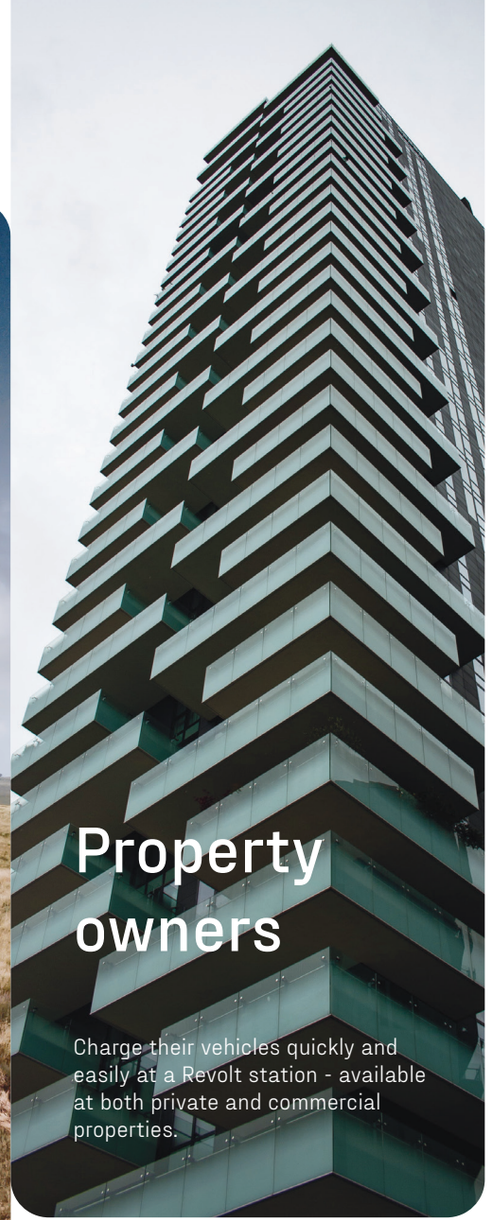


Figure 6. Customers

02.3 User groups

Customers

Revolt distinguishes between three intended user groups; Companies, Destination locations, and Property owners. These three groups represent the market segments on which Revolt focuses its sales trying to deploy its proposition. The three intended user groups are customers who subscribe to the product. As a result of conversations within Revolt, the buying behaviour reflects that it is hardly ever the case that a consumer orders single or multiple HUBs. Next to the placement of the HUB, it is often combined with one or more ONE's and/or WALLBOX's. A short description of these groups can be found in the figures on the left.

Companies

All sorts of businesses can install Revolt charging solutions in their desired destination. Whether large corporate offices or a local carpentry business, both can benefit from Revolt charging solutions. It offers employees and visitors an easy charging solution at work without a significant investment.

Destination locations

A destination location is the last point of a particular route or course; think of destinations for recreation, entertainment, sports, and tourism. Due to the large flow of passers-by, these locations are often the most interesting for placing a HUB. Because visitors are parked here for a more extended period, for instance, half a day, they can leave the location with a fully-charged vehicle. .

Property owners
The association of owners of apartment complexes can also submit a request for the installation of Revolt charging stations. This makes it possible for residents to charge their vehicles when at home.

Users

The customers are initially the most important link for purchasing the products. However, after the purchase, another essential group turns to confirm the choice of a charging solution: the user. The HUB users consist of; EV Drivers, Passers-by, and Advertisers. Therefore, a distinction can be made between two groups directly related to the HUB; customers and consumers. A person may fall into two groups, e.g. a facility manager driving an EV. If this is the case, this person is classified in the group 'customers' because this group is proportionally smaller considering the HUB's degree of purchase and use. This choice is made for investigation purposes only.

EV Drivers
People driving an EV are the most critical focus group regarding the HUB's interaction while charging their vehicle quickly and easily. This group includes all persons with a vehicle capable of charging at a charging station.

Advertisers
The two advertisement screens enable advertisers to reach and engage with their audience where they spend time. Time slots can be bought to show their content on specific HUBs throughout the country to target their audience accurately.

Passers-by
This group views the advertisements on the two screens of the HUB. People who do not charge their vehicle at the HUB can still interact with the HUB both consciously or unconsciously. The advertisement screen allows them to watch advertisements while passing by the HUB. Giving the HUB a distinctive appearance can increase the number of views.

User surveys

Revolt has done extensive research into the requirements and wishes of the customers when it comes to the proposition of the HUB. Unfortunately, the users' perception did not include. A survey has been conducted to understand the current users' perceptions. The survey is aimed primarily at EV drivers. The choice for EV drivers above the other two groups is based on the value of intensity and number of interactions with the HUB. Further information about the results and takeaways can be found in section 04.3.

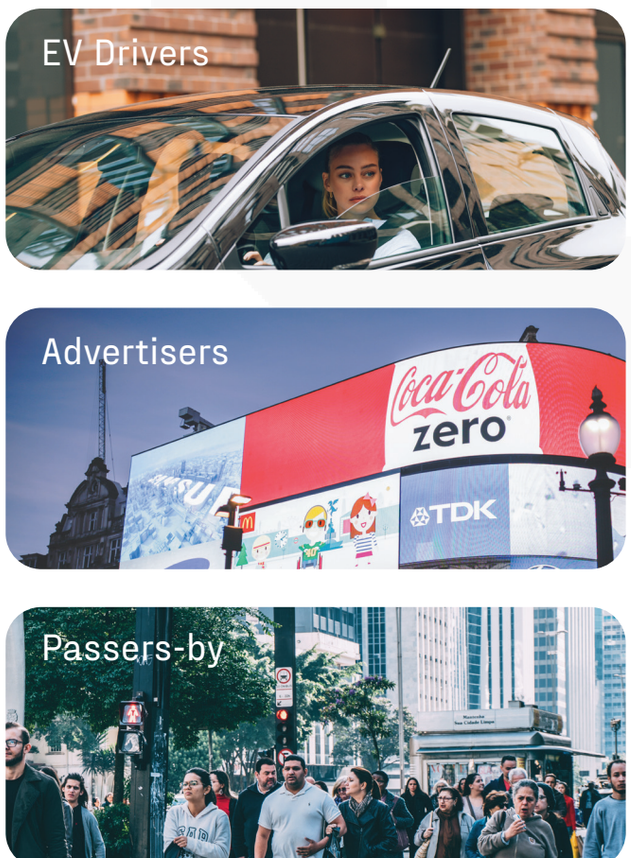


Figure 7. Users

02.4 Product portfolio

Examining the product portfolio (figure 8) focuses only on the products intended for the consumer market; the HUB, ONE, and both single and double WALLBOX. Therefore, the product comparison will not include mobile charging solutions such as the Mobile Battery and Charger (figure 9). This is because these products are categorized in a different market segment where the practical solution is far beyond the appearance and interaction of the product.

Examining the product portfolio focuses only on the products that focus on the consumer market. Therefore, the product comparison will not include mobile charging solutions such as the Mobile Battery and Charger. This is because these products are out of scope and have no need to be redesigned in the short term. The results of the overview visually represent which market the products are aimed at, as well as current similarities and differences in design.

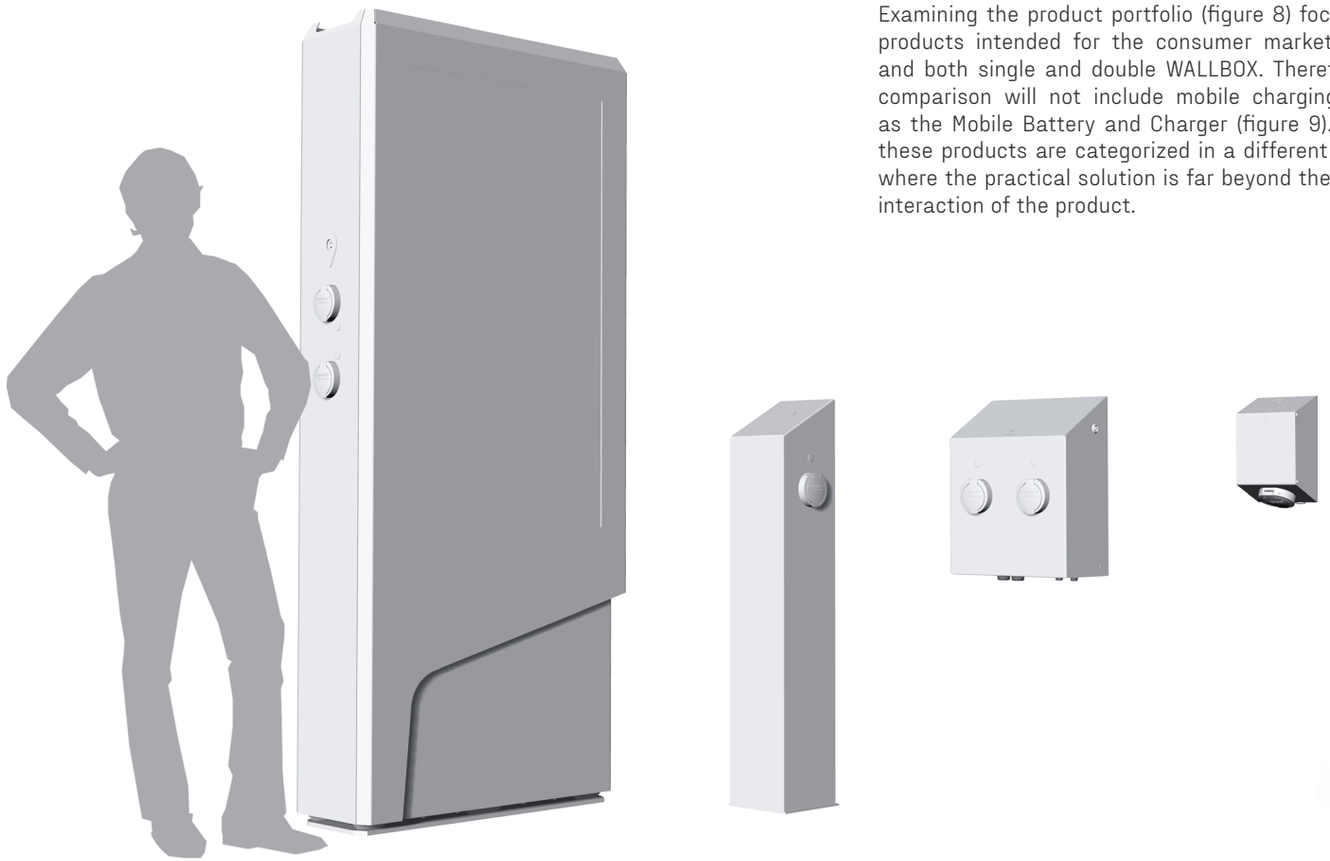


Figure 8. Revolt's current product portfolio

Figure 9. Revolt Battery and Mobile Charger

Form

It is noticeable that a comparable basis in form language can be found in all products.

1 *Square base shape*
All four products seem to have been designed using a rectangle as the basic shape. The long vertical sides are a recurring theme when looking at the products from different sides. Not only do the sides suggest a rectangle, but also the top and bottom of the product often bring back the memory.

2 *Sharp corners*
The vertical and horizontal sides are frequently interrupted by a sharp corner. The choice of this type of rounding contributes to the rectangular and static appearance from which the product is designed.

3 *Flat surfacing*
In the entire portfolio, only flat surfaces are used that flow into each other, whether on the front, side, or top. The flat surfaces present a calm and solid appearance. A form of unity is created by giving the scanner's surface the same angle as all products.

4 *Static and balanced appearance*
Almost all vertical lines are perpendicular to the ground, giving the products a static appearance. Moreover, this straight line pattern balances the product and makes it easy to align with houses, offices, and other buildings. Except for the HUB, diagonal lines have been used to create a more dynamic and modern look to hide the product's heaviness somewhat.v

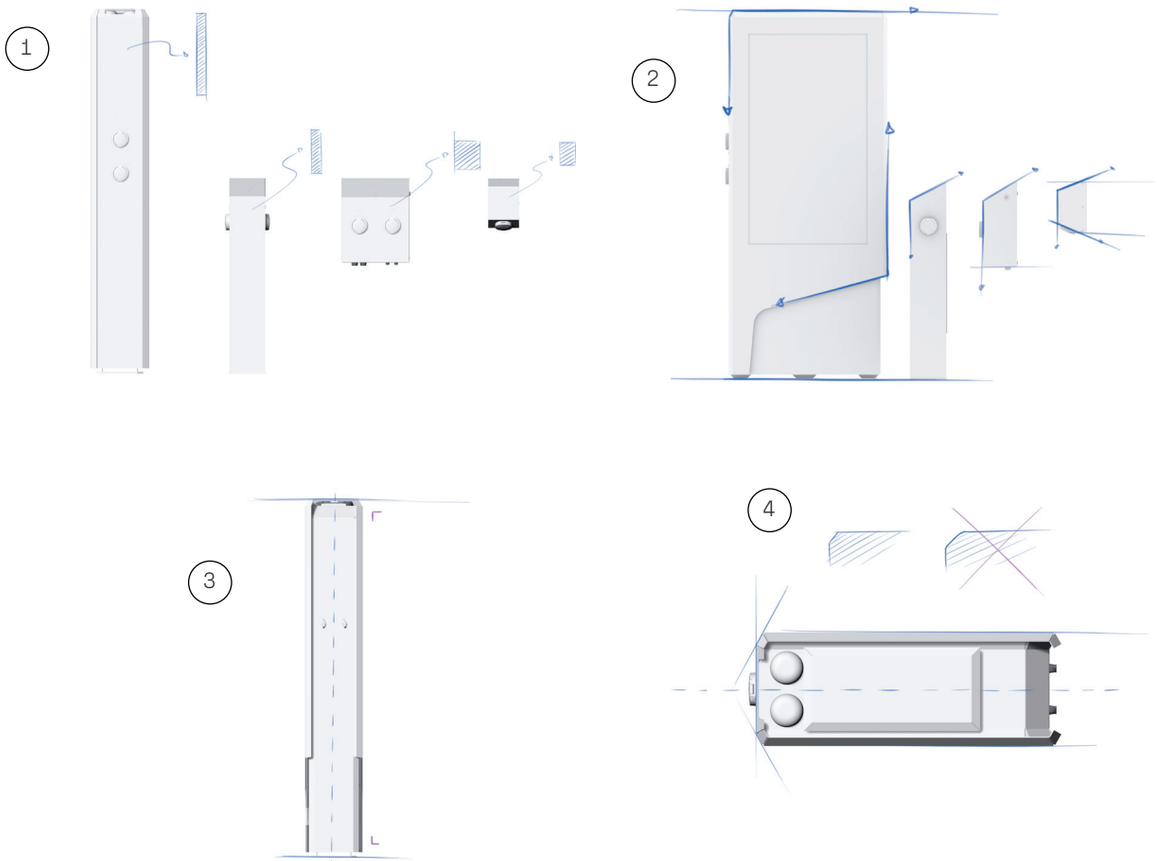


Figure 10. Stainless steel sheets

Figure 12. Manual finishing

Figure 11. Tubular profiles

Materials

Stainless steel sheets

In addition to the HUB, the single and double wallboxes are also manufactured out of stainless steel. The sheets have a thickness of 3 mm, which can still be seen from the outside with various products (figure 10). The products have a premium and solid appearance, which benefits the experience due to the material thickness.

Tubular profile

The ONE is the only product manufactured from a tubular profile (figure 11). Since the initial shape is a square profile, its overall shape is predetermined. In this case, the production method significantly impacts the freedom of form.

Manual finishing and impregnated surfaces

The basic materials of all products are the same, but they also have similar processing. The sheet metal parts are pre-processed by a laser cutting machine, after which they are bent and welded manually. The rough processing is done manually, as well as polishing, cleaning, and impregnating the surface with a unique finish to avoid irregularities (figure 12).

Interaction

Luminous and angled RFID scanner

The current interaction involves several actions, the first being is scanning the charge card. The current location of the RFID scanner is indicated by a bright green luminous drop with a black ‘e’ in the centre. The drop interface is angled on all products except the HUB, where it is positioned vertically. This drop is also used by the brand Streetplug on the charging stations, where the black ‘e’ comes from the company’s logo.

Small button-like LED indication
The LED indicators show the status of the interaction showing a blue or green colour (figure 14). The LED indicators are located near the product's charging sockets. The word 'near' is specifically chosen since the location of the indicators varies within the product portfolio.

General covered charging sockets
Additional action must be carried out to insert the charging plug into the charging station. The cover of the socket must be lifted to allow the plug to be inserted. This requires two hands. The lid feels solid and closes well when the plug is removed.

Advertisement screens
The media screens on the side are visible when no objects are surrounding the HUB. However, when a vehicle is parked in front of the HUB the visibility of the screen decreases dramatically (figure 15). In addition, the screen is equipped with a UV-resistant film which reduces the heat and the reflection of light. Nevertheless, it is difficult to read the screen when exposed to sunlight because of the reflection (figure 16).

Positioning of the HUB
The positioning of the HUB significantly impacts the advertising screens' visibility. The HUB has no fixed positioning; therefore, each location has to be considered for optimal positioning to get the highest number of views. Furthermore, the HUB also influences the interaction while charging a vehicle. The charging cables can therefore run uncomfortably in front of the interface.

Figure 13. Revolt interface

Figure 14. Sockets and LED indication

Figure 15. Vehicle blocking view

Figure 16. Screen reflection

Figure 17. Logo sticker

Figure 18. Instruction sticker

Figure 19. Bottom texture sticker

Figure 20. Additional sticker

Stickering

On the current products, different stickers can be found for the logos (figure 17), instructions (figure 18), and bottom texture (figure 19). An additional sticker (figure 20 is added in specific cases to allow persons without a charge card to charge. The positioning of the stickers is different on the products and ranges from vertical and horizontal alignment to centre and side sticker alignment.

External stickering company

In all cases, the stickers has been manually added to the product. Fleetshield B.V. is the company that produces the stickers and applies them to the products. The stickers are ISO 9001-2015 certified, indicating that the internal processes are in order and therefore offer a quality guarantee. In addition to production and assembly, Fleetshield registers and archives all services and orders for Revolt.


revolt

02.5 Visual brand identity

The visual brand identity combines visual elements used to express the purpose, mission, and value to its consumers (Digital Brand Blueprint, 2019). This includes brand colours, a logo, fonts, visual language, and content display. The purpose, process, and results of Revolt were discussed textually in the previous chapter but will now be related to the desired visualisation.

Brand Refresh

Before explaining the current visual brand identity, it is necessary to understand that Revolt has been engaged in a brand refresh during the project. Significant visual changes have occurred during the reorganisation of Revolt's identity; therefore, it is essential to explain this translation of identity within the project. Also, the initial purpose for this project stems partly from the fact that Revolt's current products tell a different story compared to their desired message. Currently, there is almost no relation between the physical representation of the products versus the company's purpose, cause, and belief.

The previous chapter discussed the intended textual appearance of the company, which has somewhat changed while redefining the brand. Where some visual elements were still somewhat blurred, they have found a complete definition and elaboration through the brand refresh. In other words, the company's story is now defined in detail, and a future-proof way of visualising has been devised. This new 'tone of voice' and 'tone of visuals' are leading during the HUB redesign.

The character traits of Revolt are incorporated into three main components for increased understanding to ensure the HUB's redesign communicates Revolt's new visual brand identity: Colours, Logos, and Visual language. The components serve as support during the Design and Development phase later in the project.

Brand comparison

It was decided to work out both visual brand identities concisely to see a clear transition between the current design of the HUB and the redesign. Both brand identities have been elaborated based on the three topics communicating the identity. However, it was decided only to show the results of the brand refresh to maintain clarity within the project. A concise elaboration of the old identity can be found in Appendix 6.

Refreshed colors

The new palette (figure 21) consists of four base colours and three accent colours. In combination with white as the new base colour, the cool shades of gray provide plenty of opportunities to create serenity. This calmness is essential because a company wants people to look at its products, services, and images.

The accent colours are to support the brand's recognition. For example, the dark blue colour returns mainly as the primary accent colour and is mainly used as a substitute for grayscale if a backplane should consist of any natural colour. The two brighter shades of accent colours bring the brand more in relation to the market in which Revolt operates. The market is moving fast since technology is always in motion. The forward-looking and dynamic accent colours will help the brand identity be progressive and high-tech.

The gradients can be used in two ways: a white or black background (figure 22). There is an interplay of the accent colours in the gradient that are sometimes complemented by more and less saturated colours. All used shades have been recorded, providing guidelines for the brand's new identity.

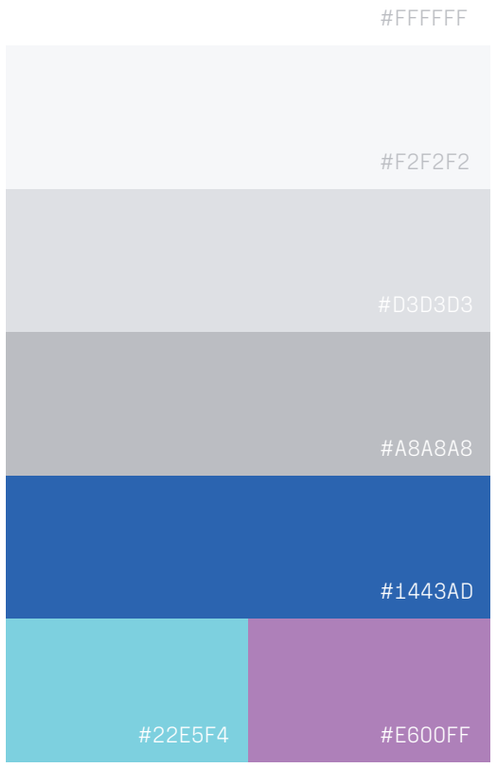
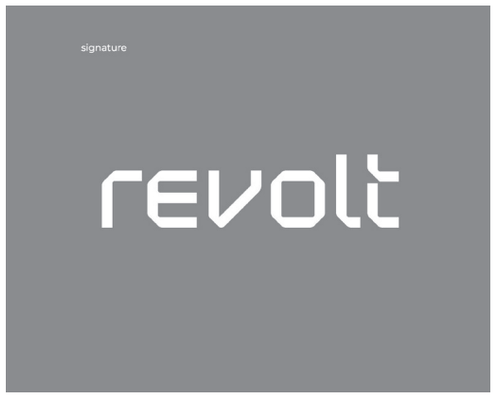


Figure 21. Colour palette

Figure 22. Colour gradients



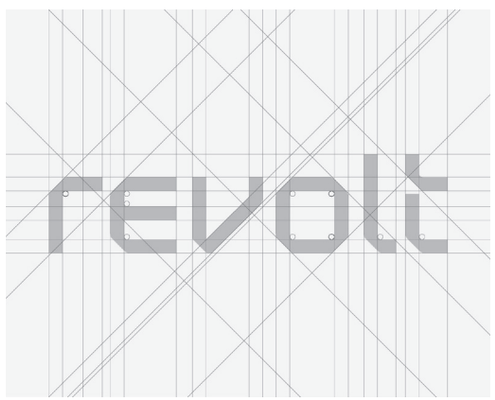


Figure 23. New logo

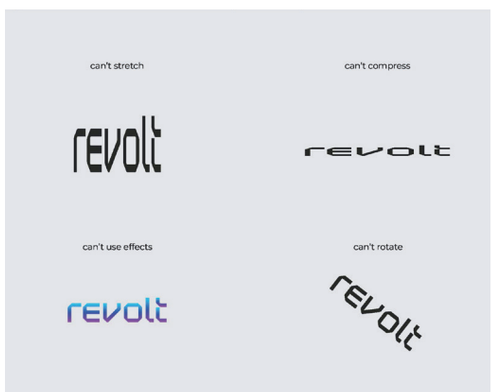


Figure 24. Practical use logo

Refreshed logo

The new logo could be evaluated by drawing up a list of areas for improvement over the old logo. There was a choice between several options, but after multiple rounds of feedback and design iterations, it finally became the one shown in figure 23.

In this case, the logo lends itself perfectly to publications and product use. The proportions of height and length were incorporated into the new design, making the logo look more confident and timeless. Being in line with guiding principles, the logo has a sincere appearance and reflects the technological movement of the company. It is impossible to modify the logo in the new case, as seen in figure 24.

Refreshed visual language

The new visual language plays on the weaknesses of the old character. Three major themes can be found in the new visual material: Sustainability (figure 25), personality (figure 26), and movement (figure 27). Together, these three themes are a visual representation of the company's new vision. The professional imagery gives the company a premium feel, which is supported by the complementary new logo and colour palette. In addition to the premium feel of the brand, additional photography of new partnerships (figure 28) is added to the visual language. The overall tone of the imagery is much calmer, making it appear more mature and wise. Also, only proprietary imagery is used, ensuring that no other company has access to it.

Slogan

The slogan 'we charge the future ' has been reframed to 'we charge the future together' and has been further explained by meanings:

We = we share stories from various audiences who are part of the Revolt journey.

Charge = The sustainable products, locations, and team Revolt that makes everything possible.

Future = We tell our innovative character and share our view on the future.

Together = We do not do this alone, but with our team, stakeholders, partners, and customers.

Figure 25. Sustainability

Figure 26. Movement

Figure 27. Personality

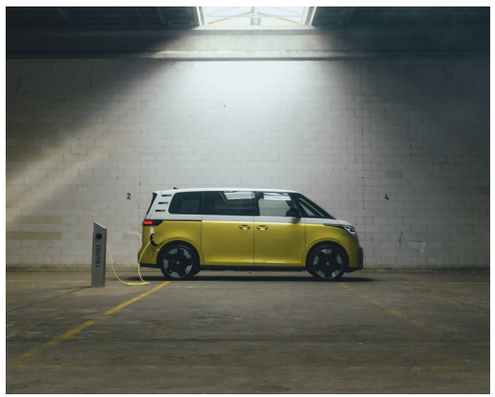


Figure 28. Partnerships

02.6 Company's opportunities

The findings of the company analysis are provided below, categorised along with the four previously established sections. Bullet-points state the findings to secure clarity since the findings are clustered into design opportunities. In Chapter 06, all findings from the deconstruction phase will be clustered into building blocks to use during the design phase. Weaker versions or double statements within the design opportunities were omitted.

Brand values and operations

- Physical translation of the brand's mission and vision to find cohesion between statements and their implementation by the company, e.g.:
  - Aspirational towards the future.
  - Make it feel tangible.
  - Sell the dream of electric mobility.
  - Information provision to increase transparency.
- Make the tone of being leading in the form language and user
- interaction to establish a product-related brand identity.

Product portfolio

- Creating a vision for future product development to increase the product's recognisability and establish Revolt's own identity.
- Similar user interface to increase user interaction.
- Similar user interaction to increase the recognizability.
- Coherent form characteristics for brand recognition.
- Coherent use of logo positioning and colour for product portfolio in order to create unity.
- Coherent use of sustainable materials for product portfolio in order to create unity and translate brand values.

Visual brand identity

- Product-to-consumer relationship to increase the company's loyalty and recognizability, enabling the opportunity for faster growth.
- Balanced use of colours and gradients in order to create unity and maintain a clear overview of subtlety.
- Distinctive but calm form language in order to address a premium, clear, and personal character.
- Form language that supports the premium quality in order to target more corporate-oriented companies to maintain high-quality standards.
- Using visual focus to increase user interaction and intuitiveness of actions.

User groups

- Investigate the requirements and desires of the focus groups:
  - Consumers
  - Users
  - Advertisers
  - Passers-by
- Form coherency in the product portfolio.

Responsibility for being a Brand-driven Innovator

At the beginning of the project, it was observed that a shared understanding of the company's assets was missing, especially product-related information. In order to gather information, it was necessary to call upon every possible person in the company and its various stakeholders. Being sent from pillar to post raises concerns because Revolt intends to move forward and says movement plays a vital role in all assets, which means Revolt wants to drive innovation. This also means that the brand sets in motion a process of change, intending to improve a situation or create value (Roscam Abbing E., 2011).

Being a brand-driven innovator implies two things:

- The brand inspires and sets in motion that process of change.
- The brand challenges the people involved in the innovation process to improve something or create some kind of value.

In Revolt's case, it is as follows:

- Revolt inspires people and starts leading the movement to charge the future of sustainable transportation.
- Revolt challenges employees to develop or improve services or create value for existing services that can charge the future of sustainable transportation.

This results in Revolt fulfilling the function as a bridge between marketing on the one hand and the departments where innovation takes place on the other. The ideal situation for optimal brand-driven innovation is shown in figure 29. While collecting all the current information about the HUB, certain

obstacles were noticed receiving information. The shared understanding of Revolt-related topics was limited to none, which harms the technical development of opportunities for innovative products (figure 30).

The gap between 'the innovation function' and the rest of the company makes it unnoticeable for 'the outside world' to perceive innovative developments, while these should take place at a brand-driven innovator Revolt is endeavouring to be. The company's relationships are based on a shared understanding of value, and a shared vision of how that value can be enjoyed or benefited from (Roscam Abbing E., 2011).

It is not implied that no innovation ever takes place within marketing, but for a brand to inspire innovation, it is inevitable that departments outside marketing will have to be able to work with it and be inspired by it. Two rules can be derived from this understanding:

- Revolt must demonstrate a clear understanding of the people they aspire to do business with and what they find of value. They also have to possess a vision of their organisation's role in delivering that value to their intended users.

- Revolt must capture this value and turn it into actual propositions (products, services or experiences).

The future is too complex to predict what it will look like exactly. The only way to get a grip on it is to decide which role you, as a company, want to play in it. Revolt decided to move sustainable mobility forward and become the challenger in this market. When taking this role, these values should have a strong foundation in its brand's values and products.

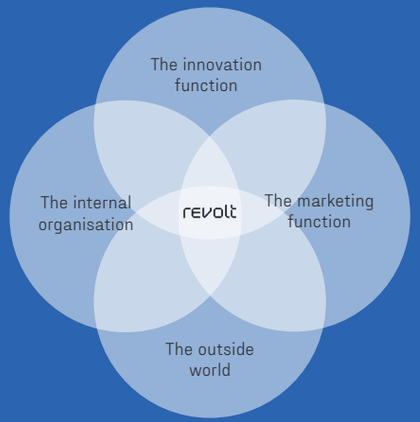


Figure 29. Ideal situation

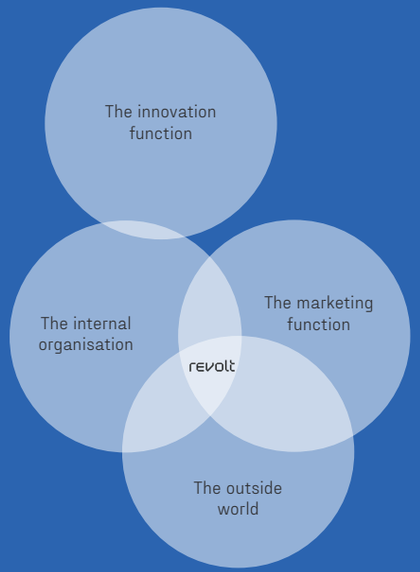
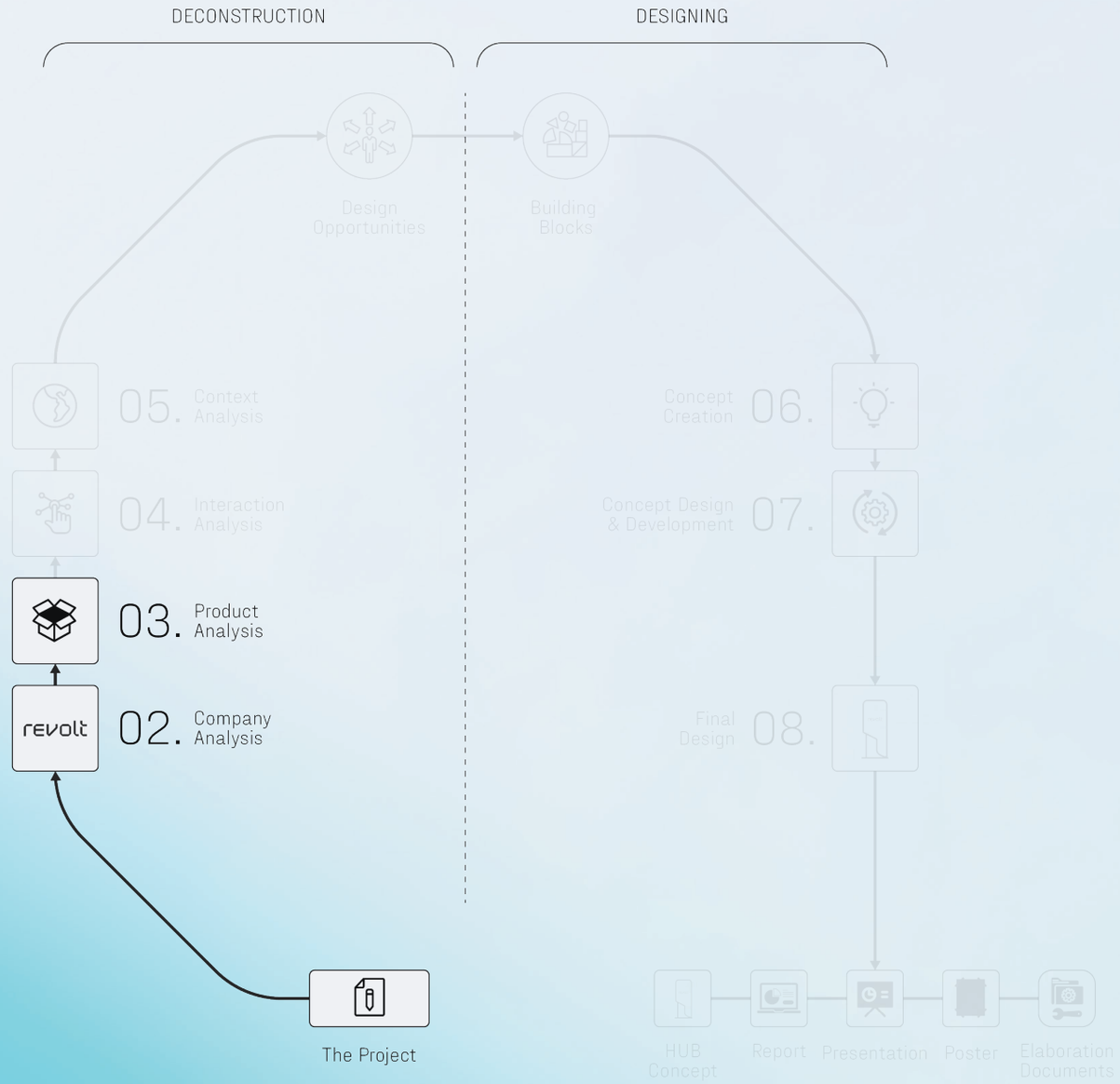


Figure 30. Revolt's situation

03. Product analysis

The product analysis consists of three parts to determine the design opportunities. Firstly, technical analysis will identify the areas that may require adjustments. In addition to purely technical aspects, internal stakeholders are analysed to categorise activities, expertises, and interests. At last, competitor analysis will determine the current market positioning of the HUB.



03.1 Technical analysis

The product has been divided into six sections, based on a co-created SWOT analysis (Appendix 3), to make a valuable and comprehensive technical analysis of the HUB (figure 31):

1. **Component architecture**
The layout of all internal and external components used.

2. **Overall enclosure**
These casings cover the internal components from external factors, e.g., water, dust, and possible hazards.

3. **Climate management**
These internal components air-condition the temperature inside the HUB, preventing freezing or overheating.

4. **Media screens**
The two advertisement screens, including their casing and mounting system to the door.

5. **AC Charging Interface**
The components the user interacts with while charging an EV.

6. **AC Charging & Media components**
These components enable charging an EV and showing advertisements on the media screens.

The sections are categorised based on function and placement. For each section, the components and their current behaviour will be examined. In conclusion, an assessment will be made on what opportunities this offers for the redesign.

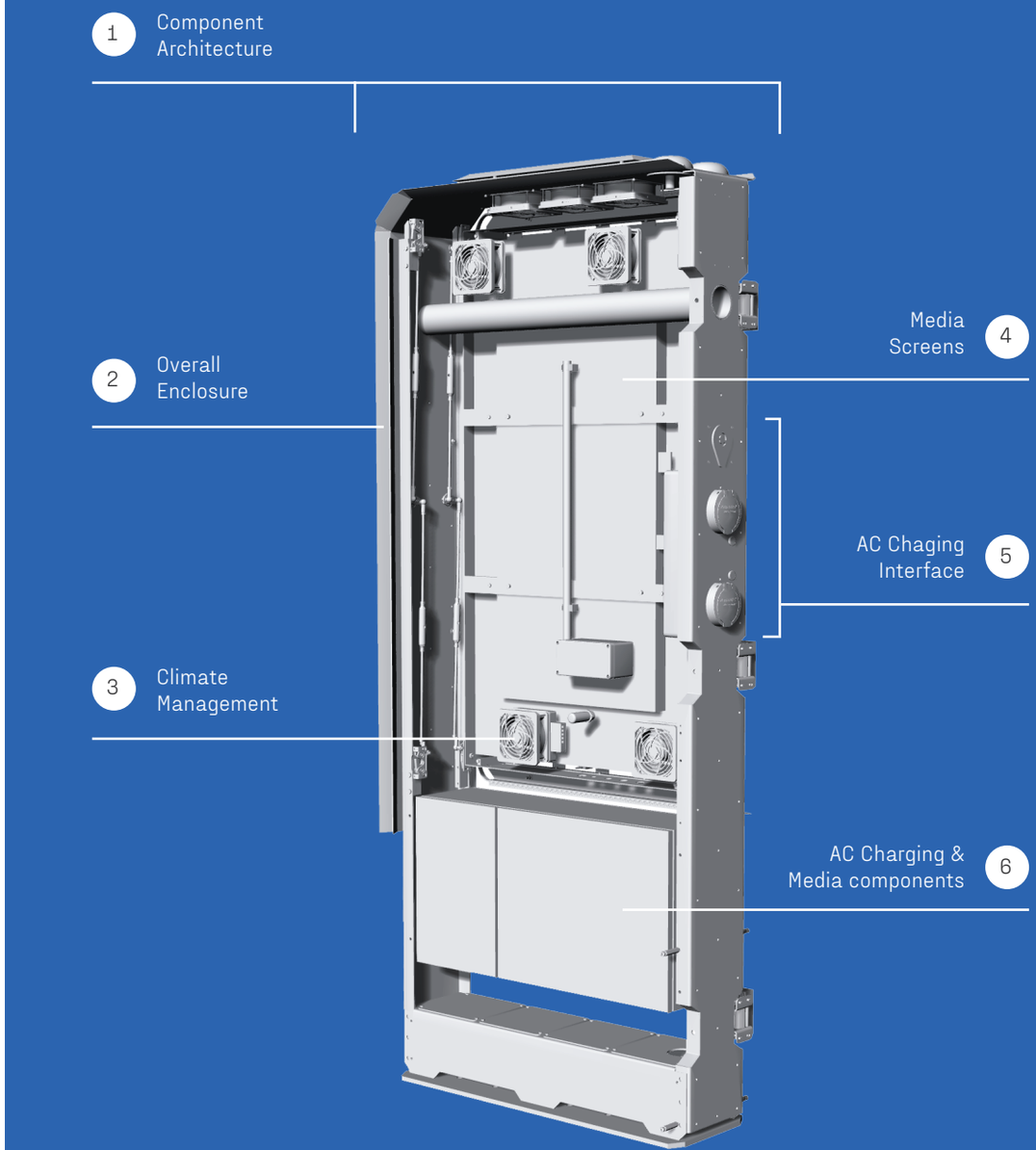


Figure 31. Sectional layout

1. Component architecture

The first step is to look at the general inside of the HUB. The first thing to notice is that many components are enclosed in an extra casing. This applies to the media screens (figure 32), AC sockets (figure 33), and the AC Charging and Media components (figure 34). The case protects the electronic components from water, dust, and other external factors that could cause damage. The IP-certified casings are then connected by electrical wires that provide the components with electricity, connectivity, and data transfer. Remarkably, components that have similar functionalities are not always placed close together. As a result, electrical wires run through the entire product connecting the components.

It is noticeable that some components are pre-manufactured, making them easier to integrate, requiring no calibration, and making electrics compatible for a small production run (Flynn, 2022). However, this only applies to the ventilation grid on top of the HUB and AC Charging components (figure 35). This method of production increases efficiency and makes it easier to implement modifications.

Figure 32. Media screens enclosure

Figure 33. AC sockets enclosure

Figure 34. AC charging and Media components enclosure

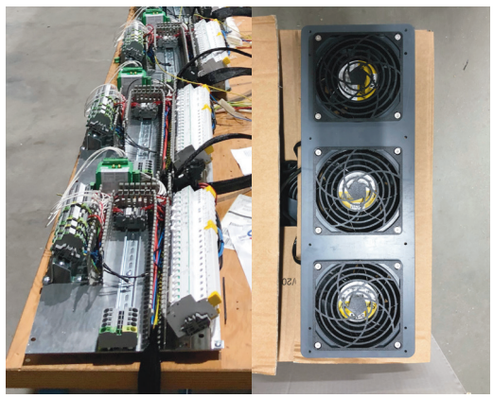


Figure 35. Pre-manufactured ventilation grid and AC charging components

2. Overall enclosure

Materialization

The HUBs enclosure is challenging to manufacture into an engaging design because of the choice of materials. This is one of the reasons why the HUB currently looks rectangular, static, and bulky. Sharp, visibly curved corners and seams make for unsettling detailing. On the outside, the finish looks acceptable, but when the HUB opens, it is noticeable that many plates are welded together by hand or attached in some other way (figure 36).

The enclosure in contact with the outside world is impregnated with a special coating to protect against moisture and dirt, but rust can still be seen (figure 37 and 39). Discussions with the technical experts from PIA Automation have clarified that rust can be caused by fine grinding underneath the coating. While the sturdy and modern look should come across as premium, the irregularities on the surface of the enclosure do not support this. It must be mentioned that the current HUBs are left outside for a maximum of one and a half years, while a consumer's subscription lasts for at least five years.

The consequences of the enclosure's finishing can also be seen inside the HUB. Dirt such as dust, insects, and drops of moisture can be found on the internal casings where the electrical components are located. A remark should also be made here about the tarnished fans that regulate the climate inside the HUB (figure 38). The dirt inside mainly affects the repairability and maintenance included in the subscription. Over five years, Revolt desires to carry out as little maintenance as possible so that they derive minimal costs.

Figure 36. Stainless steel welding

Figure 37. Rust on stainless steel surface

Figure 38. Tarnished fans

Figure 39. Rust on stainless steel surface

Figure 40. Stainless steel edges

Figure 41. Unnecessary use of stainless steel

Figure 42. Unused space around enclosures for pre-manufacture components

Figure 43. Unused space around frame components

Unnecessary use of materials

Extra stainless steel edges are attached to the frame (figure 40), ensuring the two doors at the front and back of the HUB close properly. By closing the doors this way, three stainless steel plates are attached, which results in almost one centimetre of material (figure 41). This unnecessary use of material can be found in several places, especially parts running around corners.

Unused internal space

The HUB has specific dimensions, mainly based on the size of the screens, the lifting beam, fans, and the AC Charging and Media components. Because the width is an accumulation of the thickness of the screens and the lifting beam, this dimension causes a large amount of unused space in other places, e.g. around premanufactures components (figure 42). This is extremely unfortunate, as an optimisation of the space could benefit the overall design of the HUB. There is space left between the screens and at the sides and bottom (figure 43). Because all components are placed in a separate casing, the freedom for optimisation has been minimalised.

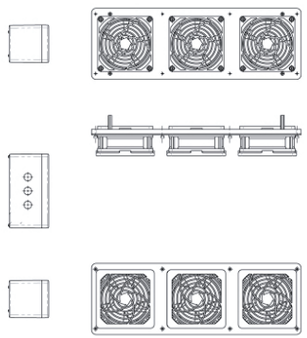


Figure 44. Installed fans for climate management

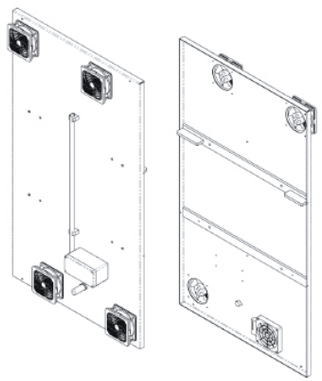


Figure 45. Fans mounted to media screens

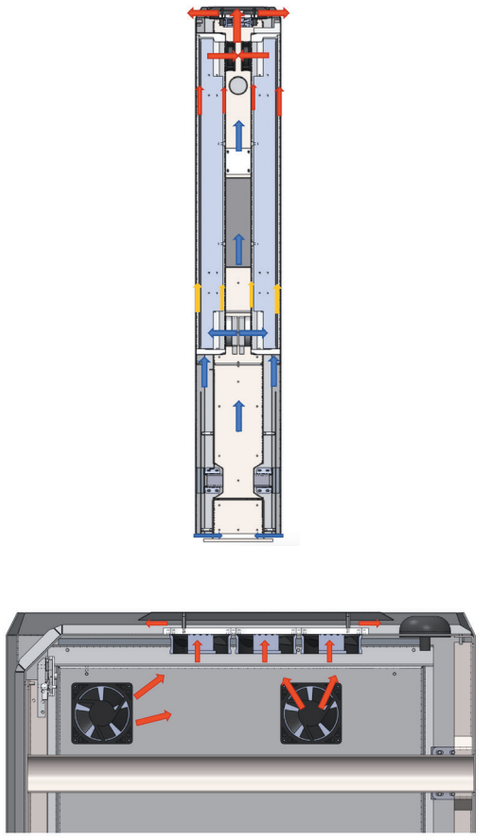


Figure 46. Airflow for climate regulation

3. Climate management

To provide cooling for the screens and components, twelve fans (figure 44) have been mounted in the HUB to prevent them from overheating. Most attention is paid to the media screens, where four fans are mounted on each casing (figure 45). The current airflow (figure 46) through the HUB uses the outside air to cool components. The air enters the HUB at the bottom, running through openings constructed in the frame. The two fans on the bottom of the media screens ensure a supply of cold air pulled upwards at the front and rear of the screens. The two upper fans then remove the heated air. However, the heat displaced from the formwork of the screens is still in the HUB. The three extra fans on top of the HUB allow the heated air to be discharged outside. These three fans are designed in such a way that the user is not able to see them from the ground.

Air supply

Within the climate management of the HUB, each component must be carefully examined, whether cold air has to be supplied or warm air has to be exhausted. With the possibility of displaying advertisements, the current media section only generates heat and needs a fan to dissipate it (Delhez, 2022).

4. Screens

The two Dynascan 55” 4000 nits fanless high brightness digital signage displays make it possible to show stationary and moving advertisements on the HUB. The screens have a built-in media player and a high number of nits so that there is still good readability even during high sunlight. In addition, the screens do not have built-in fans, also called passive cooling. In this case, the heat leaves the product naturally and is not stimulated by, for example, fans or other active air currents that remove heat from the product. As a result, the screens need an external heat removal system that removes the heat around the product.

The heat generated by the screens exits the screen casing at the back through special ventilation gaps. However, heat is also generated at the front by the LCD screens. The heat cannot be easily extracted at the front because a glass plate is sealing the screen off from the outside world. This positive effect is that the screen cannot be damaged or humidified but does generate extra heat. As a result, heat must be dissipated from the front and back by a cool external airflow to prevent overheating. The front of the screen has priority, as this is where most heat is generated.

Heating

Besides cooling, the screen may also need to be heated in a cold environment. The screen develops heat, but only when the screen is on. In theory, the advertisement screen does not switch off, but a personal arrangement can change the statement. In this case, no more heat is generated, and an external heat supply is needed in cold environments to enable the screen to start up. Currently, this is done by a heating element located at the rear of the screen casing. The heating element heats an aluminium backplate that conducts the heat and warms the entire back of the case. This will not be necessary if there is a stable climate inside the HUB (Kevin Delhez, 2022).

Mounting

The current screens are attached to the HUBs doors and closed by a large aluminium casing. The casing was developed to protect the screen from dirt and moisture and to provide the right climate. Because the screens are hanging from the door, they become cumbersome and solid hinges are needed to hold the weight (figure 40).

About carrying out any repairs and maintenance, several screws must be removed before the backplate can be dismantled. After removing the backplate, the screen can be removed from the casing with a special manoeuvre. This step is relatively simple because special clamps are attached to the top to make this possible (figure 48).

Figure 47. Media screen

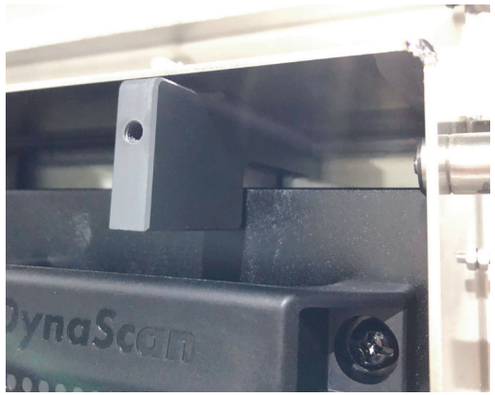


Figure 48. Special clamp to secure the media screen

5. AC Charging Interface

Several components of the AC Charging Interface of the HUB must be used to charge an EV (figure 49). The interface consists of three components: the RFID droplet, the LED indicator, and the charging sockets. These are all components needed to make an AC charging session possible in terms of the interface. Further information on the interaction and investigation at other charging stations can be found in Chapter 04.

1 *RFID droplet*

The charge card/tag must be scanned at the RFID drop to initiate a charging transaction. The scanner is located at the top of the HUB. The RFID droplet is equipped with a PCB with LEDs that ensure that the droplet can emit light. In addition, the PCD is processed in a plastic mould which protects the PCB from unwanted external factors and dims the LED's light. The PCB is custom-made, making it possible to add extra LEDs and position them in different patterns. The mould used to make the plastic casing can be adjusted accordingly.

2 *Charge sockets*

For the HUB to transfer power to the vehicle, the plug must be connected to one of the two sockets. The sockets are 'off-the-shelf' components of the Mennekes brand. The sockets give a solid feeling during use due to the material used and the strength of the spring used to close the lid.

A socket may be wet, causing water to enter the socket. If this is the case, the water is drained off by a special outlet that releases it into the socket's casing. The casing ensures the water falls into the HUB through a hole on the bottom.

3 *LED indicator*

The LED indicators on the interface visualise the interaction state to the user. The universal off-the-shelf LEDs have a button-like appearance and can be found in all products in the product portfolio.

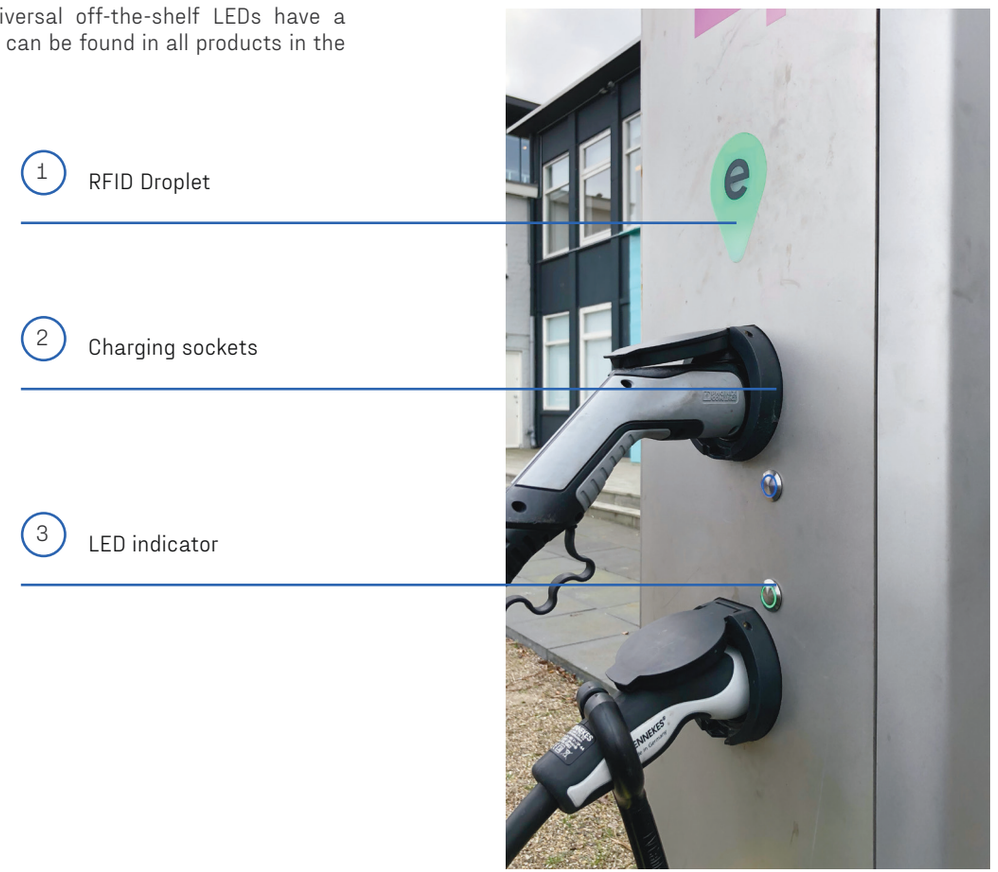


Figure 49. AC charging interface components

Figure 50. AC charging and media infrastructure

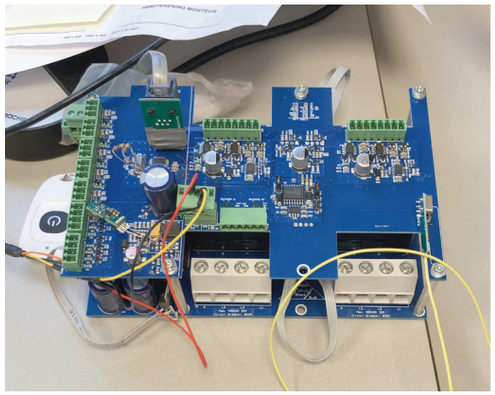


Figure 51. Prototype of new controller

Figure 52. Server

Figure 53. Router

6. AC Charging & Media components

The casing containing the components for enabling electric charging and displaying the advertisements is made to measure. The HUB dimensions do not match the available universal electricity cabinets. In other words: Function follows form.

AC Charging components

Currently, there are two departments to make electric charging possible, the interface and the charging components. The second group takes care of converting the current to be transferred to the vehicle through the sockets and plug. The current infrastructure for electricity conversion enabling EV charging is quite large (figure 50). At the time of research, Streetplug is developing its own controller, which will be more than half the total size of the components (figure 51). In addition to the controller, the only components required will be a relay and a KWh-meter, initially for the number of sockets. The current and future components do not generate significant heat and therefore do not need to be cooled.

Media components

The media components consist of a server (figure 52), a router (figure 53) that receives data, and an antenna. All of the components are universal products provided by Windside Digital.

Energy usage

The six established categories' analyses cover all Hub's internal and external components. However, one important element is still missing, encompassing all the investigated categories: component-based energy consumption. While this project is supported by two important pillars, user-friendliness and sustainability, the remark must be made on whether this concept is the optimal combination of EV charging and outdoor advertising. Revolt states that its mission is to make clean energy available to everyone, everywhere and at all times. This excludes that the product should also be environmentally friendly, but by raising this point, the question is put on the table to look for possible solutions for its startling energy consumption.

All internal components of the HUB together use an amount of 345 Watts of energy per hour (Streetplug, 2022). The advertising model is based on the screens of an installed HUB are always switched on, whether day or night. This statement results in the HUB consuming about 3022 kWh of energy per year. This amount is almost equivalent to an average household (3000 - 3500 kWh) in the Netherlands, based on three individuals (Engie, 2022) or charging over 52 Volkswagens ID.3's (EV database, 2020), based on a 58 kWh battery pack. Nevertheless, this only applies to the HUB to display advertisements to passers-by.

Another major energy consumer is the required air conditioning inside the HUB. Of course, it is essential that components have to be cooled or heated to ensure proper operation. However, whether this aligns with the company's core values is questionable. Note that the charging facility for AC charging does not require cooling. This distinguishes between the essential components to enable electric charging and the additional components for displaying advertisements. Apart from the media screens, the energy consumption of the fans is the highest of all product components.

Investigating solutions or alternatives lies beyond this project's scope but should certainly be given attention if the project is further elaborated. The energy consumption of the HUB casts serious doubts on whether the entire concept aligns with the sustainable energy transition and the corresponding values established by Revolt (figure 54).

Energy compensation

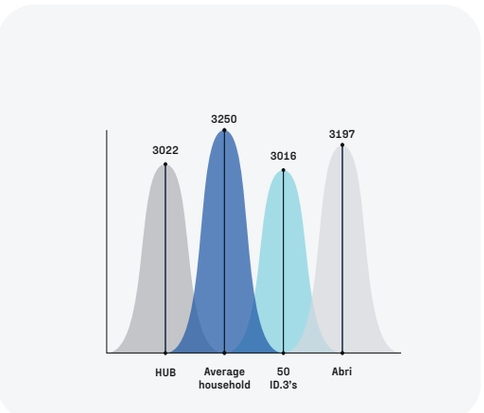
As previously concluded, clean energy does not generate any greenhouse gases during production. Revolt claims to make clean energy available anytime, anywhere. Besides the energy consumption of the HUB, this combination makes the kind of electricity used by the HUB also relevant.

Currently, the electricity supply used to display advertisements is determined by the customer's energy provider (Revolt, 2022). Hence, it is uncertain what the electricity's composition is when it comes to the origin of the electricity, i.e. a mix of green and grey electricity. It is challenging to make a statement about the compensation for the energy used by the HUB because this only concerns electrical appliances. The reason to convert the energy consumption is necessary to find possibilities to compensate for the consumption if the electricity supply remains unchanged.

In order to assess the HUB's carbon emissions, the average carbon emissions during the generation of energy in the energy sector in the Netherlands are used. This assumption is made because of uncertainty towards the consumer's energy provider. By calculating the average number, an indication of the impact can be made.

Considering the carbon intensity of the electricity sector in the Netherlands in 2021, 325 grams of carbon dioxide were emitted

Figure 54. Energy consumption



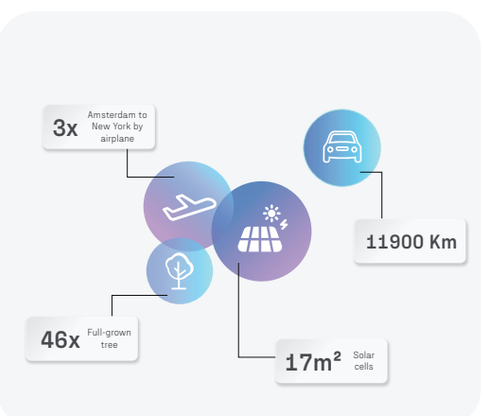


Figure 55. Energy compensation

to generate 1 kilowatt-hour (gCO_2/KWh) of electricity (Statista, 2022). This means that over 980 kilograms of CO_2 are emitted to power the HUB for a year. In 2020, the average CO_2 emission of newly sold passenger cars reached a value of approximately 82,5 grams per kilometre (ACEA, 2021). This amount applies to the cars sold in the Netherlands. To provide a representative image of the impact: the energy consumption of the HUB can drive more than 11900 km. All data are calculations on an annual basis.

So in order to be able to comply with the vision drawn up by Revolt, some form of compensation will have to take place if the type of electricity supply keeps uncertain. It is unacceptable to state that clean energy will be made available when all factors are uncertain. The only certain factor is that the ruling currently being made is irrational.

As a concession to the statement, it is possible to compensate for carbon emissions through various initiatives (figure 55). For example, it is possible to plant trees or install solar panels. A fully grown tree absorbs an average of 21 grams of CO_2 annually. This means that more than 46 full-grown trees are needed to compensate for the carbon emissions of the HUB.
mpensate for the carbon emissions of the HUB.

Findings: Technical analysis

Extensive and ineffective ventilation grid
The extensive ventilation grid is unnecessary if there is a controlled airflow through the HUB. This will help reduce the number of fans and thus save energy and costs.

Premanufactured control management
The AC charging infrastructure is pre-manufactured, allowing easy customisation and a reduction of development costs and production time.

Custom-made electrical cabinet
The cabinet in which the AC charging infrastructure is located is currently custom-made. Custom-made products in small quantities result in more intensive production processing and, therefore, an increase in costs.

Screen enclosure on the door
The frames in which the media screens are cased increase the door's weight considerably. Due to the weight, large and expensive hinges are required that must be mounted on the frame. Therefore, not only is it necessary to have a solid door but also the frame must be able to bear this weight. Note that the weight increases as the door opens further.

Inconsistency in used space
The placement of the components seems largely a consequence of the frame's construction, instead of the other way around. This makes possible further optimisation of the layout and, therefore, space-saving between components.

Unnecessary use of materials
Because the frame is part of the enclosure in some places, it sometimes happens that three layers of material are attached on top of each other. By separating the frame and housing and allowing them to perform their original function, the applicability of modifications is increased, and a material reduction can be achieved.

Labour intensive material processing
The entire enclosure is made of stainless steel sheets that do not lend themselves to any organic form language. In this case, round forms require intensive and manual material processing, which must be repeated for each product.

Sentitive material for enclosure
Despite the impregnation of a special anti-oxidation coating, the material of the enclosure still allows the development of rust and surface irregularities.

Inside components affected by environment
The incomplete sealing of the HUB's enclosure allows moisture, dust and vermin to attack the internal components.

Custom-made frame
The steel sheets require specific settings on a laser machine capable of machining sheet steel. After this, the parts are bent and assembled if necessary. The current manufacturing method offers the possibility for modification because of low investment costs. Frame adjustments are beyond the scope.

Cause and consequence
The overall enclosure is not water or dustproof; therefore, the screens must be covered by an extra casing. Consequently, the cooling airflow for the screens' passive cooling is disrupted. Four extra ventilators are needed to provide enough airflow to cool down the screen inside the casing. Since this has to be done for both screens, there is an increase in energy consumption, a decrease in internal space, and an increase in the overall thickness of the HUB.

The overall enclosure being part of the frame is another cause with severe consequences. The integration of both parts makes it hard to decrease the thickness of the HUB since the lifting beam interferes with this significant adjustment. Designing an independent frame, having the ability to be lifted, together with separate water and dustproof enclosure, enables the design to decrease in width significantly.

03.2 Internal stakeholders

A stakeholder analysis is conducted to understand individuals and organisations' behaviour, intentions, interrelations, and interests to assess decision-making or implementation processes. Only stakeholders concerning the redesign of the HUB will be taken into account.

This analysis's information will help assess the feasibility and viability of implementing founded design opportunities. Table 2 and 3 provide the findings of the stakeholder characteristics around the development of the current HUB.

	ACTIVITIES	EXPERTISES	EMOTIONAL INTEREST	FINANCIAL INTEREST	OPPORTUNITIES
Pon Holdings	- Providing capital - Investing professional resources and tools.	N/a	5	5	- Increase trust by increasing sales by offering a future-proof product portfolio.
PIA Automation	- Construction and design of hardware and electrical panels.	- Hardware engineering - Software engineering - Electrical panel manufacturing	3	4	- Assembling modular hardware panels.
Verborg Engineering	- Design of the current HUB. - Processing and manufacturing of sheet metal.	- Design of machines, controllers, and equipment. - Manufacturing of components and equipment.	1	2	- In-house (by Revolt) product design.
Streetplug	- Current supplier of the ONE. - Provision of the components for the charging facility.	- Charging technology development. - Electric Charging Platform.	3	3	- Utilize current resources. - In-house design of the Revolt ONE. - As Revolt grows, more and more tasks can be taken over.
Unica	- Installation of the HUB.	- Allround technical service provider.	1	2	- Increase the ease of installation of the HUB.
Windside Digital	- Provision of the components for the media department.	- Digital Signage. - Narrowcasting. - Programmatic Advertising.	1	2	N/a
Groundplug	- Construction and installation of the foundation.	- Foundation engineering.	1	2	N/a

Table 2. Stakeholder characteristics

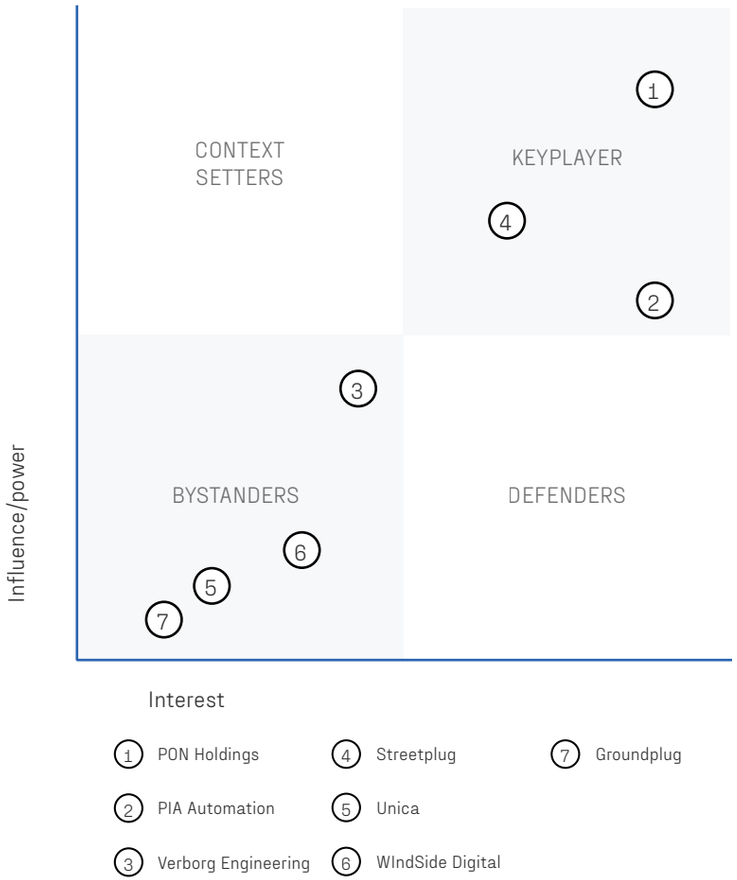


Table 3. Stakeholder analysis matrix

Findings: Future task division

Currently, there is considerable uncertainty and lack of clarity regarding the task distribution within the product development process. Revolt hands out the decisions because there is currently insufficient knowledge to make these choices independently. This includes materialisation, design and the technical development of products. In order to make Revolt excel as a brand-driven innovator, the redesign of the HUB must consider a transparent task distribution. This task distribution is based on the most efficient combination between the stakeholders' expertise and the required tasks to be carried out. It is crucial that Revolt divides the tasks and can do the decision-making themselves. It is, therefore, necessary that sufficient knowledge is available within Revolt to allow the decision-making on product innovation. Internal decision-making reduces uncertainty and lack of clarity in the task distribution. In addition to redesigning the HUB, it is essential to evaluate this for all products to approach everything similarly.

It should be noted that Revolt is currently a start-up, and other tasks may take priority. However, the internal pressure to further develop the products and reduce costs to maintain a profitable business model calls the prioritisation into question. Currently, the HUB, with a cost of EUR 21,684.66 (ex. VAT), is extremely high, leaving aside the ONE, with a cost of EUR 2450 (ex. VAT). In addition to these two products, two other products, the WALLBOX 1 & 2, are currently being prioritised for a redesign.

Therefore, it can be concluded that the current products do not provide the desired comfort and need to be researched to save costs. Because the manufacturing and production are located at Streetplug, they do not assign this the desired priority. Since Revolt only buys these products, this step should be initiated by Revolt.

03.3 Competitors

This section focuses on a competitor analysis serving as a critical component for strategic thinking and decision-making in shaping a competitive marketing advantage. All comparable products related to the HUB are considered and evaluated. First, a list of comparable products has been established after a Harris profile has assessed them by a list of requirements (Appendix 17).

Comparable products

The concept of a multimedia charging station is not a well-known phenomenon at the beginning of 2022. Therefore, the requirements of certain product-related features have not yet been specified, and everyone can assign a different meaning to it. In order to be able to analyse comparable products, conditions have been established regarding the essential components that a multimedia charging station must consist of:

1. At least one AC charging opportunity to charge an EV.
2. Two screens available for outdoor advertising.

Early-stage of development

A note should be made about the development of the existing comparable products. Integrating a charging facility with an advertising column is a relatively new concept. Therefore, some products are in a highly early phase and difficult to compare with further developed variants due to the limited information available. In order to make a fair and well-founded analysis, all information regarding the requirements for the assessment must be available. This implies that a company actively offers the product in the market, i.e., the product can be ordered. With this, models for tests and pilot studies are excluded.

Harris profile

A Harris profile has been established to assess current competitors' products. A Harris profile is a graphic representation of the strengths and weaknesses of design concepts concerning predefined requirements (Delft Design Guide, 2020). Besides using the model for concept design, it is also possible to evaluate comparable products, as long as the requirements remain identical for each evaluation.

The requirements for the Harris profile (Table 4) are based on the most critical product-related factors that play a part in purchasing an electric charging solution (Revolt, 2022). Note that this excludes the proposition of the products, thus the financial and subscription benefits, since this is beyond the scope. Therefore, the Harris profile's outcome may differ from a known final customer's decision, who selects the financial benefits over product features.

All requirements are ranked in order of importance, and even numbers are used to prevent neutral scoring. The two most competitive products, Volta Charging and Volt-E, can be seen in figure 56, 57, and 58. All other performed profiles can be found in Appendix 7 and 9.

Ease of use	The degree of naturalness to operate the charging station.
Charging type	Representation of the diversity of connector types (sockets).
Charging speed	Representation of the power outputs of available sockets.
Provision of information	A process within which information is provided to users.
Suatainability	Degree of environmental impact of the charging station.
Overall appearance	Degree of emotional impressions cause by the charging station.
Advertisement	The degree of advertisment opportunities

Table 4. Harris profile requirements

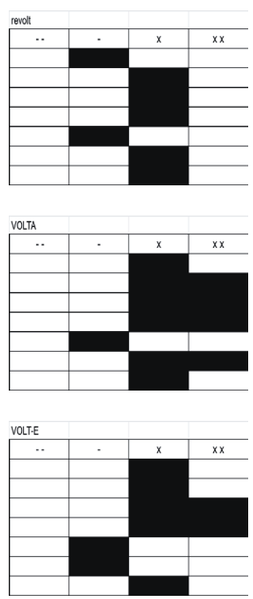


Figure 56. Most competitive profiles

Figure 57. Volta charging

Figure 58. Volt-E

Findings: Competitors

The results of the profiles display significant differences. Although some score well on information provision, it does not mean that ease of use is equally good. Considering the results of the two most significant competitors, the charging station of VOLTA stands out from the rest. This difference is mainly because the charging station is available in both AC and DC versions. As a result, it satisfies the customer's wishes, especially regarding the type and speed of charging. The LED strip adds a dynamic look to the charging station, emphasising its finishing. The use of natural concrete texture, along with dark plastic, creates a modern and reliable appearance.

Regarding technical implementation, the VOLT-E charge post is well thought out. The possibility to set the number of kW gives the user extra flexibility. However, the charging station requires some improvement, especially in terms of appearance and sustainability. Many stickers on the charging station create an industrial look, making the product appear unattractive. This appearance is emphasised by the cabinet being made entirely of stainless steel without a distinctive design.

For the Revolt HUB, the most strategic advantage can be gained in interaction, type of charging and information provision. Like all other charging stations, little attention has been paid to the sustainability factor with the HUB. By putting a product on the market that fully enhances the user experience in an environmentally friendly way, a strong advantage can be created over the competitors. A mature design and the use of natural-looking materials should ensure a calm but solid appearance. In addition, it can be made more attractive for advertisers if an extra form of advertising is added. This could be achieved, for example, by listing advertisers on the website and future in-app advertising. The outcomes of the method are used to develop design opportunities to gain a strategic advantage.

03.4 Product opportunities

Technical analysis

The use of stainless steel sheets makes the current design very labour-intensive, consuming much time and money. The unnecessary use of materials is also a significant cost factor, especially with the recent price increases in the steel industry. The enclosure is not entirely water, and dustproof, which affects its climate regulation. There is no stable climate, which requires the extensive installation of fans. Components are corroded by external factors, which means that this type of finishing and detailing puts future repair and maintenance costs at risk. The construction of the current frame is not optimal for the placement of the components, which significantly increases the dimensions of the HUB. A great deal of modification is required to apply future innovations in charging technology and enclosure materials, which will have its aftermath until a thorough redesign prepares the HUB for this. Based on the technical analysis findings, the following design opportunities were identified:

- Water and dustproof casing enabling optimisation of the component layout.
- Optimised climate management system to decrease energy usage and amount of used components.
- Repositioning components in order to optimise internal space and decrease total volume.
- Clustering parts into modular components stimulate efficiency and lowers production costs.
- Using premanufactured and off-the-shelf components decrease production intensity and lower production costs.
- Increase the use of sustainable materials to decrease carbon footprint.
- Future-proof frame construction enables modifications for technological developments without significant frame modifications.

Stakeholders

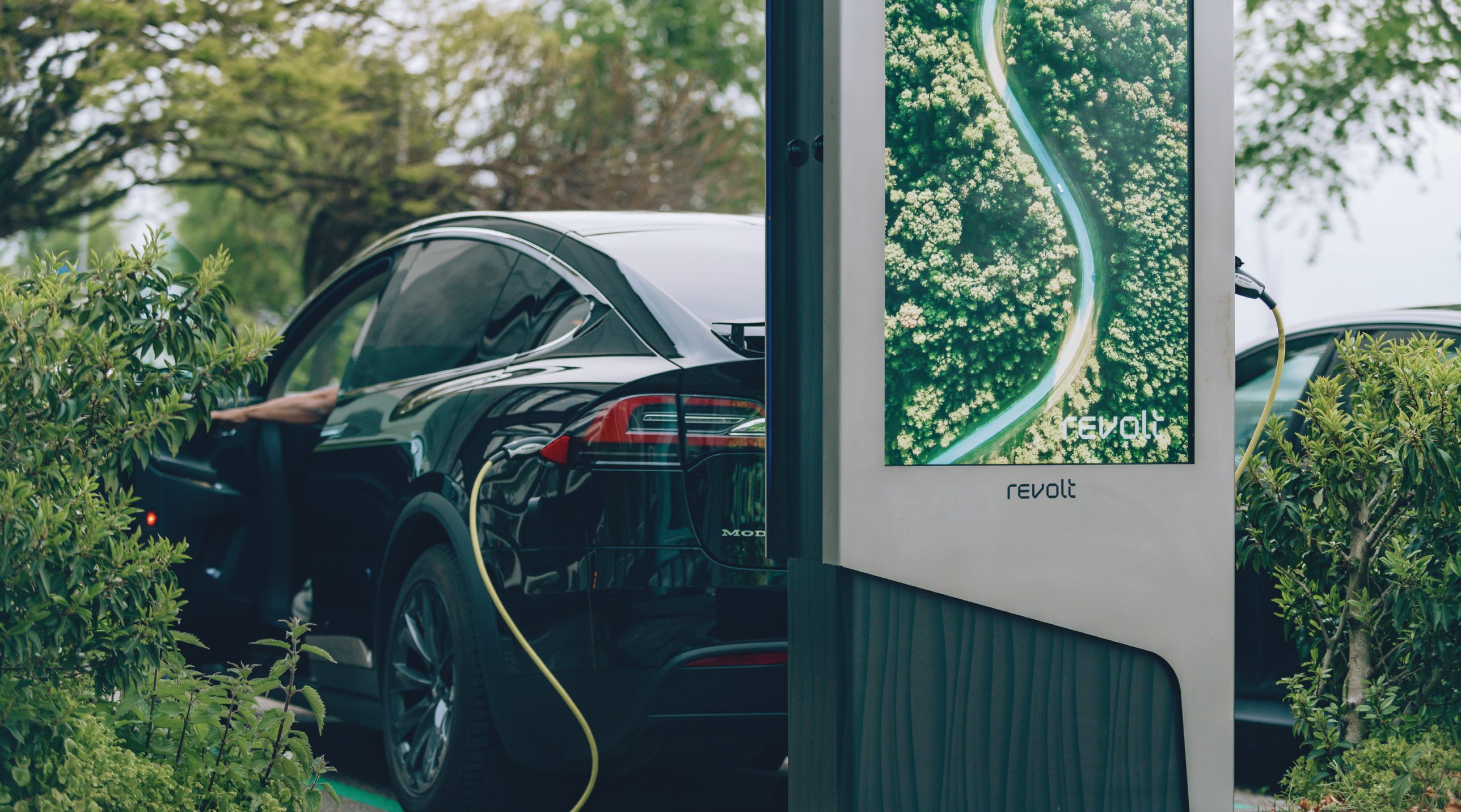
The current design of the HUB has emerged from several iterations applied to previous problems. Due to the ever minor manual adjustments, the production of the HUB has become intensive. Different partners were involved simultaneously and worked together on the design without a real vision. A solution was missing combining different design flows and visionary directions to solve the core problem. The presentation of the stakeholders' activities, expertise, and interests shows where possible opportunities might arise. The following design opportunities were identified:

- Bridging the gap between sales, marketing, and innovative engineering to become a real brand-driven innovator.
- In-house design of all products for the consumer market to effectively control product innovation.
- Clear task division based on expertise to increase efficiency and eliminate misunderstanding.
  - **Revolt:** Internal and external concept design of the HUB.
  - **PIA Automation:** Modular hardware and enclosure assembly.
  - **Streetplug:** Internal hardware and software development.
  - **Verborg Engineering:** Frame manufacturing and assembly.
  - **External manufacturing company:** External enclosure development.
- Making design choices internally, stakeholders depend on Revolt rather than the other way around.
- Taking the first steps towards a complete in-house HUB production to increase cost-efficiency.

Competitors

There are currently few market competitors offering comparable products. With the entry of the biggest competitor, Volta, into Europe, steps will have to be taken quickly to compete. Many companies are developing similar products that put pressure on taking innovative steps in terms of quality, product portfolio, and user interaction to give Revolt a significant competitive advantage. Based on the findings of the stakeholder analysis, the following design opportunities were identified:

- Improvement of the overall design and detailing to increase the quality of the product distinguishing itself at the product level.
- Unique user interaction to build brand loyalty and make users acquainted with other future products from Revolt.
- Customisation by type of charging and market segment to tailor the product to the customers' needs.
- Quality and coherency with other products within the product range to build a recognisable and trusted product portfolio.
- Real-time information about charging puts the user at ease and reduces anxiety during charging.
- Physical AC and DC charging cables increase the ease of use.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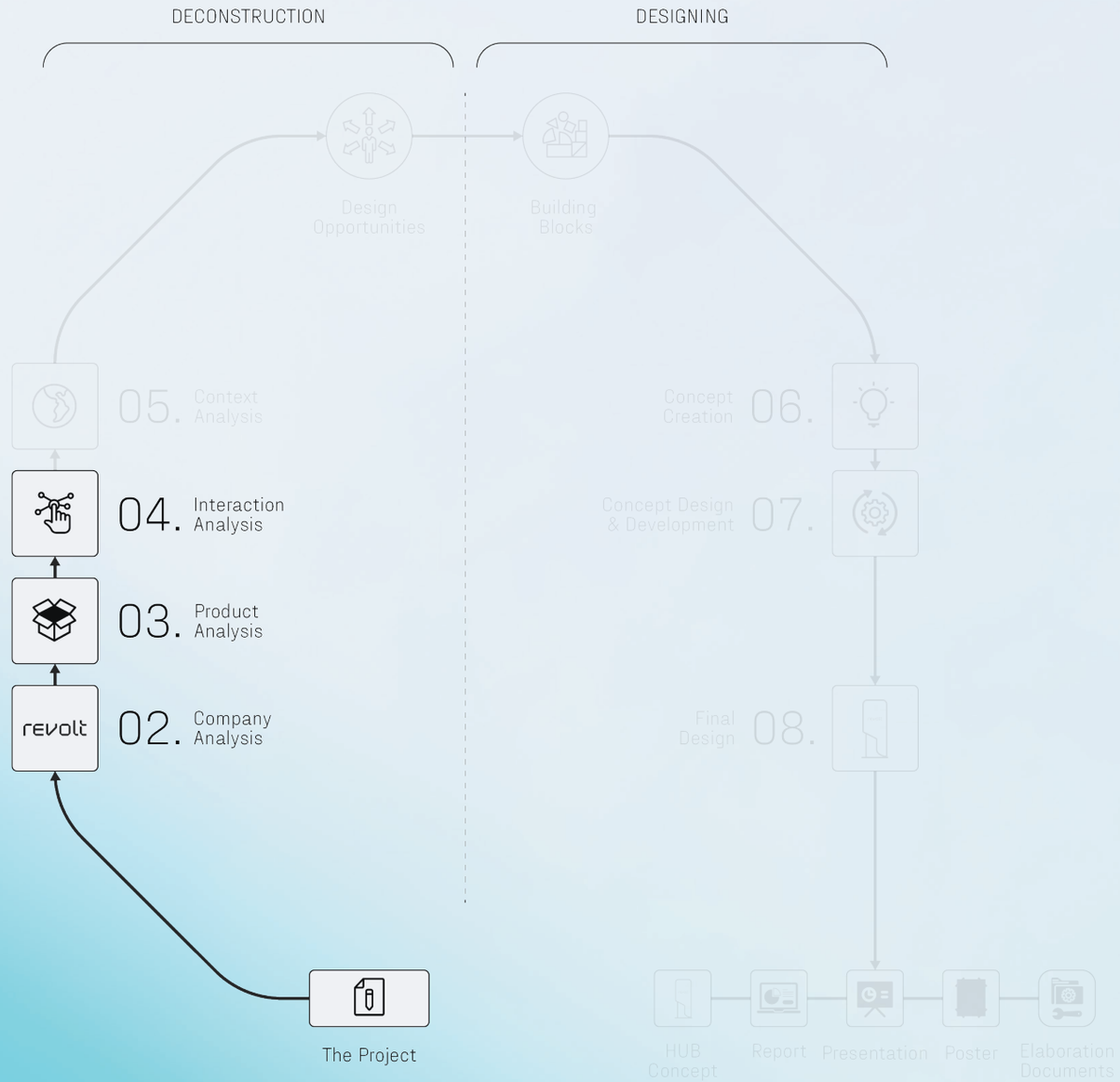
04. Interaction analysis

After analysing the HUB in isolation, this chapter is about the product in use. First of all, the core principles of an interaction will be researched to gain sufficient knowledge for the designing phase. Subsequently, the interaction of the HUB will be examined after the interaction of other popular EV charging stations will be investigated. The consumer's perception of the product will be considered since people can also have non-physical interactions. Finally, design opportunities will be created to support the concept design phase before the decision-making process.



04.1 Product experience

The interaction with a product contributes to the complete user experience. In order to design an interaction, it is inevitable to understand the nature of an interaction. Following Desmet and Hekkert (2007), we distinguish three components or levels of product experience: aesthetic pleasure, attribution of meaning, and emotional response. Because the HUB is used physically and non-physically, an elaboration of the concepts helps to understand the impact the appearance can have on users' senses. The obtained knowledge will then be used in formulating the user research criteria and designing the new interaction.

Aesthetic pleasure	-	The degree to which all our senses are gratified.
Attribution of meaning	-	The meanings we attach to the product.
Emotional response	-	The feelings and emotions that are elicited.

Aesthetic experience

At the aesthetic level, we consider a product's capacity to delight one or more of our sensory modalities (Desmet, P. M. A. & Hekkert, P., 2007). For example, a person may be impressed by the soft and organic texture of a bar of soap, the smell of freshly cut grass, or the deep rumbling sound of an Italian sports car.

Experience of meaning

When it comes to the experience of meaning, it primarily plays into cognition. Through cognitive processes, like interpretation, memory retrieval, and associations, we enable ourselves to recognise metaphors, assign personality or other expressive characteristics, and assess products' personal or symbolic significance (Desmet, P. M. A. & Hekkert, P., 2007). Think of a new chair that reminds you of your childhood, a display that makes you think of a touchscreen, or a heating lamp that looks like a sun.

Emotional experience

At the emotional level, we refer to those affective phenomena typically considered in emotion psychology and in everyday language about emotions, love and disgust, fear and desire, pride and despair, to name a few (Desmet, P. M. A. & Hekkert, P., 2007). Emotional experiences include a phone that refuses to charge, a building constructed entirely of renewable building materials, or new shoes that are completely covered in mud.

Particular experiences may activate other levels of experience. An experienced meaning may give rise to emotional responses and aesthetic experiences, and vice versa (Desmet, P. M. A. & Hekkert, P., 2007). For example, one might become proud of ownership or unconcerned about a subscription when they have to choose between buying or subscribing to a product/service. It is also possible that a product with an appearance can cause a particular emotion or experienced meaning. For example, a wall covered with exotic plants can make you feel relaxed or remind you of a holiday.

The basic model of product emotions

The model of product emotions (figure 59) used during this project is derived from the appraisal theory of Desmet (2002). The model explains that the emotions resulting from an interaction with a product consist of three universal key variables. The leading variables in the process are a concern, a stimulus, and an appraisal.

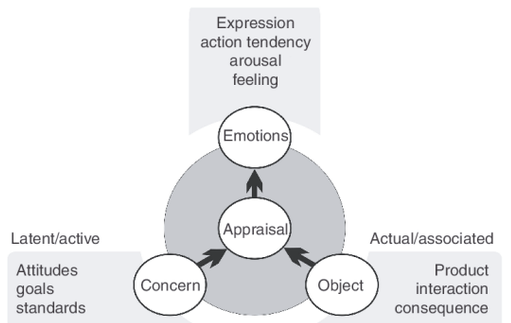


Figure 59. The model of product emotions

The model illustrates that a user has a particular concern. This concern could be, for example, arriving on time at an unknown destination or the fear that an EV is not fully charged. Concerns are the dispositions we bring into the emotional process, and products are construed as emotionally relevant only in the context of one's concerns (Lazarus, 1991). The user then interacts with a product, followed by an appraisal. This appraisal generated by the interaction evokes a consecutive emotion as a response. Different people, who assign different meanings to a particular product, will most likely have different emotional responses (Desmet, P. M. A. & Hekkert, P., 2007). Nevertheless, it is good to recall that one is a consequence of another. As a result, an interaction is challenging to design because each individual judges differently about it, but understanding the fundaments of interaction will further support the project.

04.2 HUB interaction analysis

Poka Yoke

Poka Yoke originated from Japan and was introduced by Shigeo Shingo as part of the Toyota production system. Poka means “unintentional error”, and Yoke means “prevention”. It is not about detecting or correcting an error but preventing it from happening again (The lean six sigma company, 2022). Poka Yoke is used to designing processes, making mistakes almost impossible.

- **Visual aids:** these tools can be seen and visualise the process. This can include a road sign that shows which way you can drive;
- **Visual control aids:** these tools alert you to deviations and guide your behaviour. For example, a barrier that stops you from going in a certain direction;
- **Failsafe:** means to ‘force’ people to do something. For example, there is no other exit to reach a specific location.

The HUB redesign must consider that both new and experienced users will interact. Both groups should have a positive experience, making preventing unintentional errors essential. During the design of the desired interaction, the components of Poka Yoke will be considered.

A general step-by-step strategy has been drawn up to assess all charging station interactions similarly. This roadmap shows which interactions a user must go through to charge an EV. The roadmap is based on the performed in-field charging sessions and consists of the following steps:

1. **Scan** - To start a charging session, a charge card must be scanned to enable a transaction to be activated.
2. **Connect** - To transfer power from the charging station to the car, a charging cable must be connected between the charging station and the vehicle.
3. **Charge** - After connecting, there will be a state where the charging station charges the EV and (optionally) provides the user with real-time data.
4. **Disconnect** - After the EV has been partially or fully charged, it must be disconnected from the charging station.
5. **Ready** - The interaction must end to conclude the transaction and continue travelling.

Besides the step-by-step plan, a list of salient interaction points will be drawn up. Based on the five steps, the details of the interaction can be positive, neutral, or negative. A figure of the interaction can be seen per charging station analysed. A further step-by-step explanation of the interactions can be found in Appendix 10.

Summary of in-field interaction analysis

After using different charging stations, it can be concluded that some things stand out. A summary of the characteristics that are experienced as positive and negative are set out on page 64. All findings will help to identify design opportunities for the interaction of the HUB’s redesign.

Positive:

- The solid feeling of components boosts the premium feeling of the charging station.
- A clear indication of an RFID scanner is highly recommended for the user interaction flow.
- Clear and appealing LED indicators address premium feeling.
- Physical charging cables highly influence ease of use.
- Information about a charging session eliminates uncertainty.

Negative:

- Complex and inconvenient charging ergonomics impact the overall experience.
- Additional information on the interface can distract from the essence.
- ‘Cheap’ design of the interface highly influence reliability and premium feeling.
- Unclear LED indicators have an impact on the clarity and reliability of the interaction.

Revolt HUB

The HUB interface consists of an RFID scanner, two charging sockets, two LED indicators, and a sticker. The RFID scanner is intended to scan the charging card and is positioned above all the other interface components. The two charging sockets are located vertically underneath the scanner and symmetrically concerning the entire side. The LED indicators are located between the charging sockets but are aligned slightly more to the right of the centre. At the very bottom of the interface is a sticker with information about the charging socket and contact details for reporting any damages or malfunctions.

Figure 60. Revolt HUB

Salient points of interaction:

Positive:
- Solid feeling when charging
- Bright LED's
- No distracting components

Neutral:
- LED indicators show the state of interaction
- No extra interactions needed

Negative:
- Unclear where to scan the card
- Uncomfortable charging ergonomics
- No charging information, like costs, speed, or time
- Individual cable is hard to handle and becomes annoying to roll up
- Small LED indicators
- LED indicators look like buttons
- Dirty material behavior

Figure 61. Volt-E

04.3 In-field interaction analysis

EV Box BusinessLine

The interface of the EV Box BusinessLine consists of an RFID scanner, a charging socket, an LED ring, and a sticker. The scanner is indicated by an icon of a hand holding a charge card surrounded by circles. The socket is at the bottom of the front of the charging station, surrounded by a ring of twelve LEDs. A sticker providing information about charging connects the two components. All components are vertically aligned and symmetrical concerning the positioning of the product.

Figure 62. EV Box BusinessLine

Salient points of interaction:

Positive:
- Clear indication of where to scan the card
- Clear indication by LED indicators
- Solid casing during use

Neutral:
- LED indicators show the state of interaction
- No extra interactions needed

Negative:
- A lot of distracting information (stickers) on the enclosure
- Boring user interaction
- No charging information, like costs, speed or time

Vattenfall InCharge (Gemeente Amsterdam) (interface: EVBox BusinessLine)

This EV Box charging station, on behalf of Vattenfall InCharge, is used in the charging infrastructure of the municipality of Amsterdam and has the same interface as the EV Box BusinessLine. This charging station was included in the study because it has two charging points facing the side of the product. In addition, the interface in this product is low above the ground, and the LEDs show different colours.

Figure 63. Vattenfall InCharge

Salient points of interaction:

Positive:
- Clear indication of where to scan the card
- Solid casing during use

Neutral:
- No extra interactions needed

Negative:
- Unclear LED indicator looks broken
- LED indicator confuses interaction, no back-up
- Bad material behavior
- Uncomfortable charging ergonomics
- No charging information, like costs, speed or time
- Individual cable is hard to handle and becomes annoying to roll up

Alpitronic Hypercharger

The Hypercharger of Alpitronic is a DC charging station that can often be found at gas stations, parking places, or highways. This product's interface consists of an RFID scanner, a scanner for a payment card, a display, four buttons, two types of charging cables, LED rings, and stickers.

The HMI of the Hypercharger is positioned on the side of the product. The interface features a display showing information such as an introductory text, a step-by-step plan, and charging data. The display can be operated using the four buttons below the screen. A loading transaction can be initiated by scanning the RFID scanner below the buttons or holding a payment card against the scanner at the far right of the interface. The interface consists of a large panel placed vertically from the inside.

Figure 64. Alpitronic Hypercharger

Around the corner are two types of charging cables, CCS and CHAdeMO, so different types of cars can be charged. The charging cables hang in a holder surrounded by smooth LED rings. Stickers are found on the product to give more information about the car's components or the electric charging procedure.

Salient points of interaction:

Positive:

- Clear and appealing LED indicators.
- Clear indication of where to scan the card.
- Physical charging cables.
- Information about charging.
- Various types of charging connectors.
- Information about the charging session.

Neutral:

- 'Industrial' and 'nonpersonal' feeling.

Negative:

- A lot of information and buttons.
- Dark and blue interface makes the interaction feel 'cheap' and 'sketchy' (not premium).
- Interface and physical cables are visible at a glance. Industrial aesthetics give an impersonal feeling.
- A lot of interaction is needed to start and stop the charging session.
- Clear indication when the charger in a state of error:

04.4 HUB appearance

Survey

Apart from the EV drivers, a group uses the HUB in a non-physical way, the passers-by. This group might notice the HUB and potentially view the advertisements being displayed on the screens. A non-physical interaction does not mean that this consumer cannot have a positive or negative experience. As discussed in section 04.1, an experience of meaning can impact cognition. For example, a person may have particular interpretations, memory retrievals, or associations when encountering the HUB. Apart from passers-by, it could also be people looking for a place to charge their vehicle one day. A certain degree of conspicuousness or association can play into the hands of Revolt. Besides the definition and vision of Revolt, there was a need to understand the consumers' perceptions of the current HUB. Therefore, a survey was conducted with EV drivers and companies electrifying their fleet.

The survey aims to determine what potential customers and users value when using an EV charging station. Users are asked in what way they currently receive or miss information about the charging session and how this way of information provision is perceived. Because the HUB has two different purposes, it is important whether the HUB is seen as an EV charging station or as an outdoor advertisement screen. By means of propositions, it will be examined how customers and users assess the current product.

The customer survey determines which aspects a company considers necessary regarding a new charging station. This means which functionalities and external features the solution should have according to their company or personal motivation.

Method

The survey was prepared according to guidelines established by Rob Fitzpatrick (The Mom test, 2013) and exploratory talks with a former Associate professor of Anthropometrics at TU Delft and a lecturer of interaction Design at TU Delft. In addition to academic benchmarks, questions were asked about what Revolt staff would like to know about their user groups. Answers were obtained through a work session, of which the results can be found in Appendix 11a and 11b. The survey consists of multiple open-ended, ranked scale, and Likert scale questions to ensure appropriate variety and willingness to participate. The list of questions for the user is in Appendix 12a and for the customers in Appendix 12b.

Participants

The determined participants are users and potential buyers of current EV charging stations since this generates valuable insights since they are familiar with these types of products. A total of 17 EV drivers and five customers participated. A quarter of the users own an EV for a maximum of 1 year, while the rest have been driving an EV for longer. Driving electric is mainly related to financial benefits or an environmental choice; both score equally high.

In order to maximise the number of responses from EV drivers, a flyer was designed and distributed under the windscreen wipers of parked EVs. In addition, an e-mail was sent to all companies in the system that have not opted for a Revolt solution. The flyer can be found in Appendix 13.

It should be noted that the five customers, in this case, were potential customers who ultimately did not choose Revolt. These customers were chosen to find out the reasoning behind their final decision.

The only requirement for meaningful results is whether they have come into contact with the appearance of an EV charging station. Among users, this is through use and buyers through their orientation. The passers-by were not included in this survey because they do not have significant input into purchasing a HUB (Revolt, 2022).

Results

The results were processed by converting the obtained data into graphs. This structured visual presentation of the data provides a practical illustration of the answers to the questions asked. The complete overview of the answers and graphs can be found in Appendix 12a and Appendix 12b.

Survey results overview

Users

- **Financial benefits and environmental awareness are the main drivers.**
  For people, the financial benefits and environmental awareness are the main drivers for driving an EV.

- **A brand is the main driver for selecting an EV charging station.**
  Users indicate that when looking for an available charging station, the brand will be the deciding factor when there is a choice between two different charging stations. So a reliable status can be beneficial.

- EV drivers are anxious about the reliability and speed of EV charging stations.
  Much information is communicated to the user via the vehicle or telephone, not via the charging station. This method requires an extra action for the user to check to get the desired information.

- Interaction is key.
  For users, the interaction with a charging station is the most decisive factor in charging their car. Together with the previous argument, it offers opportunities to improve the interaction significantly.

- Diversity in HUB perception.
  There is a big difference in the perception of the HUB, whether it is a charging station or an outdoor advertising opportunity. It can be detrimental if a Revolt product is not recognised when EV drivers search for an available charging station.

- Do not care about the aesthetics of the EV charging station.
  EV drivers care little about the aesthetics of a charging station. Practical features are preferred over aesthetic elements.

- The HUB does not support the primary consideration of driving an EV.
  A large part of the users indicates that they drive an EV because of sustainability considerations. If the question is asked whether the HUB supports their choice to drive electric, the answer is convincingly no.

Buyers

- Costs are the priority.
  Buyers prioritise the costs of a charging station above other aspects like user-friendliness, product quality, sustainability or technological developments.

- Appearance is classified last.
  Buyers place the most negligible value on the appearance of the charging station during the search for a solution.

- User interaction is more important than aesthetics.
  In all questions about the important factors when selecting or buying a charging station, the appearance of the charging station ends last. On the other hand, the interaction always comes second, behind the cost. From this, it can be concluded that the interaction will determine the design, also known as form follows function.

- Sustainability in personal top 3.
  If a participant could choose the company, they would choose a sustainable charge point instead.

- Diversity in HUB perception.
  There is a big difference in the perception of the HUB, whether it is a charging station or an outdoor advertising opportunity.

- No added value on the product level to convince people to use the HUB.
  Besides the fact that the HUB fulfils its practical function as a charging station and outdoor advertising platform, there is no added value on the product level.

04.5 Interaction and appearance opportunities

The findings of the interaction analysis are processed to design opportunities and provided below, categorised along the three previously established sub-chapters. Bullet points state the opportunities to secure clarity since the findings are clustered. Further clustering takes place in Chapter 06.

Product experience

The experience that users of a product have can be divided into three different ways of experience: Aesthetic experience, the experience of meaning, and emotional experience. To design a complete and positive experience, the concerns of an EV driver while charging their EV should be considered. The interaction with the HUB can solve these concerns quickly and adequately. The appraisal will be positive in this case, so the final emotion will also be positive. Based on the research findings on product experience, the following design opportunities were identified:

- By identifying all the concerns that users have during the loading process, the new interaction can anticipate them.
- A higher degree of aesthetic experience and the experience of meaning will result in a higher degree of emotional experience.
- The aesthetic experience can be enhanced using materials, textures, colours, and sounds.
- Experience of meaning can be enhanced by allowing users to identify the reasons for driving an EV.
- A unique aesthetic experience and interaction can enhance memory retrieval.
- The HUB's appearance should correspond to the association users should have, a charging station with the opportunity for outdoor advertising.
- Personalising the interaction can assign some form of personalisation to their charging session and establish brand loyalty.

HUB and in-field interaction

The positioning and layout of a charging station interface are paramount. It is not beneficial if the interface is positioned too low, disappears behind charging cables or is not in the same field of vision. Too many components make the interaction cluttered and create a restless feeling. The use of LED rings around the charging sockets provides a great deal of clarity and, if appropriately designed, contributes to the quality of the interaction. The fixed cables in the DC chargers significantly increase the ease of use and avoid the extra handling that comes with using a personal cable. Based on the findings of the HUB and in-field interaction analysis, the following design opportunities were identified:

- Visual feedback by LED ring is needed to support the user while interacting.
- Information about the charging session is needed to eliminate uncertainties and boost reliability.
- Clear and appealing LED indicators will address premium feeling, quality, and clarify interaction flow.
- A backup interaction feature can be used as guidance for the LED indicators.
- A Display is preferable to software updates as compared to replacing stickers and physical components.

HUB appearance

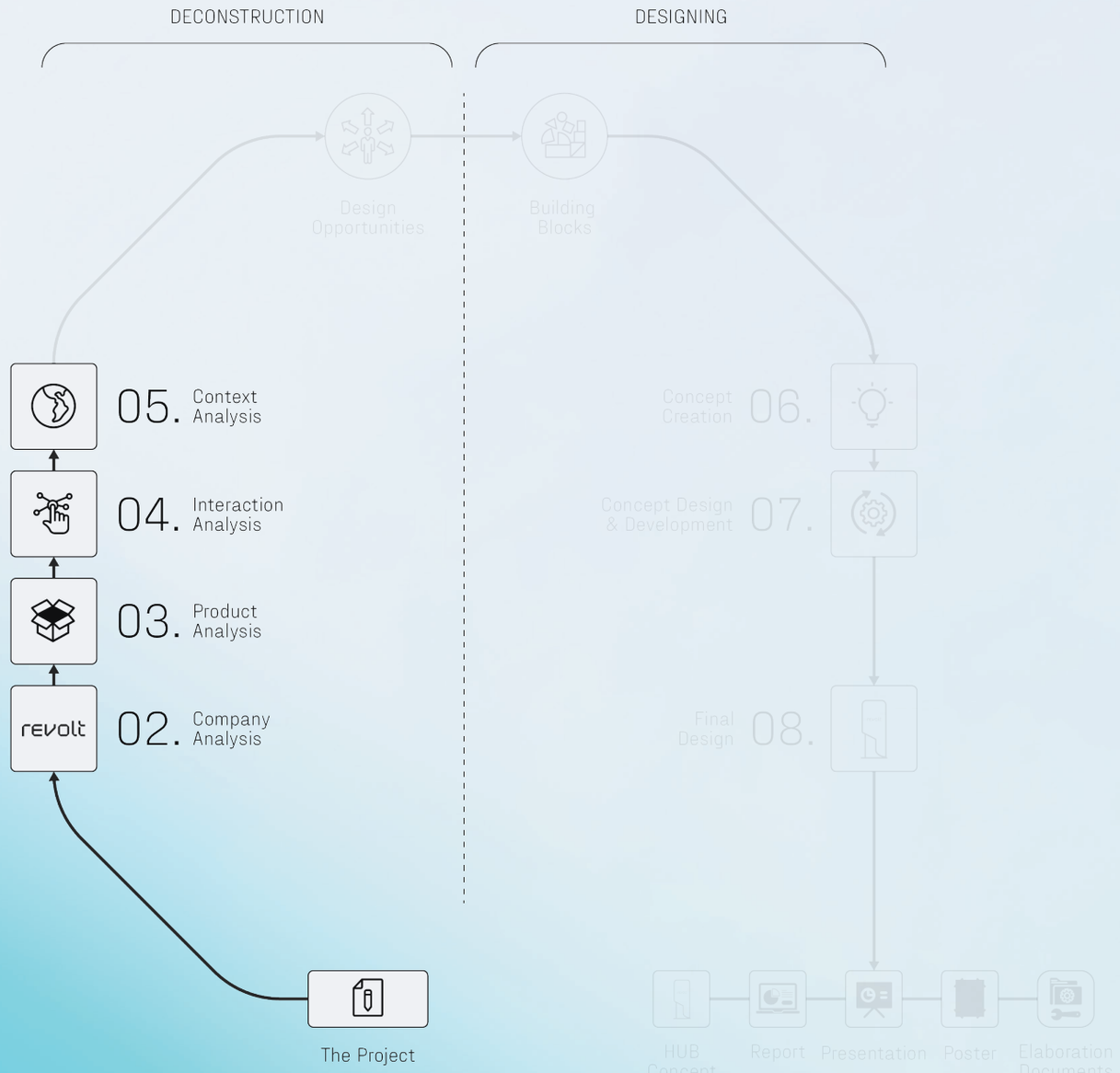
The survey conducted indicates people's perception when they encounter the HUB. When HUB is not perceived as an EV charging station, it can evoke an incorrect experience of meaning. This can also arise when a person perceives the HUB as a DC fast charger instead of a generic AC charging station. It is therefore crucial that the HUB is perceived at first sight as the product it is intended for. So not outdoor advertising with a charging possibility, but a charging station with outdoor advertising possibilities. The cost is leading for both groups, followed by the interaction. The form, in this case, follows the product's function, where the function is charging an EV. Based on the research on HUB appearance, the following design opportunities were identified:

- Form follows function
- Appearance should support the primary consideration of driving an EV to boost the right perception by users.
- The HUB should be a charging station with optional outdoor advertising since this is the actual meaning.
- Sustainability is more important than aesthetics.
- EV drivers are anxious about reliability and speed.


AWAREHOUSE
15

05. Context Analysis

The product and its interaction are carefully described. Analysing the context will be the last subject of the deconstruction process. Firstly, the context the designer of the current HUB was encountering will be examined to understand the decisions made. Then, the context will be analysed by a literature review established on the experiences and opinions of EV drivers over the past years. Finally, a list of design opportunities will be identified for the opportunity clustering.



05.1 Designers context

The analysis of the context is basically about the designer's situation when designing a product, in this case, the current HUB. In other words, it is about the internal and external factors that the designs had to cope with. These aspects can be both positive and negative.

The story behind the HUB

At the beginning of 2021, the first version of the HUB was launched. The concept version (figure 65 and 66) was co-designed by four students of the faculty of Industrial design engineering at the Delft University of Technology and then technically engineered and developed by PIA Automation. The first version was designed by Verborg engineering, who did a great job designing one of the first multimedia charging stations, but it lacks a vision behind the design. This vision is needed to consider user experience, accommodate future technology developments, and increase the HUB's sustainability factor.

Design iterations

Since the first version, several adjustments have been made to the HUB. For example, the slump of the charging sockets have been removed, antennas have been mounted on the roof, and three fans have been installed for ventilation purposes. These iterations were added to the design instead of being pre-integrated. The difference between these is essential since effectiveness in manufacturability decreases and costs increase when adding components to an existing design. Because all possible factors are written out in this project, a complete concept can be developed based on all design opportunities. This concept will not have to ignore unforeseen issues to guarantee a future-proof design.

Figure 65. HUB concept 2021

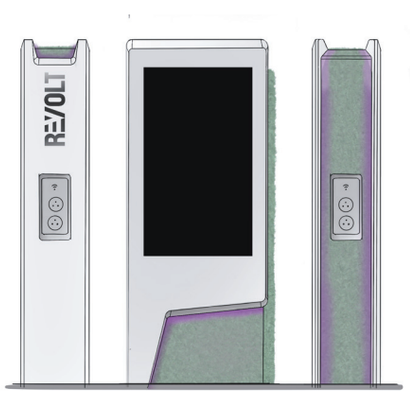


Figure 66. HUB ontwerp 2021

05.2 Literature review

Four studies were used as a foundation for the literature review; EV driver survey report 2020 and 2021 and Nationaal Laadonderzoek 2020 and 2021. Two studies were conducted the same way every year, making it possible to analyse the data between them. The studies were conducted in Europe and the Netherlands, making it possible to compare these data. The data and conclusions of these studies were validated or adjusted based on other literature studies.

Shifting from innovator to early adopters

Gradually, a shift from 'innovators' to 'early adopters' in conformity with Rogers' (1995) innovation and adoption model (figure 67). Rogers' adoption curve illustrates how new technology is adopted in society. This curve describes five types of people: innovators, early adopters, early majority, late majority, and laggards. Innovators are people who always want to be the first to try out a new invention. They are followed by the early adopters: people who try out new techniques relatively early. The largest group is formed by the early majority and the late majority, the majority who try out a new technique. The laggards are those who stay behind; they prefer to stick with the old familiar. The opinion of these new users is critical and partly determines the breakthrough of electric transport among the general public. Therefore, it is essential to deal carefully with the opinions and experiences of this group.

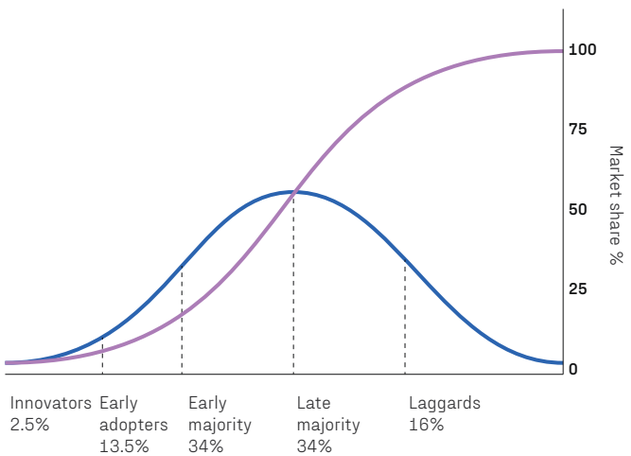


Figure 67. Rogers' innovation and adoption model

Bottlenecks in public AC charging points

The respondents of the surveys were asked the open question concerning the (other) bottlenecks they experience with public charging stations:

Of all EV drivers, 78% sometimes charge at a public charging station in the street. They experience a wide range of bottlenecks (Nationaal laadonderzoek, 2021).

72% of all 'public chargers' feel that there are insufficient charging stations in their neighbourhood (Nationaal laadonderzoek, 2021). The increase in the number of electric vehicles is currently faster than the increase in the charging infrastructure. As a result, it is getting busier at charging stations. In addition, not all municipalities have a good charging station policy, which means it is not always easy for EV drivers to request a charging station.

Over 70% have experienced that their charging spot was occupied by a fossil fuel vehicle or an electric vehicle that was not charging in the past six months (Nationaal laadonderzoek, 2021). Electric cars unnecessarily occupying charging spots when they are not charging is called 'charging station life'.

About 60% indicated that they did not know the cost of a charging session at a public charging station once or twice in the past year (Nationaal laadonderzoek, 2021).

Bottlenecks in public DC charging stations

Fast charging is an integral part of the charging mix. 83% of all respondents indicated that they sometimes use fast chargers (Nationaal laadonderzoek, 2021).

Over half (51%) of the respondents had experienced a shortage of fast chargers over six months (Nationaal laadonderzoek, 2021).

Almost half of the respondents (49%) had experienced one or more occasions during six months that it was too busy at the fast chargers (Nationaal laadonderzoek, 2021). This volume increase is a new development.

At fast chargers, the charging speed isexperienced too low by 31% of the respondents (Nationaal laadonderzoek, 2021). This experience may have to do with increasing congestion: if more cars charge simultaneously, the charging speed may drop.

The charging costs at fast chargers are generally better known than at the 'regular' public charging station. 30% of respondents indicated that in one or more cases in the past six months, they had no idea about the costs of charging (compared to 60% for public charging) (Nationaal laadonderzoek, 2021). This feeling is caused by the information provision at fast chargers (showing charging speed, costs, and consumption). Nevertheless, 30% is still too high a percentage. As an EV driver, the costs of a charging session should always be possible to trace. At petrol stations, showing the costs are even used for marketing purposes near highways.

Convenience is key

Ease of use is the main priority when it comes to charging stations (EV driver survey report 2021). When choosing a solution, those who own a charging station emphasise ease of use, with more than half (52%) citing this as their primary consideration. A third of respondents (33%) say the charging station's price is important, while a quarter (26%) say a recommendation from a third party, such as a leasing company, a dealer, or an employer, is the most influential factor in their decision.

Convenience is also critical when it comes to charging station providers. Ease of use is frequently mentioned (35%) as the

primary decision driver for respondents' preferred charging station provider. In comparison, a quarter of respondents (24%) mentioned the technical specifications of the hardware as an important factor in their choice

Reliability is the most valuable

What respondents value most in a charge point provider is evident. The product's reliability is mentioned by 46% of respondents, while smart functionalities (such as automatic reimbursement of energy usage by the employer or remote start-and-stop functionality) are mentioned by 19% of EV drivers as the most important. Customer service quality is important to 11% of respondents (EV driver survey report 2021).

Transparency of pricing

The charging cost is a hot topic among EV owners. Before starting a charging session, 43% of EV drivers say they know how much it will cost them. Although, 37% of respondents say they will look up the price of a session before charging. Two out of every five respondents say they have had at least one charging session where the actual cost differed from the price displayed at the charging station (EV driver survey report 2021).

Room for improvement

On the other hand, EV drivers are very clear about what will have the greatest impact on their charging experience. The most significant improvements for a better charging experience are faster charging (48%), increased availability of charging stations (46%), and a single charge card for any public charging stations (41%). Furthermore, it gives 20% to the fact that there is a need to charge without using a charging card, and it gives 20% to the fact that they would find it comfortable using fixed charging cables (EV driver survey report 2021).

Fast charging would be a more significant improvement in the Netherlands than in other countries. The availability of charging stations is more important in Germany, the United Kingdom, and France. Except for the Netherlands, switching to a single card for a seamless charging experience is the most pressing issue. This is likely due to the Netherlands' high roaming rates (EV driver survey report 2021).

Willingness to act more sustainable

One thing that will not change is that climate change drives the shift to electric vehicles more than anything else. This change is the case for governments and businesses aiming to meet emissions targets. More than half of drivers cite environmental concerns as one of their top two reasons for choosing an EV over a traditional vehicle (EV driver survey report 2021).

Charging cards and charging applications

EV drivers generally have multiple charge cards and charging applications. On average, an EV driver has 2.6 charging cards from various providers. EV drivers also have numeral apps for checking where charging facilities are available: an average of 1.6 apps per EV driver (Nationaal laadonderzoek, 2021).

Many EV drivers have more than one card, and applications are probably related to not all cards working correctly at all the available charging stations. In this case, people have an alternative at their disposal. In addition, one card sometimes offers more benefits than another at the same charging station. Furthermore, when abroad, EV drivers usually need more cards to be able to charge at all.

The same goes for the applications: if one app does not work or does not provide enough information, you can consult or use another app to verify the information. Ideally, and much more user-friendly, users should be able to manage with one charging card and one charging app. An overview was made of the best-known platforms to provide an understanding of the charging cards and charging applications. The overview with accompanying explanations can be found in Appendix 14.

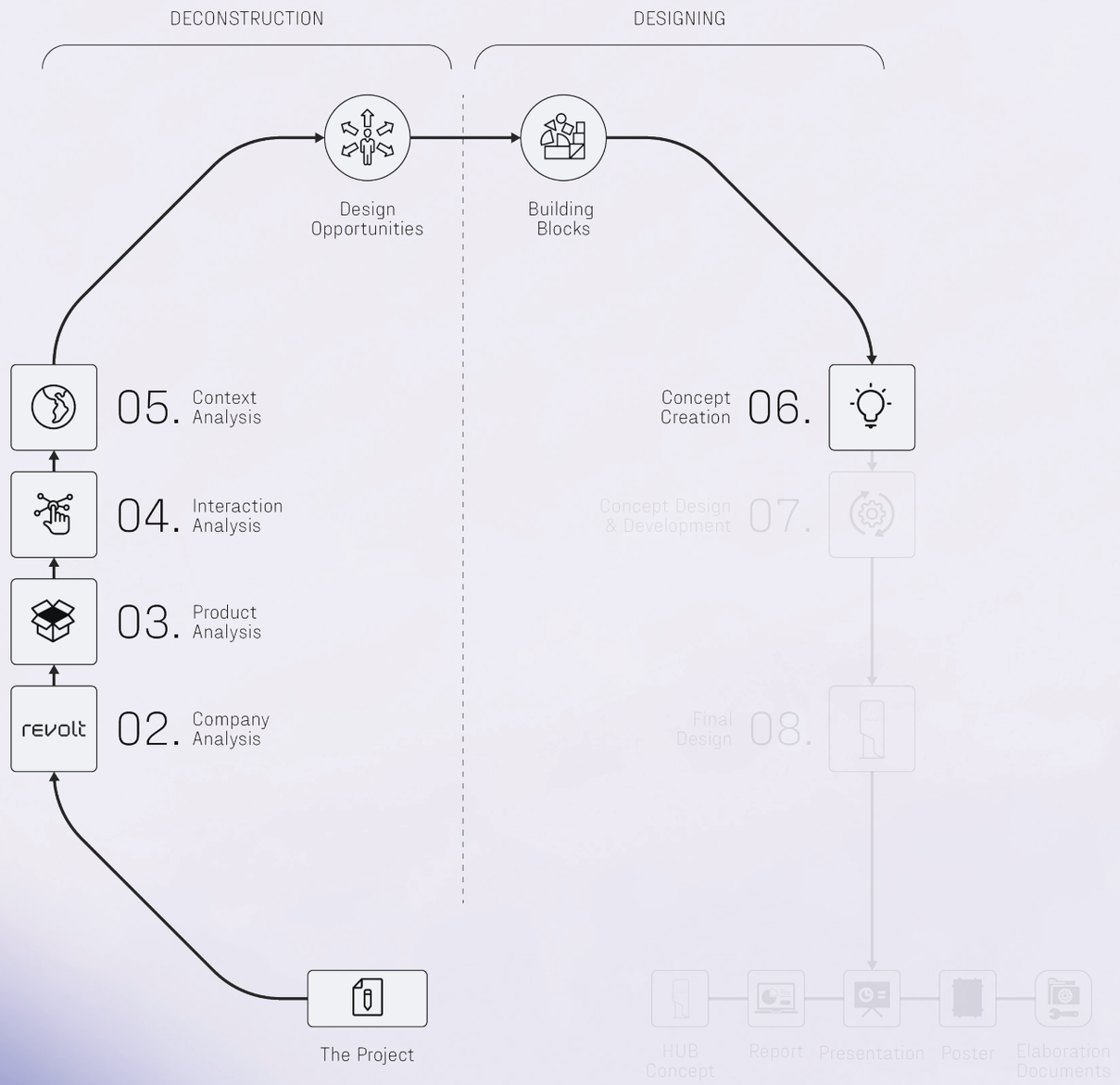
05.3 Context opportunities

Investigating the general context of electric charging has provided many interesting insights into how current users experience charging. The shift from ‘innovators’ to ‘early adopters’ offers excellent opportunities for Revolt if this group perceives the company as positive. The opinions of both groups are essential for the adoption among the early majority and late majority because they primarily base their choice on the opinions and experiences of the first two groups. These opinions mainly concern the interaction, the provision of information, and the ease of use of the charging transaction. Proper interaction contributes especially to the reliability and transparency of a charging station and thus the company. Users are loyal and want to return to one of the same brands more often because of a satisfactory experience. Most users drive an EV because of sustainability considerations and therefore feel an affinity for similar features. Based on the findings of the stakeholder analysis, the following design opportunities were identified:

- Ease of use is the main driver by consumers to choose a charging station.
- An incremental shift from 'innovators' to 'early adopters' opens doors for a headstart by the 'early majority'.
- A display better organises information provision at fast chargers.
- Openness to sustainability because the main reason for driving electric is for sustainability reasons.
- Acknowledgment of sustainability consideration by adding sustainable features.
- Information about charging speed, costs, and smart functionalities attract users' attention.
- Reducing the number of charging cards and apps will increase the user experience.
- Making it possible to charge via the telephone/ application is preferred over a charging card.
- Responding to consumers' anxiety that their car is not fully charged.
- Create a feasible expectation pattern to increase charging reliability by providing information.
- RFID Scanner must be compatible with all charging cards and applications, primarily applications.

06. Concept creation

The design opportunities that emerged from the analyses will first be clustered into new so-called meta-factors. Next, the new clusters will be converted into building blocks to develop concepts. These building blocks conclude the deconstruction phase and serve as a basis for the designing phase. Thirdly, the concepts will be designed based on viability and lead time according to concept levels. Finally, the concepts will be chosen, and a final design direction will be determined.

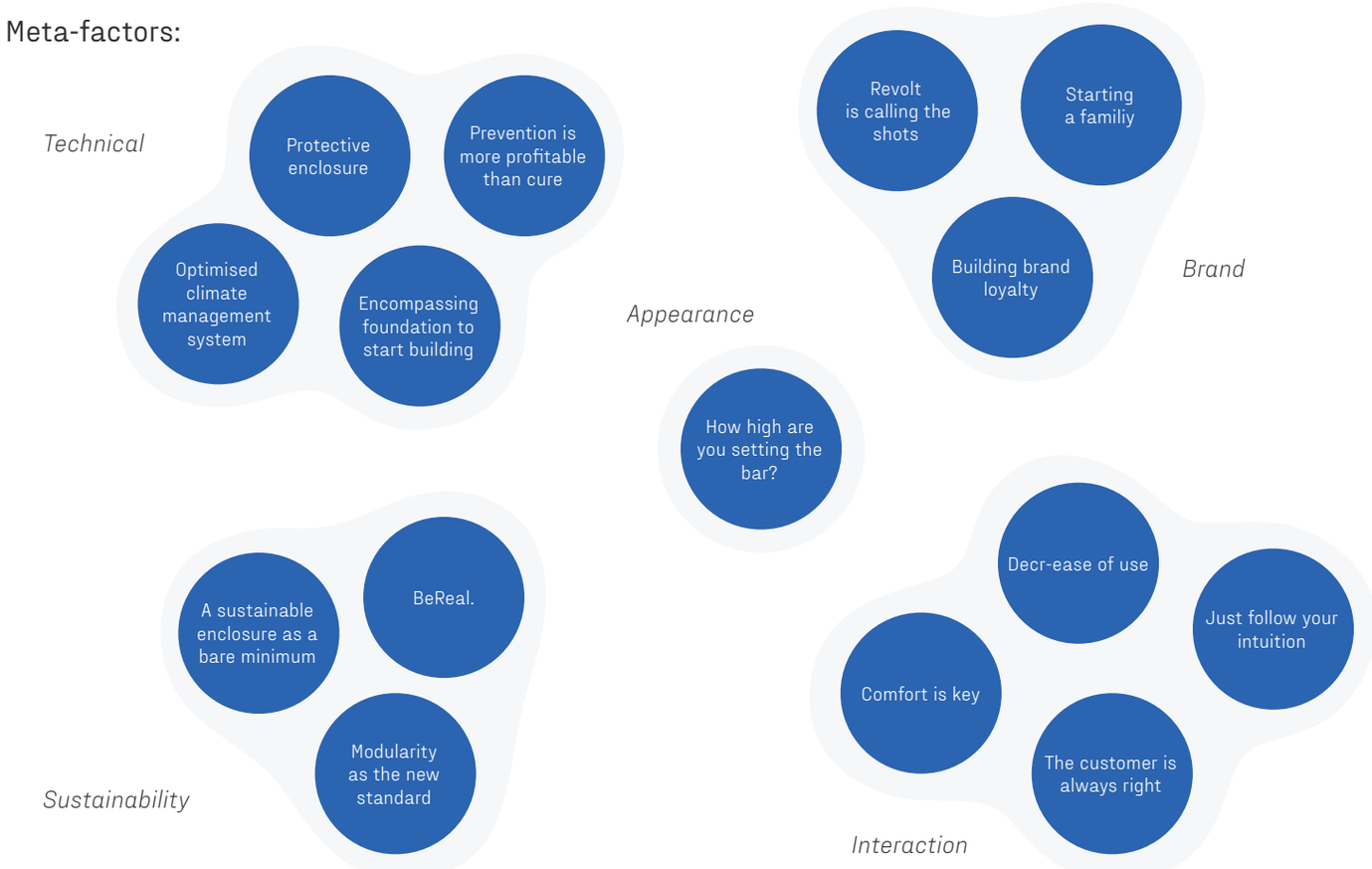


06.1 Opportunity clustering

The ViP method of Hekkert and van Dijk (2011) helps structure the design process, so it can be called a design methodology. The writers refrained from using that term to avoid unwanted connotations and framed their process as a ‘design approach’. The ViP method serves as design guidance for a final product and offers the possibility to reframe this approach at certain stages. By going through the process several times, it was decided to construct the designing phase differently for this project. The found opportunities serve as principles, trends and developments and lead to the establishment of the meta-factors. Three company-focused concept levels will generate the final design direction instead of the development of a designer domain.

Next, the findings will be clustered into common-quality clusters: A combination of factors that all point to the same (underlying) direction and form a meta-factor. The meta-factors will then be used to develop building blocks.

An overview of all common-quality clusters (meta-factors) is available in overview 2. These meta-factors are a result of all founded design opportunities. A substantive explanation of all clusters can be found in Appendix 15.



Overview 2. Meta-factors

06.2 Building blocks

The meta-factors offer a wide variety of possibilities for concept design. The meta-factors are translated into concrete building blocks to guide the concept development. The building blocks are divided into categories based on functional similarity. A building block can have different elaboration levels; therefore, a distinction is made between two or three gradations within a category. This distinction allows for diverse combinations during the concept development in section 06.3. The building blocks can be used as 'pick and play' for concept-level generation. The building blocks can be seen in table 5.

INTERACTION
APPEARANCE
BRAND
SUSTAINABILITY
TECHNICAL

	User interface	Charging sockets	LED indicator	Physical charging cables	Customer customisation	Enclosure	Climate management system	Charging infrastructure
Gradation 1	Increased user experience by display + RFID	Off-the-shelf charging sockets	Off-the-shelf LED indicator	No AC charging cables	Software customi-sation on display	Sustainable casing	Current cli-mate system by vents	Only AC charging
Gradation 2	Modular user experience (display + RFID)	Customised charging sockets	Customised charging sockets	Only DC charging cables	Practical cus-tomisation by software and components	Sustainable + preventative casing	Manageable climate system by closed airflow	AC and DC charging
Gradation 3				AC and DC charging cables	Full custo-misation by display, compone-nents, and enclosure	Sustainable + modular + preventative casing	Optimised climated sys-tem regulated by central unit	Customisable AC and DC charging

Table 5. Building blocks

06.3 Concept levels

The motivation for developing concepts using three levels can be traced back to the origin of this project. The project started with the question of identifying minor adjustments to improve the current design of the HUB, with the enclosure and interaction as the two main pillars. As the research progressed, many new developments emerged. Not only when it concerns the analysis of the HUB but also Revolt's current market positioning, branding, and perspective on the future. When all this is considered in the thoughts for a redesign, there is a significant difference compared to the project's origin.

Two design directions were devised on top of the original design direction to ensure Revolt's vision (table 7). Concept level 1 can be translated as a visual realisation of the Revolt's existence, whereas concept level 2 partially fulfils the vision practically. The latter concept, level 3, fully responds to Revolt's existence by visually and practically incorporating the vision and extending it across the entire product portfolio.

The design concepts will be discussed separately by explaining the intended benefits based on the performed analyses, viability, feasibility, desirability, and stakeholders. The concept levels will be evaluated by radar charts, a graphical method of displaying data in quantitative variables (table 6). The quantitative variables are established according to the performed research, project scope and vision:

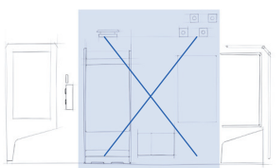
Concept values:

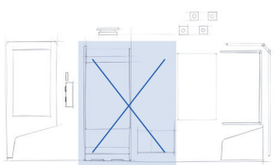
Interaction	The extent to which the concept contributes to an improved interaction. This includes for example clarity, ergonomics, and uniqueness.
Sustainability	The extent to which the concept contributes to sustainability. This includes, for example, the lifespan, energy consumption, and carbon impact.
Long-term vision	The extent to which the concept contributes to the vision of the company. This includes for example the future compatibility and connection between product and vision.
Technical feasibility	The extent to which the concept can be realised technically. This refers to the technical difficulty of, for example, the frame, climate management, and enclosure.
Economic viability	The extent to which the concept can be realised economically. This refers to the investment costs, cost price, and production quantities.
Customer desirability	The extent to which the concept contributes to the requirements and wishes of the customer. This includes user convenience, information provision and technical development.

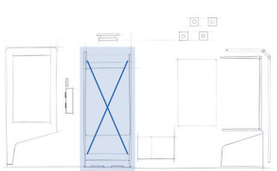
Table 6. Concept values

Concept levels:

Scope:







	User interface	Charging sockets	LED indicator	Physical charging cables	Customer customisation	Enclosure	Climate management system	Charging infrastructure
Concept level 1	Increased user experience by display + RFID	Off-the-shelf charging sockets	Off-the-shelf LED indicator	No charging cables	Software customisation on display	Sustainable casing	Current climate system by vents	Only AC charging
Concept level 2				Only DC charging cables	Practical customisation by software and components	Sustainable + preventative casing	Manageable climate system by closed airflow	AC and DC charging
Concept level 3	Modular user experience (display + RFID)	Customised charging sockets	Customised charging sockets	AC and DC charging cables	Full customisation by display, componenents, and enclosure	Sustainable + modular + preventative casing	Optimised climated system regulated by central unit	Customisable AC and DC charging

Table 7. Concept levels

Concept level 1

Viasual realisation of a strategic foundation

The first concept focuses on the essential elements that require minimal effort to increase user experience significantly. By redesigning the user interface and the enclosure of the HUB, the vital elements that impact the appearance of the HUB will be improved. The selection of building blocks is visible in table 8.

Intended benefits:

- Improved interaction by adding an (interactive) display and a unique RFID scanner will increase user experience and brand recognition.
- A sustainable and environmentally responsible material represents Revolt as a brand in the charging infrastructure and the street scene.

Pros:

- High impact without any significant internal adjustments.

Cons:

- A outdoor advertisement option with a charging facility. Internal part of the HUB requires further optimisation to be
- future-proof.
- Limited option to create unity in the product portfolio.
- Dimensions of the HUB are difficult to adjust.
- Function follows form.
- Limited possibility to make the interaction as optimal as possible.

Stakeholders:

PIA	-	Hardware and enclosure assembly
Streetplug	-	Hardware and software development
External company	-	Sustainable enclosure manufacturing

An ideation sketch for this concept is shown in figure 68, supported by an exploded view of the intended scope.

Overview 3. Radar chart - Level 2

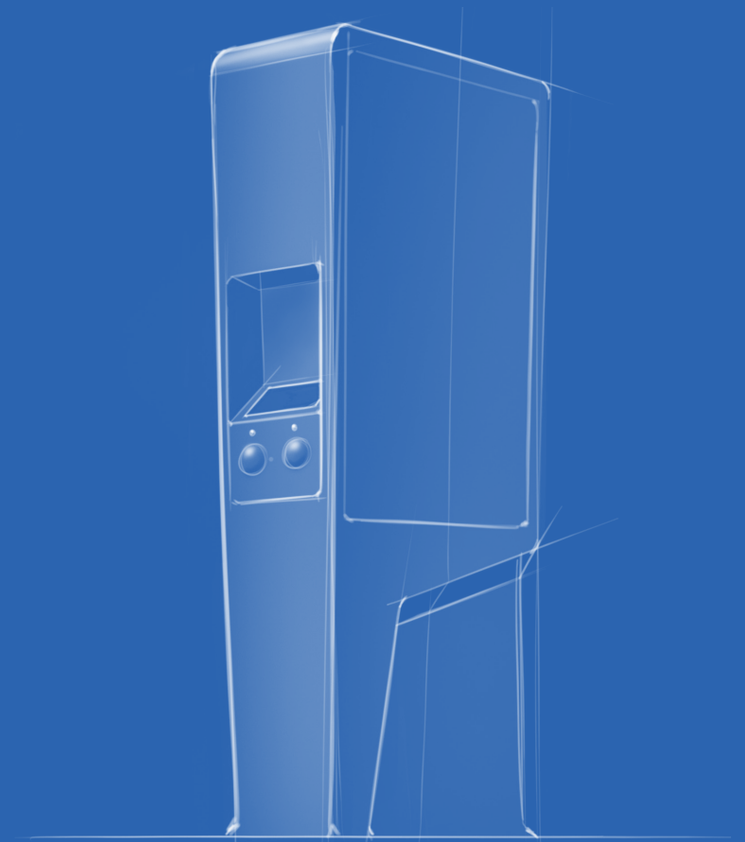


Figure 68. Concept level 1

Increased user experience by display + RFID	Off-the-shelf charging sockets	Off-the-shelf LED indicator	No charging cables
Software customisation on display	Sustainable casing	Current climate system by vents	Only AC charging

Table 8. Building blocks concept level 1

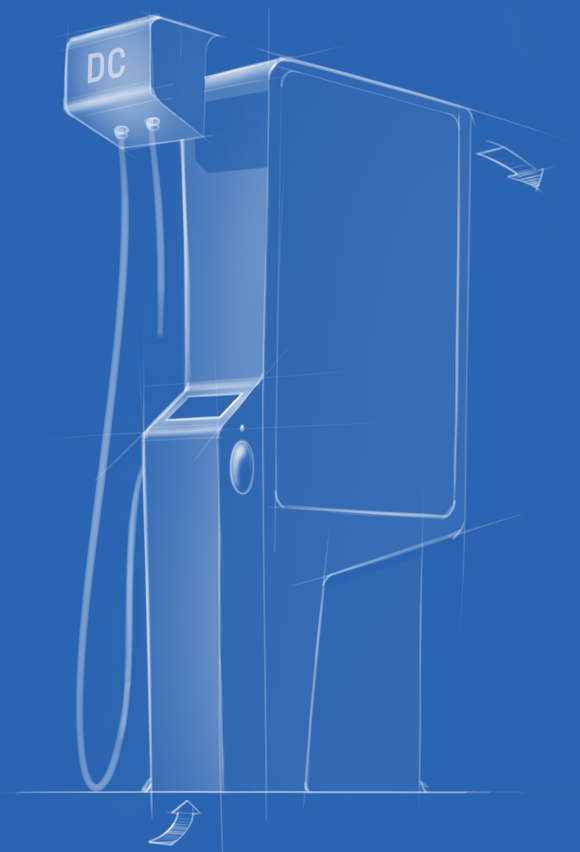


Figure 69. Concept level 2

Increased user experience by display + RFID	Off-the-shelf charging sockets	Off-the-shelf LED indicator	Only DC charging cables
Practical customisation by software and components	Sustainable + preventative casing	Manageable climate system by closed airflow	AC and DC charging

Table 9. Building blocks concept level 2

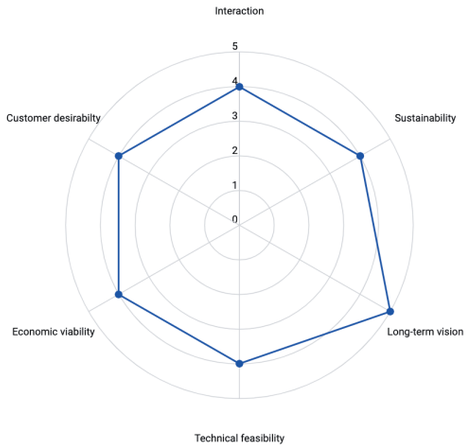
Cons:

- Internal part of the HUB requires further optimization to be future-proof, especially the media screens, climate management, and DC components.
- Dimensions of the HUB are difficult to adjust.

Stakeholders:

PIA	-	Hardware and enclosure assembly
Streetplug	-	Hardware and software development
External company	-	Sustainable enclosure manufacturing

An ideation sketch for this concept is shown in figure 69, supported by an exploded view of the intended scope.



Overview 4. Radar chart - Level 2

Concept level 2

Visual and partially practical realisation of a strategic foundation

The second concept also impacts the HUB internally to potentially increase the benefits of the redesign. In this case, the sustainable enclosure will be made water and dustproof to increase the design freedom inside the HUB. The components can be removed from their casing to ensure a long service life and reduce costs. As the fans can attract no false air, reducing the number of fans is possible. Climate optimisation reduces the total cost of components and maintenance in the long term. The selection of building blocks is visible in table 9.

Intended benefits:

- Improved interaction by adding a modular (interactive) display and a unique RFID scanner will increase user experience and brand recognition for the complete product portfolio.
- A sustainable and environmentally responsible material represents Revolt as a brand in the charging infrastructure and the street scene.
- Water and dustproof enclosure increase design opportunities for the internal components.
- By adding a section on the side of the HUB, more space will be created on the inside allowing DC charging infrastructure to be implemented.

Pros:

- A charging station with an option for outdoor advertisements.
- Form follows function, partially.
- Fewer fans can regulate manageable airflow.
- Option for DC charging
- More options to increase unique and optimal user interaction.
- Increased option to create unity in the product portfolio.

Concept level 3

Full realisation of a strategic foundation

The third design direction is most future-proof by incorporating modularity into the concept affecting the entire product portfolio. The custom-made sockets and LED indicators may be too radical a change for the moment, but it indicates the possibilities for developing this product in the future. The enclosure, in this case, is the same, but it will be designed so that parts of it can be used for other products in the portfolio. However, the additional products will have to be redesigned based on the HUB redesign. Two separate airflows for the media screens and DC module increase the applicability of the complete HUB by increasing the number of functionalities. The selection of building blocks is visible in table 10.

Intended benefits:

- Improved interaction by adding a modular (interactive) display and a unique RFID scanner will increase user experience and brand recognition for the complete product portfolio.
- A sustainable and environmentally responsible material represents Revolt as a brand in the charging infrastructure and the street scene.
- Water and dustproof enclosure increase design opportunities for the internal components.
- By adding a section on the side of the HUB, more space will be created on the inside allowing DC charging infrastructure to be implemented.

Pros:

- A charging station with an option for outdoor advertisements.
- Airconditioning can regulate manageable airflow.
- Option for DC charging
- Both AC and DC cables increase user experience.

Cons:

- Some internal parts require further optimisation to be future-proof such as the part reserved for the DC components.
- Frame dimensions are difficult to adjust.

Stakeholders:

PIA	-	Hardware and enclosure assembly
Streetplug	-	Hardware and software development
External company	-	Sustainable enclosure manufacturing

An ideation sketch for this concept is shown in figure 70, supported by an exploded view of the intended scope.

Overview 5. Radar chart - Level 3

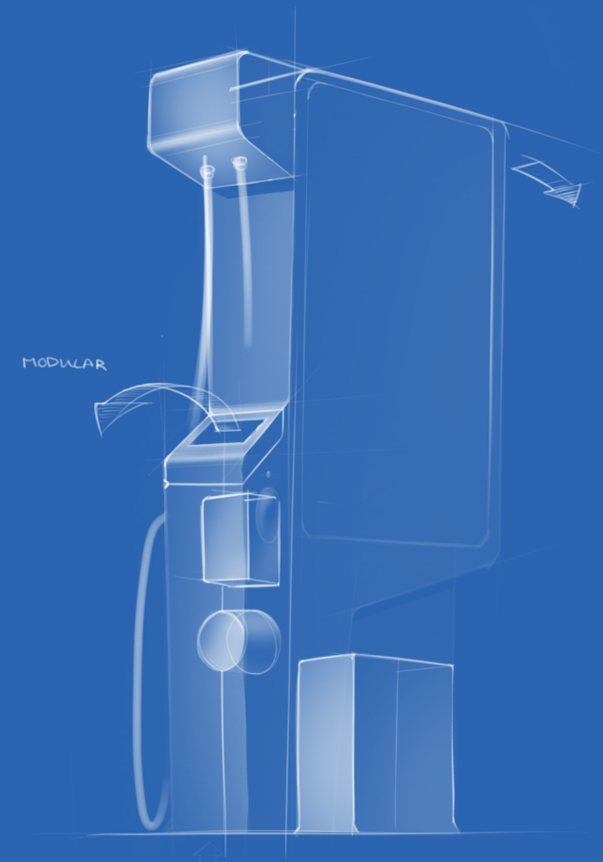


Figure 70. Concept level 3

Modular user experience (display + RFID)	Customised charging sockets	Customised charging sockets	AC and DC charging cables
Full customisa-tion by display, componenents, and enclosure	Sustainable + modular + preventative casing	Optimised climated system regulated by central unit	Customisable AC and DC charging

Table 10. Building blocks cncept level 3

06.4 Design direction

The concept levels are discussed in their content with both co-founders of Revolt, product manager at Streetplug, sales manager at Streetplug, and owner of PIA Automation and Mechanical. Based on the results of de extensive discussion, a design direction has been created for de Concept Design and Development of the HUB redesign. The discussion results have been summarised in bullet points, followed by a brief explanation. Finally, the final design direction will be defined. The topics discussed are based on the concept presentation's content, which can be found in Appendix 16.

Right time, right place, right moment.

The fact that the market is currently at a very early stage concerning Rogers' mass-market adoption model increases many opportunities. It should be noted that the Netherlands is one of the countries most advanced in the electrification of the infrastructure. If the product portfolio is thoroughly examined to make it more future-proof in terms of design, this can reduce total costs in the long term. By building a portfolio that meets all the requirements, has a coherent design language and puts the vision into practice, a product can be improved from this point through small iterations. Also, more uniformity is achieved regarding the products installed at locations because a new version is developed at an earlier stage. An example where this problem is currently well-represented is Revolt's brand identity renewal. Stickers on products show the outside world that a product belongs to Revolt because of its logo. Although the brand identity of Revolt has changed in the meantime, products are still sold with the old logos. It is conceivable that selling products with the old logo could confuse building brand awareness. In addition, it is also possible to imagine that a customer will find it remarkable if an old product is installed while media channels show a different image.

Go green of go home

Sustainability is a big factor at Revolt since the co-founders believe this should also be visible in the product portfolio. Building a unique proposition also requires a unique approach to the product portfolio. A thorough approach to redesign makes it possible to look for an optimal solution to various problems, such as the materials of the enclosure, climate management and power consumption. The products and services sold establish a relationship with the customer. A healthy basis ensures a healthy relationship.

Therefore, it is found unacceptable to state that sustainability plays a big role within the company's values without a strategic vision behind the entire product portfolio. The argument becomes questionable if Revolt intends to reduce carbon dioxide emissions without a direct contribution. Especially when a HUB with two 55" screens and twelve ventilators runs twenty-four hours seven days a week.

Delayed by heritage

Until the ideation of the concepts, modification of the frame was beyond the scope. However, based on the number of adjustments needed on the frame to implement the design direction, the remaining frame-related disadvantages, and the low investment costs, it offers more potential to rebuild the frame. Before starting concept design, the HUB's redesign can now be built from scratch. The absolute freedom of reconstructing the frame implies that several new decisions can be made. The construction of the old frame was based on a layout of old components. The development of the new frame will be based on new or improved components and can lead to an optimised layout. Further elaboration can be found in section 08.2.

The calm before the storm.

Alongside the logistical advantages of implementing a fundamental redesign earlier, Revolt can properly investigate how customers and users react to the redesign. As explained earlier, there is a correlation between the opinions of the first two groups and the early and late majority regarding product acceptance. Thorough testing with users open to technological development can provide many insights for further product optimisation. This increases the acceptance rate by the two largest groups, which can positively impact the sale of subscriptions.

Going digital

The provision of information during the charging process plays a major role in the charging experience of EV drivers. A display will have to inform the user of the required information in the future. By adding a display, it will be possible to perform software updates without changing operating stickers, for example. The switch to a digital way of information provision allows Revolt to build a digital environment in which the user finds himself when using Revolt products. Finding the right balance in building a user-friendly interface is essential and requires extensive testing.

In addition to enhancing the mental user experience, much advantage can be gained regarding the physical user experience. By improving the positioning of the charging sockets, clarifying LED indicators and adding a more intuitive RFID scanner, significant improvements can be made in the product ergonomics.

Final design direction

The discussion resulted in an agreement on the fundamental redesign of the HUB to ensure that the existing problems are solved at the origin. However, concept level 3 is too big a leap for the redesign; it was decided to adjust some elements to an interim solution. The charging socket and LED indicator will be off-the-shelf components, and it was also decided not to add physical AC cables to the HUB, exclusively for the DC version.

In addition, developing water and dustproof exterior enclosure will be considered. As a result, the components inside the HUB can be moved freely, and the component layout can be optimised to the maximum extent, together with climate management. The complete separation of the internal part from the outside air ensures a stable airflow, making it possible to simplify climate management. Finally, the HUB's overall design and interface will be considered leading for the entire product portfolio. With this, the HUB is seen as the flagship model of Revolt, the physical embodiment of the brand's vision values. The interface will be designed as a modular component to ensure the vision and recognition of Revolt.

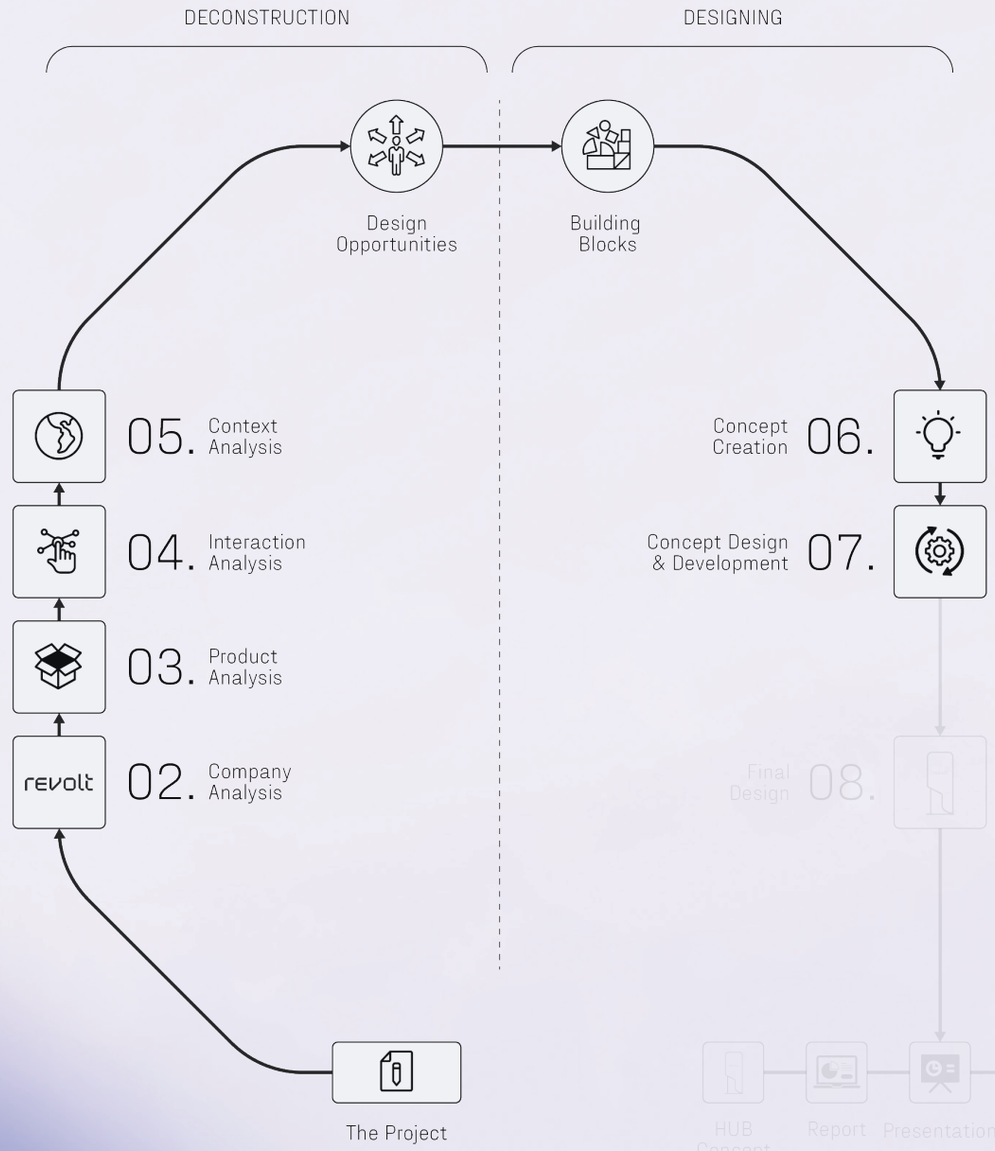
The final selection of building blocks used for the design direction is visible in table 11.

	User interface	Charging sockets	LED indicator	Physical charging cables	Customer customisation	Enclosure	Climate management system	Charging infrastructure
Concept level 1	Increased user experience by display + RFID	Off-the-shelf charging sockets	Off-the-shelf LED indicator	Only AC	Software customi-sation on display	Sustainable casing	Current cli-mate system by vents	Only AC charging
Concept level 2				Only DC	Practical customisation by software and components	Sustainable + preventa-tive casing	Manageable climate system by closed airflow	AC and DC charging
Concept level 3	Modular user experience (display + RFID)	Customised charging sockets	Customised charging sockets	AC and DC	Full custo-misation by display, compone-nents, and enclosure	Sustainable + modular + preventative casing	Optimised climated system regulated by central unit	Customisable AC and DC charging

Table 11. Building blocks - Final selection

07. Concept Design

After concluding the overall design direction in the previous chapter, this chapter is about designing a meaningful concept that answers the demands discovered. First, a vision will be established covering the selected design direction with an emotional embodiment. Secondly, intended product qualities will be concluded that shape the desired interaction and appearance and provide a foundation for the Concept Creation. Lastly, the Concept Creation phase consists of explorative sessions that develop ideas which will be concluded in a final Design. The explorative sessions are divided into three different categories; interaction, frame, and form.



07.1 Vision

Because Revolt's tone of being (see page 24) has been clearly examined, this, together with the found design opportunities (see page 80) can be forged into a unique and feasible future vision. The values leading to the realisation of the concept are shown below.

Clear	-	Is transparent and clear about everything.
Make a statement	-	Is intrinsically motivated to put the vision into practice.
Challenger	-	Is pioneering and boosting innovative products that contribute to a sustainable future.
Distinctive	-	Dares to make choices that benefit the product quality and experience.
Inspirational	-	Offers perspective and works visionary to help the customer further.

Explained: The vision

The literature review has shown that the EV market is shifting from the 'innovators' to the 'early adopters'. It is essential that the innovator and early adopters are satisfied with the product, as the early and late majority primarily base their opinions on it to gain mass market acceptance. By intervening now and redesigning the product thoroughly, it provides time and space to test the new product extensively among innovators and early adopters. Based on the results, certain parts can be modified or further developed before the early and late majority become involved.

Therefore, with my vision, I want to make people more aware of achieving the ultimate goal of this contemporary electrical transition differently. The transition to a completely electric vehicle fleet can also be achieved in a more sustainable and environmentally friendly way since not only vehicles create pollutant emissions. Moreover, product aesthetics do not have to be the leading factor in product design and can result from the essence; form follows function. Perhaps the most critical factor is the translation of the brand values into the product portfolio. The company's ideals will be pursued by enhancing the vision of Revolt concerning sustainability. The interaction is leading and should feel natural for each user group. The two core values that the concept must contain and are therefore guiding during the exploratory sessions are:

An example of Ring doorbell 4 (figure 71) will show what a physical translation of the vision could be. This practical example brings both values together in one product and substantiates the vision. The doorbell provides a sense of security when a person is not at home because you can remotely see who is at the door. The safety and security it offers increase personal privacy and a trusted feeling wherever you are.

The features of the doorbell capitalise on everyday actions that are currently performed with other products (figure 72). For example, the doorbell is controlled and set up via an application, and live images can be shown by a similar action when you pick up the phone. Push notifications provide updates about when movement is detected at the door, allowing you to maintain security unconsciously. As hardly any additional new actions are required to use the doorbell, first thoughts are often the right ones, making the interaction feel instinctively pleasant.

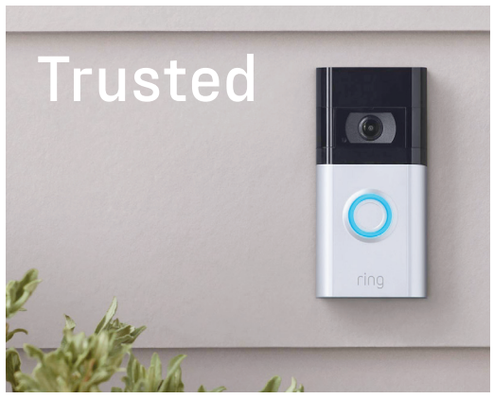


Figure 71. Physical translation vision

Figure 72. Everyday actions

07.2 Interaction and appearance qualities

Linear becoming circular

A paradigm of a linear business model is to sell more and sell faster (Products that last, 2014). For decades, companies have tried to sell as many products as possible with the highest possible margin over the production price. This way of doing business creates a large amount of waste with serious consequences. Currently, more and more companies are evolving towards a business model in which circularity plays a major role (Businessmodelinc, 2022). Nike, for example, is on a mission to realise a business model that produces no carbon and waste. The circular economy diagram is shown in figure 73 to visualise the core flows of the two business models.

There is a difference between selling products or offering them in a subscription form, which is the case with Revolt. When a subscription is signed up for a charging station, it includes maintenance and repair. In this case, the paradigm of selling more and selling faster does not apply. Therefore, it could be beneficial to investigate how to make the customer renew the subscription. In other words: Sell more by selling again.

When people buy a new product, they have a feeling of “new and improved” (Products that lasts, 2014). When a customer owns a HUB for five years and wants to extend the contract, it is desirable that the customer experiences this feeling. In Revolt’s case, when they renew the subscription, they install a HUB with the latest technology, but how can this be achieved as cost-effectively as possible for Revolt?

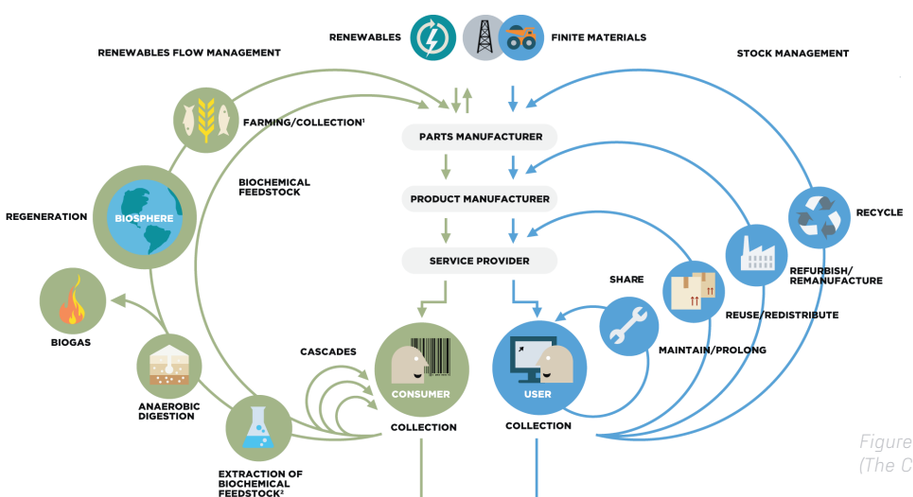


Figure 73. The circulare economy system diagram. (The Circular Economy in Detail, 2017)

Components to pre-manufactured modules

Function-oriented modules are created by placing all components with dependent tasks together. For example, a module for the media screens, media management, AC charging, DC charging, interface and climate management. The components most sensitive to technological developments, such as AC and DC charging modules, are separated from less sensitive parts, such as the frame and enclosure.

Figure 74 gives a practical illustration of the circular approach to construction. Here, the frame, housing and interface are fixed for a longer period, and all components sensitive to technological developments are interchangeable. This approach reduces the cost and intensity of any technical modifications that may need to be made in the future.

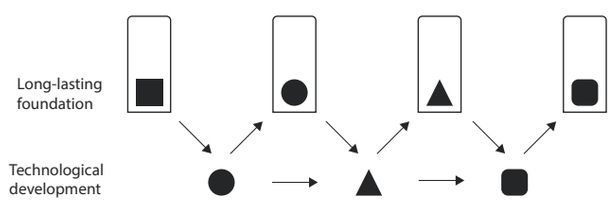


Figure 74. Circrular HUB approach

Future product portfolio

With a future vision, it is essential to consider currently existing products and those that are still to come. Therefore, in consultation with the two co-founders of Revolt, a final overview of the future product portfolio has been made. In figure 75, all possible combinations of the portfolio are shown. It considers the attachment, the number of charging sockets, AC or DC charging and fixed or loose charging cables. The options that have been desaturated and marked with a cross fall outside the future product portfolio. The project's scope is limited to redesigning the HUB with a modular interface for the entire product portfolio.

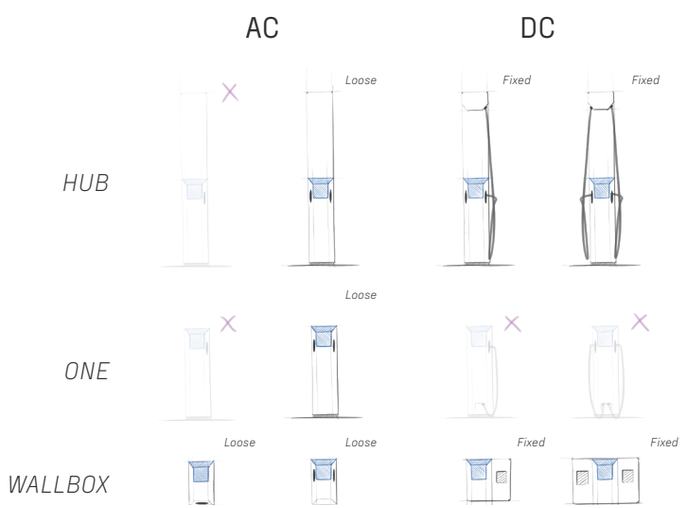


Figure 75. Future product portfolio

Figure 76. Unique modular user interface

Unique modular user interface

The survey and literature review showed that users prioritise the interaction of the charging station. Designing a unique user interaction is leading, followed by the frame and overall design. The decision was made to develop a unique modular user interface for the entire portfolio to strengthen the Revolt brand identity, increase recognition, and reduce costs. (figure 76). It is therefore essential to create the interface so that it could also fit on other products. This includes size, interaction and attachment of the module.

Modular enclosure design

During the enclosure design, the integration of the ONE will be taken into account. The design of the ONE that Revolt retails is not manufactured by Revolt itself but is bought from Streetplug and then resold. It will be examined whether it is possible to integrate the ONE's enclosure into the HUB to create a high degree of recognition (figure 77). This modular design makes it possible to save costs for the HUB because the overall production volumes of the HUB are lower than the ONE.

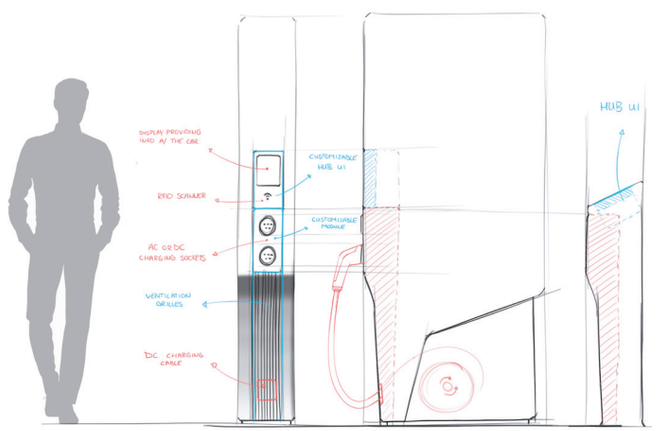


Figure 77. Modular enclosure design

Desired interaction

The interaction is leading. Scenarios were written in which a distinction is made between fixed and loose charging cables to better understand the interaction (Appendix 20). Also, consideration was given to what a novice EV driver might encounter compared to an experienced EV driver. The scenarios are drawn up in cooperation with several starting and experienced EV drivers within Revolt, Streetplug and Aim for the Moon. Based on this, it can be said that a physical charging cable significantly impacts the interaction positively. In addition, a solid information provision in which all desired information is available via a display will be necessary. Unintentional errors must be prevented through positioning, visual indications and text, also known as Poka Yoke. The desired interaction can be seen in figure 78. Based on the future product portfolio, the decision was made to exclude the physical charging cables from all AC charging stations.

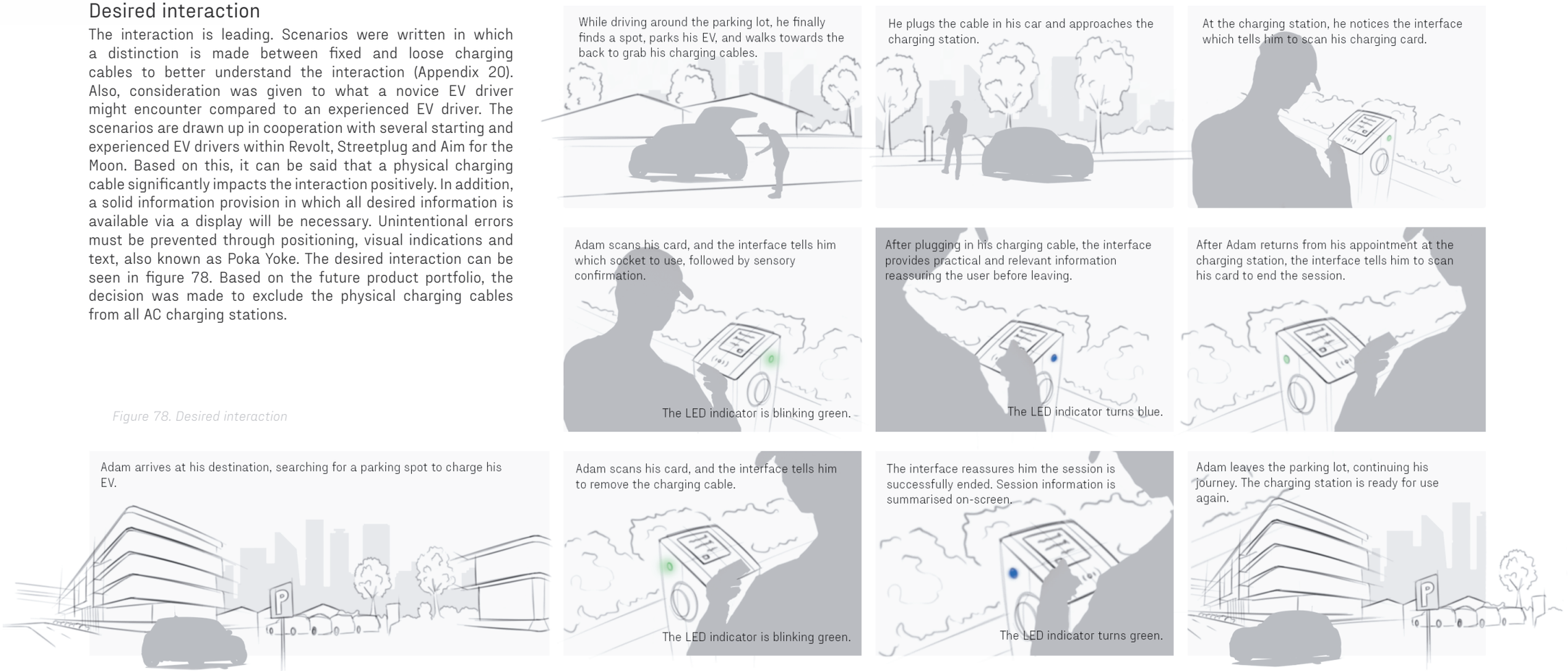


Figure 78. Desired interaction

Desired appearance

The findings have shown that little value is attached to the appearance. Therefore, the appearance of the HUB serves the interaction and the outdoor advertising. The fact that the HUB is a charging station will have to be enhanced, while the interaction must be visible from a single glance. The total volume may become more, but visually it will be kept to a minimum using visual tricks. For example, the volume can be reduced optically by using colour, highlights and shadows, proportions and textures (figure 79).

In addition, the interaction also consists of aesthetic experience (page 62. By using this aspect of interaction in the right way, a certain status can be achieved in terms of quality and durability. For example, the material's strength, thickness and type can influence the aesthetic experience.

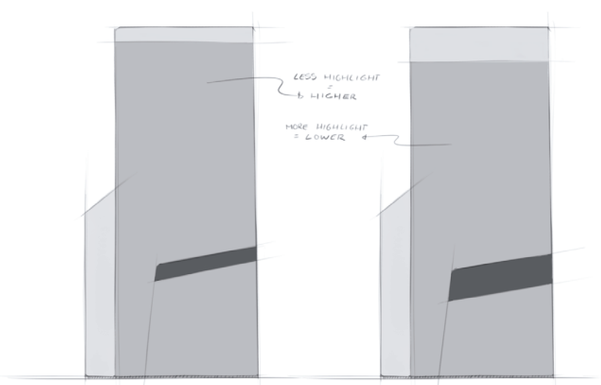


Figure 79. Visual tricks

Figure 80. Embodiment atmosphere

Moodboards

During the project, much use was made of mood boards. For instance, mood boards were created for form, materials, emotive, detailing and interaction. An overview of all the mood boards can be seen in Appendix 19a and 19b.

The mood boards conveyed a feeling or ambience while communicating the design direction to Revolt. The collections of photos and images create an atmosphere that fits the vision of the design direction. The form collage was used in particular for the general design. The contrast in the use of colour was taken into account immediately. The example in Figure 80 clearly shows that large surfaces are covered with a light colour. As the form becomes more complicated because the number of details increases, a darker colour is chosen to maintain the design's calmness.

The mood boards on detailing and interaction focus on the possibilities for visual solutions for the aesthetic appearance and experience of meaning. These components evoke sensory and cognitive stimuli the most and greatly influence the interaction.

Overview 6. Moodboard

07.3 Interaction exploration

This section provides an overview of the design process for the intended interaction for the redesign. Important thoughts and findings are set out to justify the choices made during the conceptual exploration. The end of this section shows the direction chosen for the final conceptual design. In Chapter 08, further details are provided and the final concept is shown.

Recognisability

Remarkably, no visual indication at the HUB indicates that a vehicle can be charged. The charging sockets are visible but are challenging to spot due to a viewing angle of 180 degrees maximum. In this case, the placement ensures users do not see them when approaching the HUB from the other side. A significant difference is immediately noticeable in experiments with placing a ONE next to the HUB (figure 81). Placing the sockets on the side of the HUB increases the viewing angle. Besides that, placing the sockets at the side of the HUB has another significant advantage; it increases the overview of the interaction and reduces the chance of ambiguity. The user can either use the charging socket on the left or right.

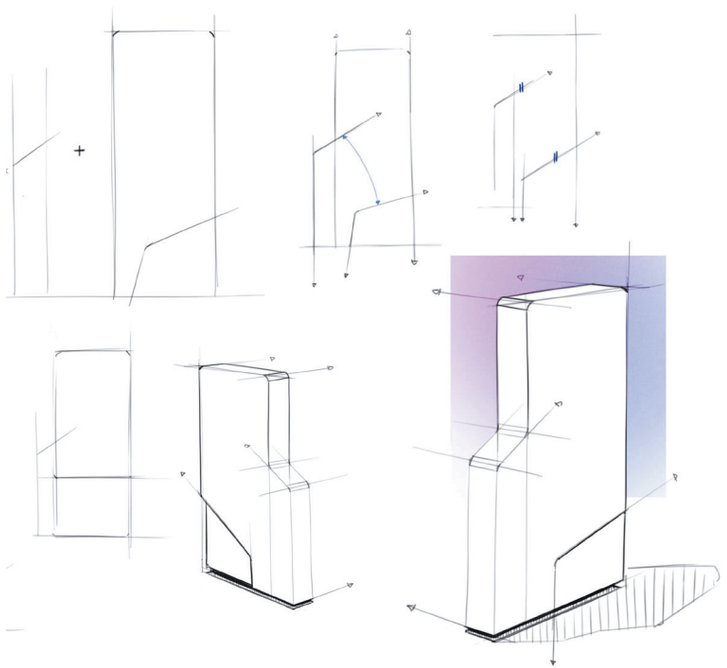


Figure 81. Experiment HUB and ONE

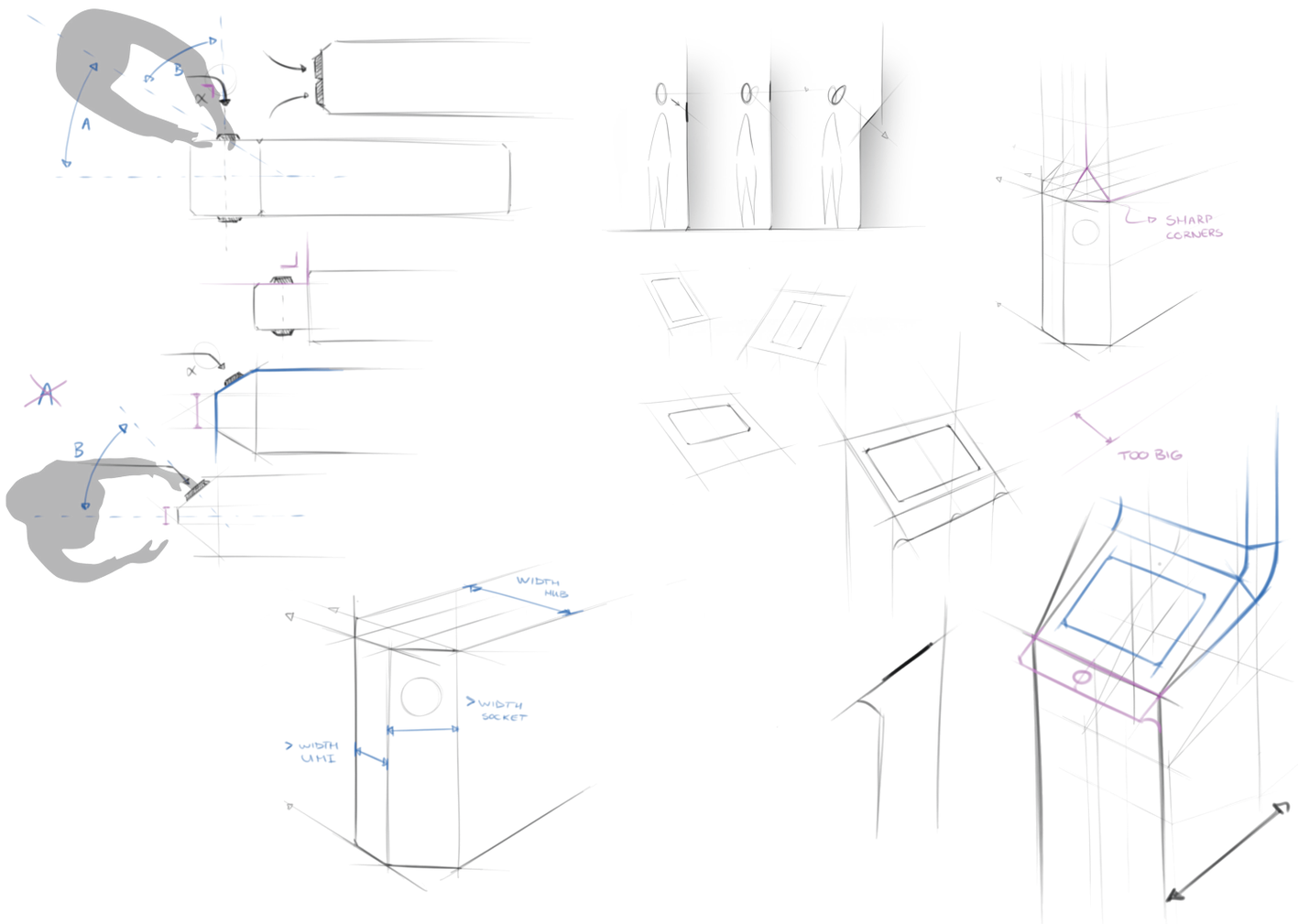
Positioning charging sockets

The vertical alignment of the charging sockets is inconvenient, and a charging plug can obstruct actions during charging unfavourably. Placing the sockets on the side of the HUB offers the possibility of making a clear interaction separated by an interactive display.

The HUB is wider than the required width for the interaction part because of the thickness of the two media screens. However, the difference in thickness can benefit the interaction because the sockets are slightly turned towards the user. This makes it possible to see all components part of the interaction at a glance.

Interactive display

An interactive display is less suitable if placed vertically (Schultz et al, 1998). Finding the optimal viewing angle increases the readability; thus, information can be read more easily from the display. Research by Schultz (1998) shows that 92% of the participants prefer the screen at an angle of 30° and 55°, and almost half (46%) adjusted it between 44° and 49°. In this study, a 2.5th percentile Japanese female and a 97.5th percentile United States male were taken into account. The screen's height is 116.68 cm (when placed in the horizontal position) from the floor. This distance is equivalent to the total length of the ONE, with 115 cm. For this project, the number of degrees of screen tilt is fixed at 47°. This number is based on the acquired data and will be used as starting value for the user test. Testing the interaction will eventually lead to further optimisation of the height and angle.



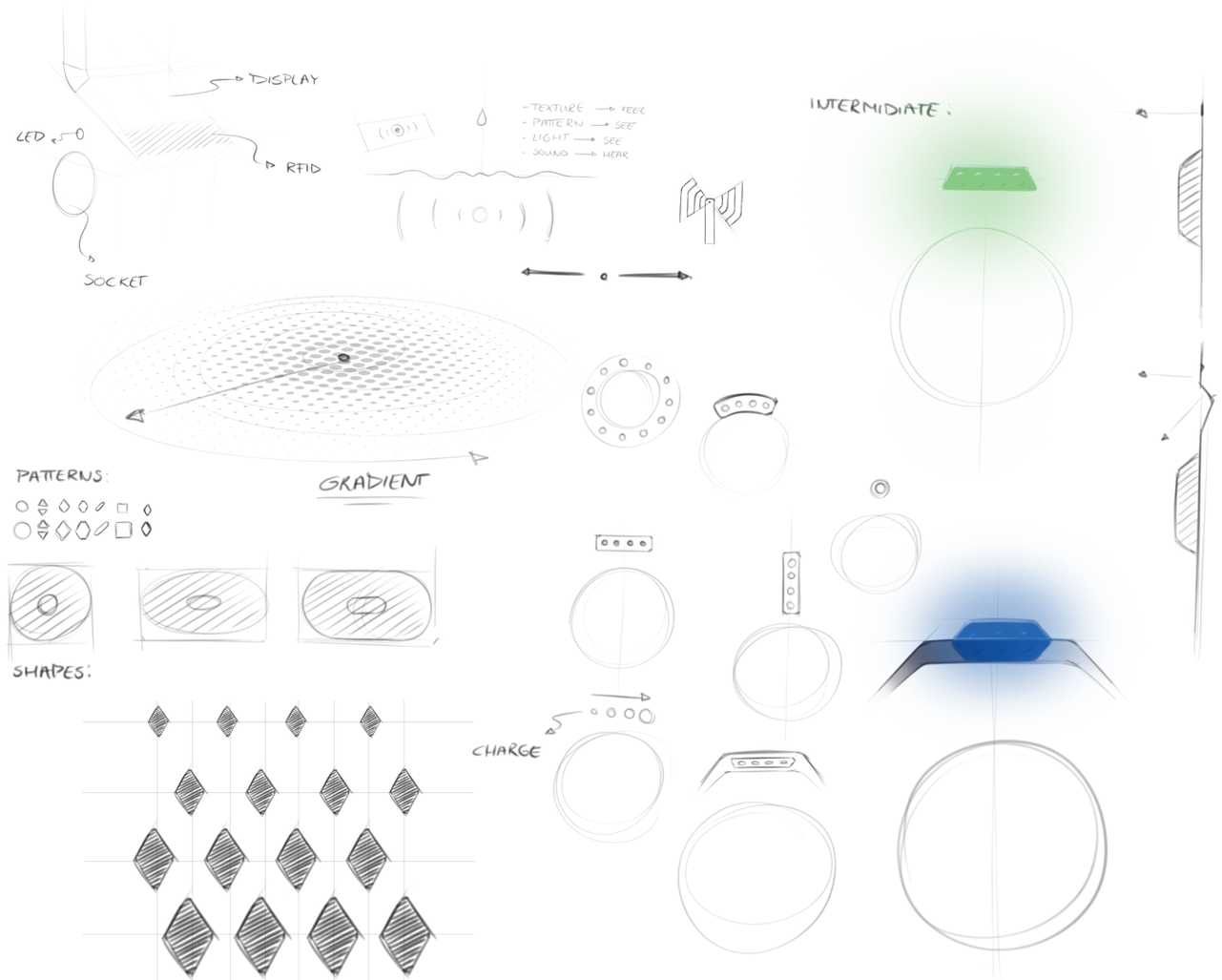


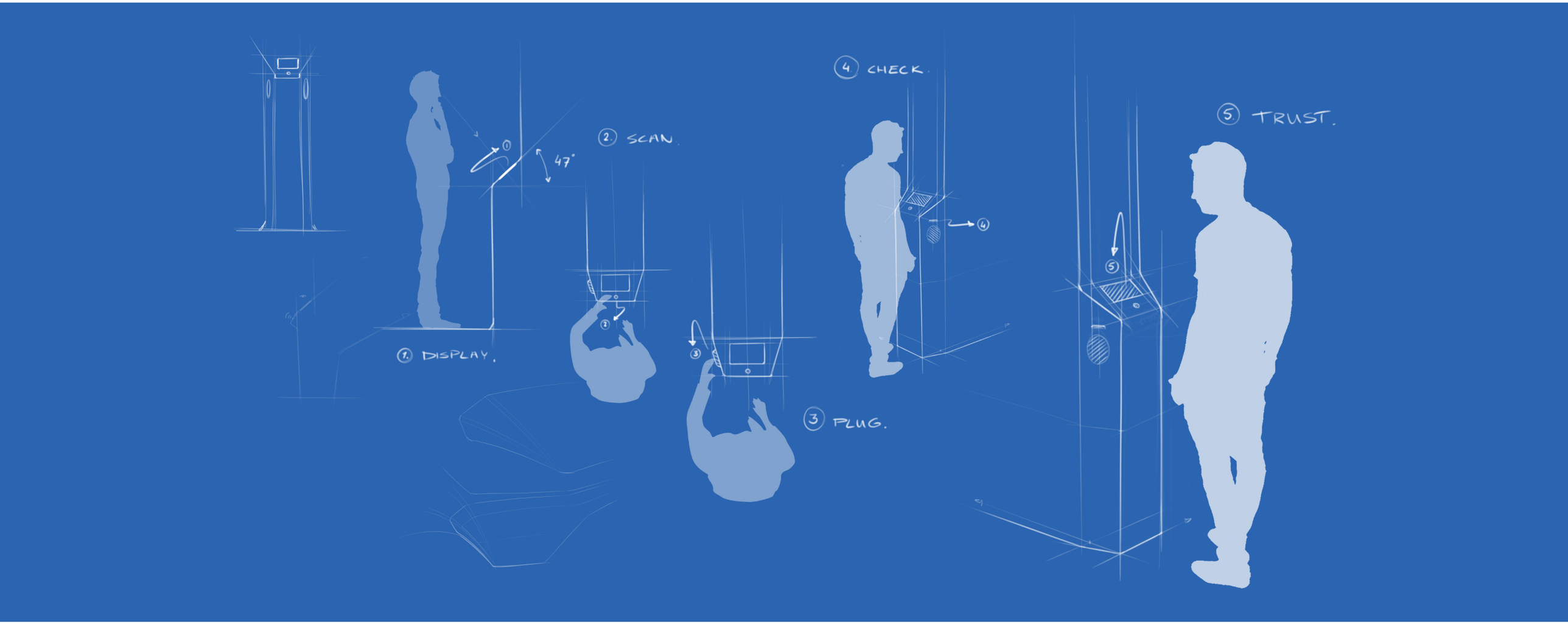
Figure 82. Exploration - LED and RFID scanner

Starting a charging session

The luminous droplet above the charging sockets must be scanned to start a charging session. This part needs repositioning and clarification to allow the process to run naturally. The scanner is part of the modular user interface and is designed with the screen as a pre-manufactural part. It is, therefore, necessary to place the scanner near the screen. Placing the scanner above the screen will result in users performing actions in front of the screen. This action is inconvenient, as it reduces the overview of the interaction. It was decided to position the scanner beneath the screen to ensure that information can be read at all times without obstructing the interactions overview. In addition, symmetry is essential to make clear that a user can use either the left or right charging socket.

LED indicator

The current function of the LED indicators is to show the status of the socket; ready to charge, charging, or fully charged. This is done using a green or blue colour. The indiction will only be used as a visual aid to confirm the status to avoid confusion. With intermediate charging stations without a screen, this is the only way of feedback which may be inconvenient for beginning EV drivers. Concerning the redesign, the required information is already displayed on the interactive screen. Therefore, it is decided to let the LED indicator fulfil the function of a subtle status indicator and be used as extra guidance or backup. Visualising the battery percentage using the LED indicator (figure 82) has been considered, but this could confuse the essence. This assumption is unvalidated and should therefore be tested during the user test.


1. DISPLAY.
2. SCAN.
47°
3 PLUG.
4 CHECK.
5 TRUST.

07.4 Frame exploration

This section provides an overview of the design process for the intended frame architecture for the redesign. Important thoughts and findings are set out to justify the choices made. The end of this section shows the direction chosen for the final conceptual design. In Chapter 08, further details are provided and the final concept can be seen. Designing the frame is not a linear process, but consists of repeatedly going through iterative circles based on the order in which the designs are discussed in this section; interaction, frame, and form.

Identifying new components

In addition to the current AC charging facility, Revolt desires the possibility of DC charging in the redesign. The difference between AC and DC charging is the current being converted by an inverter in the car, whereas with DC charging, the current is converted in the charging station itself. A DC module can send more power to an EV faster due to the lower resistance of the direct current and a higher load on the power network. Separate DC converters will have to be placed inside the HUB that can convert the current enabling DC charging. From conversations with both Revolt and Streetplug, the envisioned DC module comes from the brand Huawei. The modules are available in two different variants; 20kW and 40kW (figure 83). Both modules are equal in height, but the 40kW module is 36 mm thicker and 80 mm shorter. Exact 3D models of the DC modules are not available, but for the concept creation of the frame, the given dimensions of Streetplug can be considered (figure 84).

It is not yet sure which modules will be placed in the HUB, but for the architecture of the components, the 20kW modules have been taken into account based on the technical developments and suggestions by Streetplug.

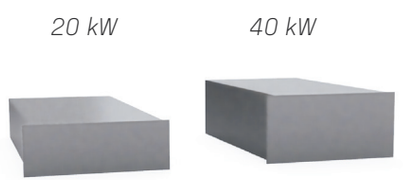


Figure 83. DC module - 20 kW and 40 kW

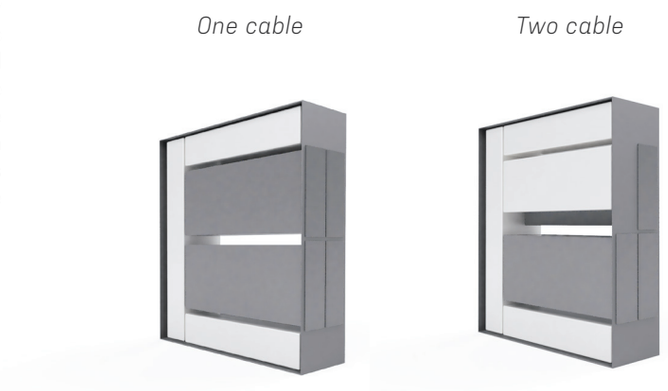


Figure 84. DC module - one and two cable layout

Additional components

Apart from the possibility of DC charging, several small components may be important in the future. These include a face recognition sensor, a light sensor and a solar cell. The reason for installing a face recognition sensor is related to programmatic advertisements. This feature makes it possible to target advertisements on age, gender, ethnicity and emotions. With this data, new and more targeted campaigns can run on the advertisement screens, which makes it more attractive for advertising agencies.

The light sensor has a particular impact on the energy consumption of the screens. Because of the large stock of screens, it is not possible for the time being to place energy-efficient LED screens in the HUB. A solution that can save power in the short term is a light sensor that measures the intensity of the light. This allows the screen to lower its brightness, for example, when it is cloudy.

As discussed earlier, it is impossible to compensate for the Hub's energy consumption with solar cells. However, adding a touch screen only increases energy consumption. The placement of a solar cell on top of the HUB is, however, sufficient to compensate for this energy consumption, assuming the touchscreen is on two-thirds of the time. A motion sensor is placed above the touchscreen so that the touchscreen switches on when a user is in front of the charging station to increase the lifespan and reduce energy consumption. This ensures that the activation of the screen has a maximum of 16 hours.

Identifying component development

Before the ideation of the construction of the new frame was started, a meeting was held with the product manager of Streetplug to see which components would be developed. This meeting concluded that the size of the facility required for AC charging would be reduced by approximately 65%. Because Streetplug will be building its own controller, this will combine the functionality of various components. By developing this controller, the new AC charging facility will consist of an internal charging socket, an external charging socket, and a controller. The dimensions of the final product are not available, but for the concept creation of the frame, we can consider the supplied estimated measurements of Streetplug (figure 85).

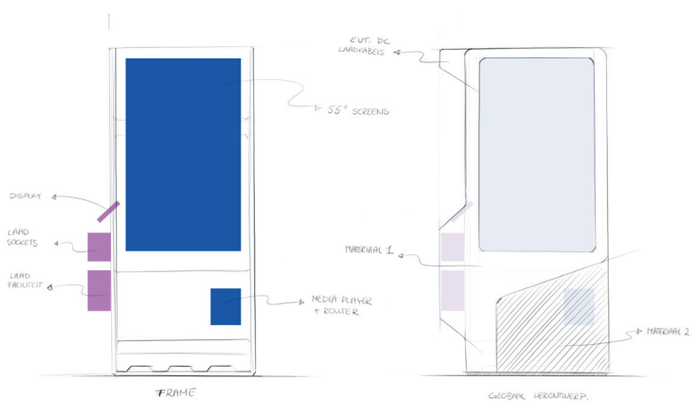
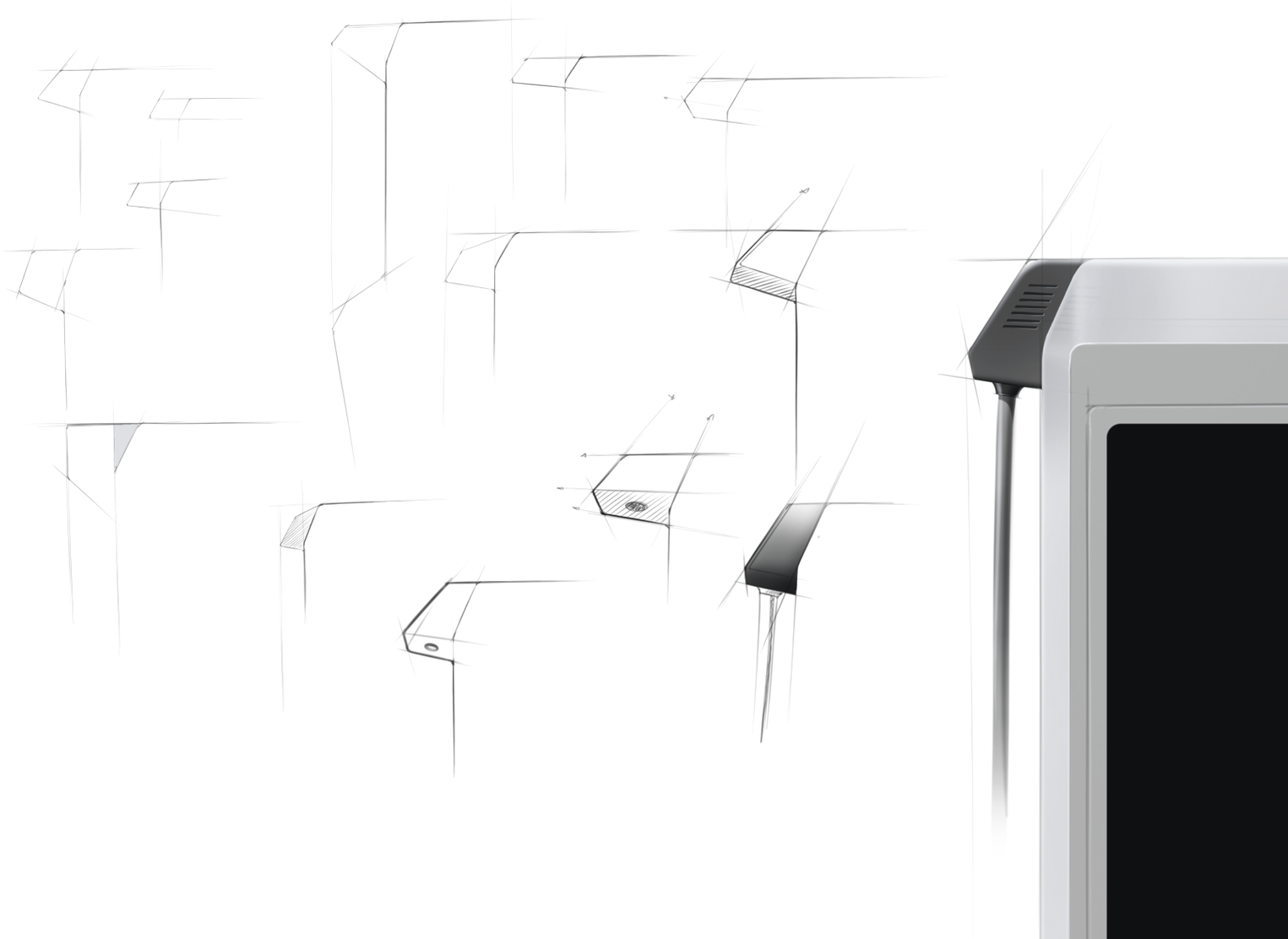


Figure 85. Supplied estimated measurements

DC charging opportunity

Fast charging significantly impacts the design since many additional components are needed internally. For example, in addition to converters, fixed cables are needed that can be plugged into an EV. This is not a choice, as DC always requires fixed cables. A consequence is that internal space must be reserved inside the frame so a pre-manufactured DC module can be installed when needed. The charging cables will be attached at the top of the HUB since the weight can negatively impact the interaction. This location enables the user to experience the least effort plugging the cables into an EV. Furthermore, it also increases visibility and recognition since users can notify the charging cables as a reference for a DC charger.



Current combination vs. new combination

Now that there is transparency on all possible components and the requirements, a balance can be established. New components will be combined based on function, requirements and modularity. Overview 7 shows a comparison between the old and new situations.

The interdependence of the components in the current HUB is exceptionally high. This makes it impossible to implement changes for some components. The new structure does offer this possibility and therefore requires less radical modifications when further development starts.

The interaction exploration results show that the components for AC charging and the interface are outside the frame. This offers the possibility of isolation and modular integration of the ONE.

OLD:

- AC sockets + LED indicator + RFID scanner
- AC charging comvponents + Media components
- Media screen + climate management + enclosure
- Frame + enclosure
- Climate management + enclosure
- Enclosure

NEW:

- AC sockets + AC charging components + LED indicator = AC charging facility
- Touchscreen + RFID scanner + motion sensor = Modular user interface
- Media screens
- Media department
- Climate management
- Enclosure
- Frame

- DC charging facility
- DC charging cables

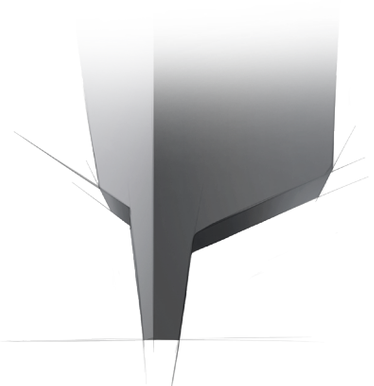
Overview 7. Component comparison

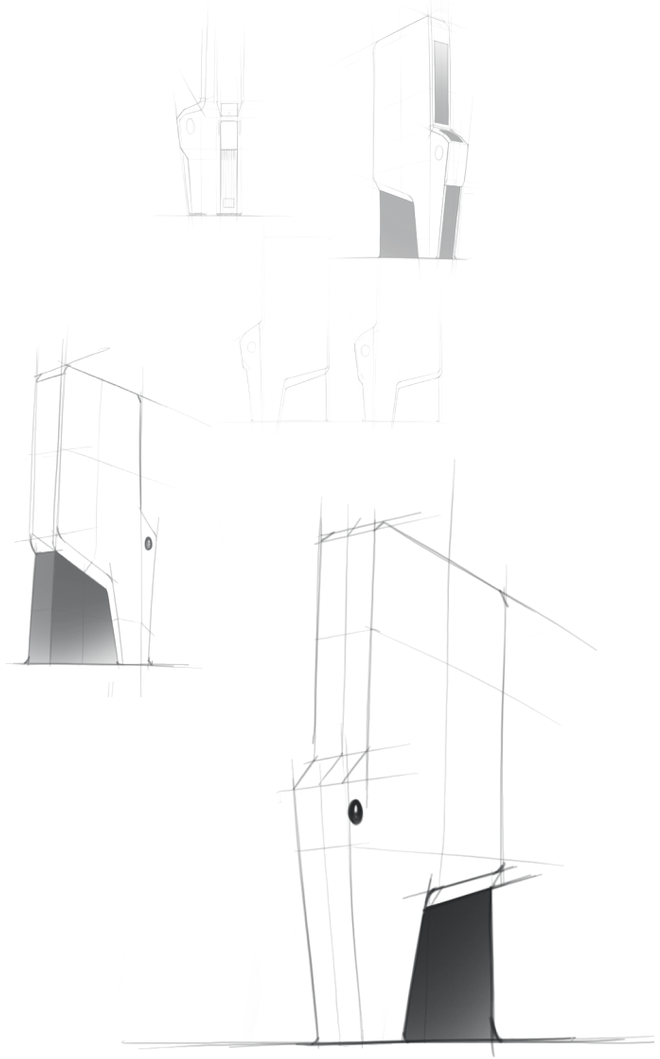
07.5 Form exploration

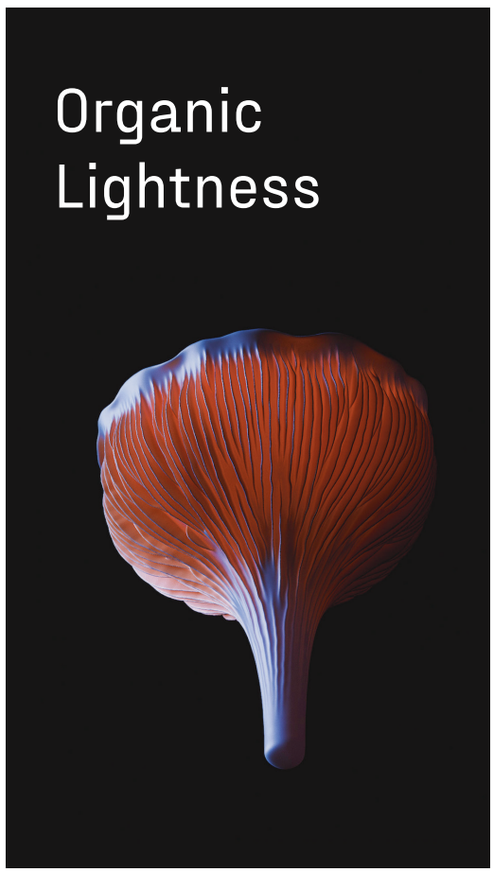
This section provides an overview of the design process for the intended external design for the redesign. Important thoughts and findings are set out to justify the choices made. The end of this section shows the direction chosen for the final conceptual design. In Chapter 08, further details are provided and the final concept can be seen.

General shape

The total volume of the HUB will be technically brought to a minimum, whereas the shape will try to contribute as much as possible. By using dynamic lines, the lightness of the design will increase. Surfaces will start narrow and end wide to make them seem less present. In this, the use of colour is crucial. By giving the less essential surfaces a darker colour, surfaces attract less attention. The same principle can be applied to the thickness of the design.







User friendliness

Making a product more approachable can lead to an increase in charging sessions. Animation is a good example where an impression that an object or person communicates is clearly visible. Bad guys are usually shaped by straight lines interspersed with sharp corners, while the characters that have a friendly appearance are designed much more curved and smooth. This is taken into account to increase the approachability of the HUB, especially in the curvature of the enclosure's corners and interaction screens' surfaces.

Shadow and highlights

Flat surfaces can often appear unwieldy, despite their precise shape. Surfaces can be made optically smaller by adding bevelled sides. As a result, these sides catch more or less light (figure 86). Trying different options will ultimately ensure the right balance of factors.

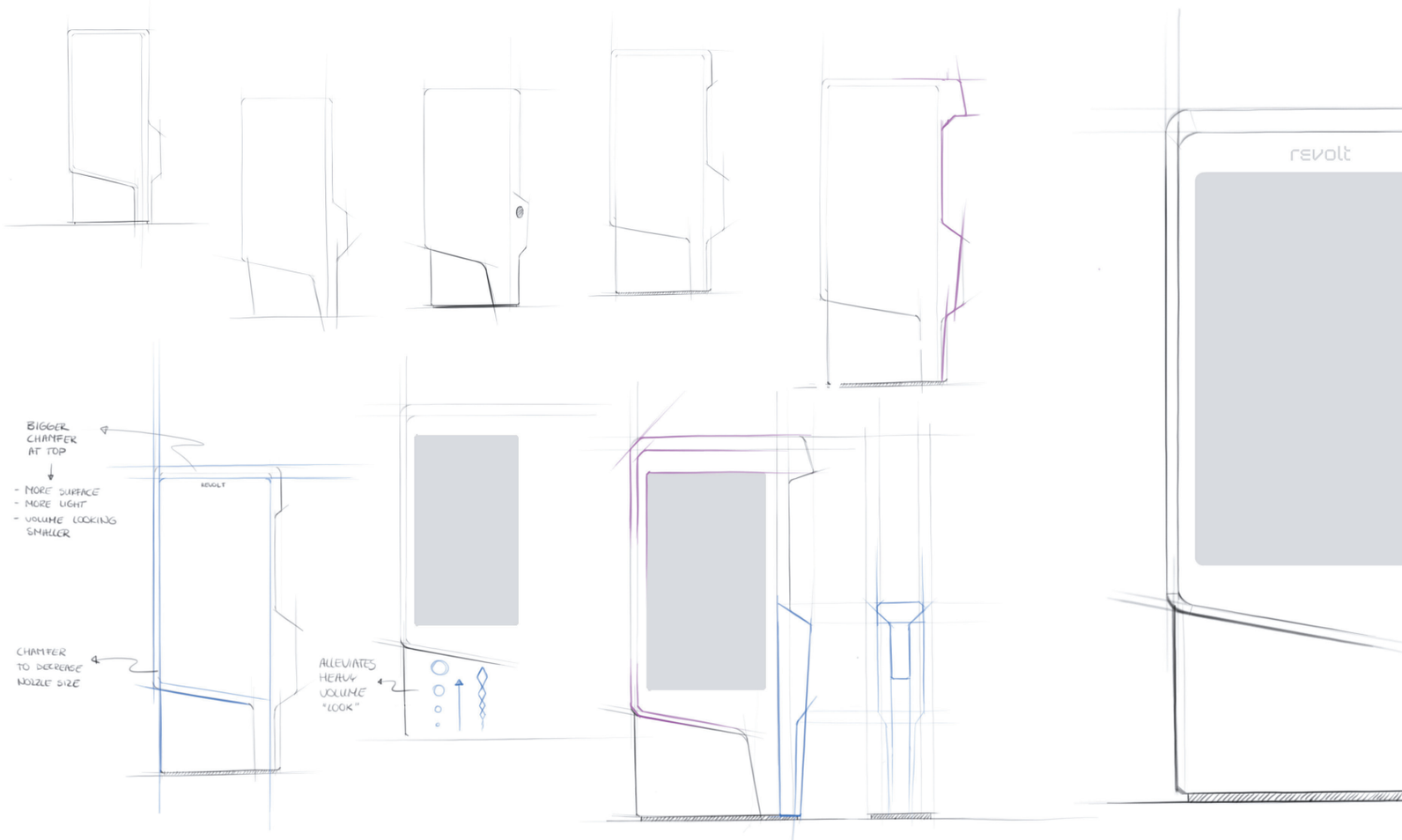
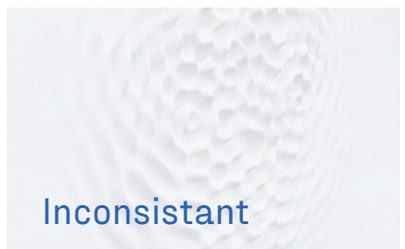
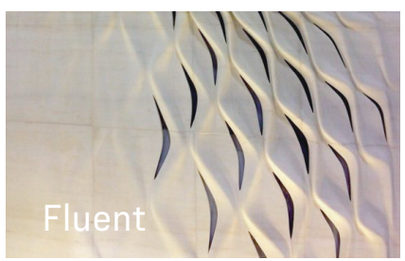


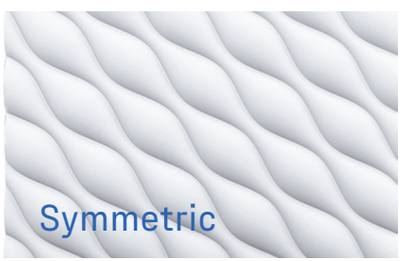
Figure 86. Ideation

Textures

Textures around the main surface can have different functions. During the exploration of different textures, the aesthetic experience and experience of meaning for users were taken into account. The texture must contribute to a durable feeling. Organic shapes give a more natural feel than modern, clean lines and are therefore more suitable. Also, the texture can remind people of climate change by using related shapes. Multiple textures related to nature were researched for optimal results.







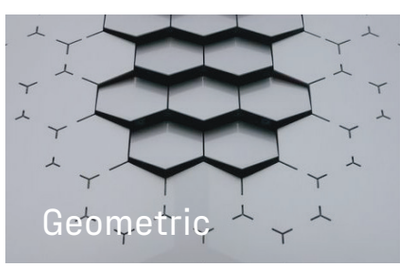
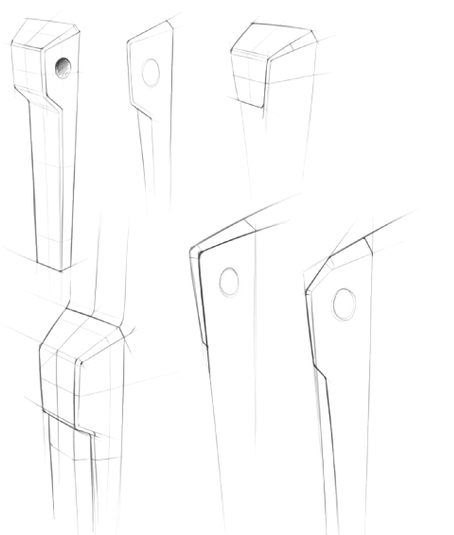
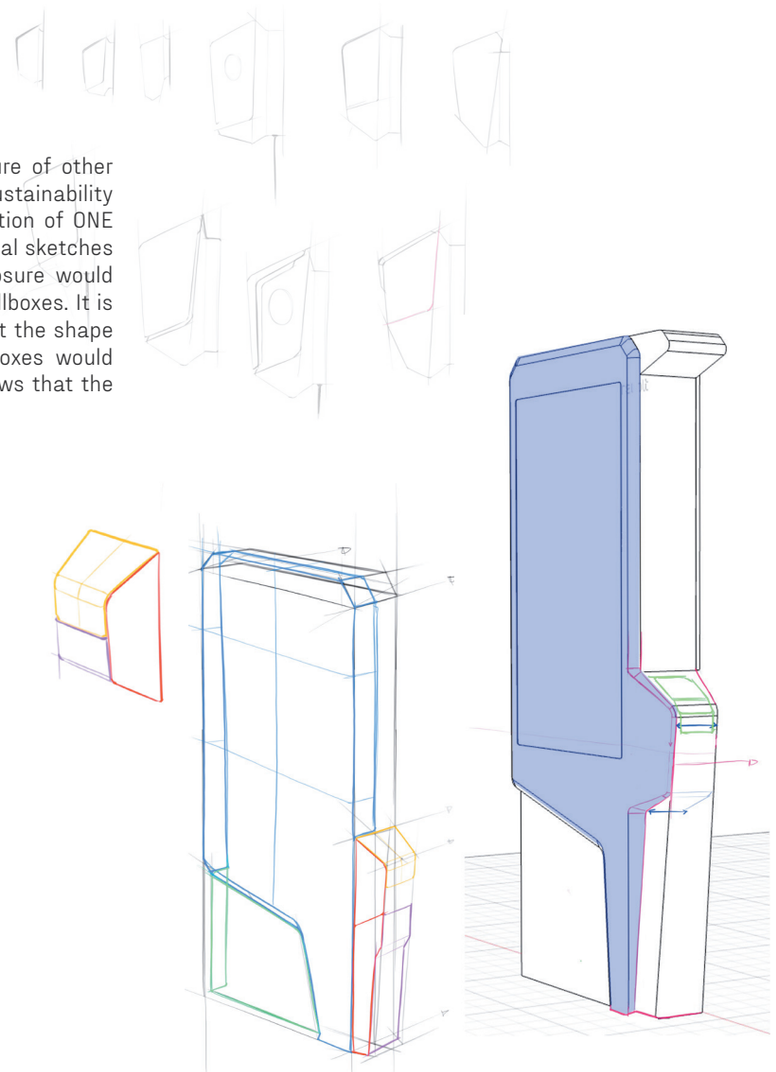


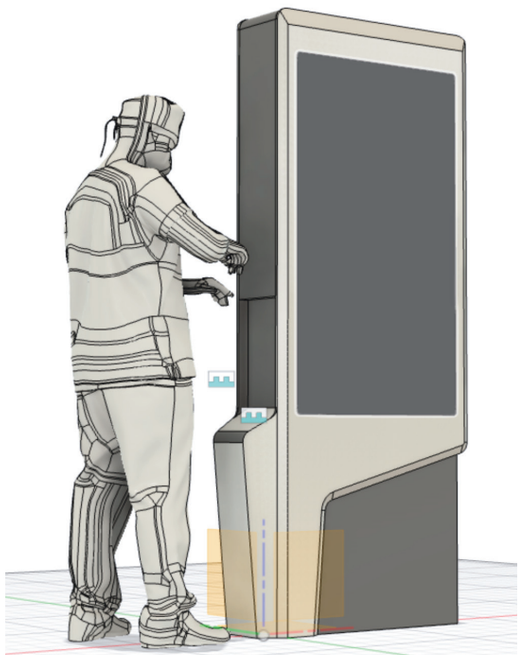
Figure 87. Depth Wallbox

Modular enclosure design

An attempt was made to incorporate the enclosure of other products into the HUB design, to increase the sustainability factor. This way, the HUB would be an amalgamation of ONE and the wallboxes. After many attempts with manual sketches and 3D CAD models, it turned out that the enclosure would have a detrimental impact on the design of the wallboxes. It is possible to use the enclosure, but this would affect the shape and interaction so that the volume of the wallboxes would become awkward for wall mounting. Figure 87 shows that the depth of the wallbox is the main problem.





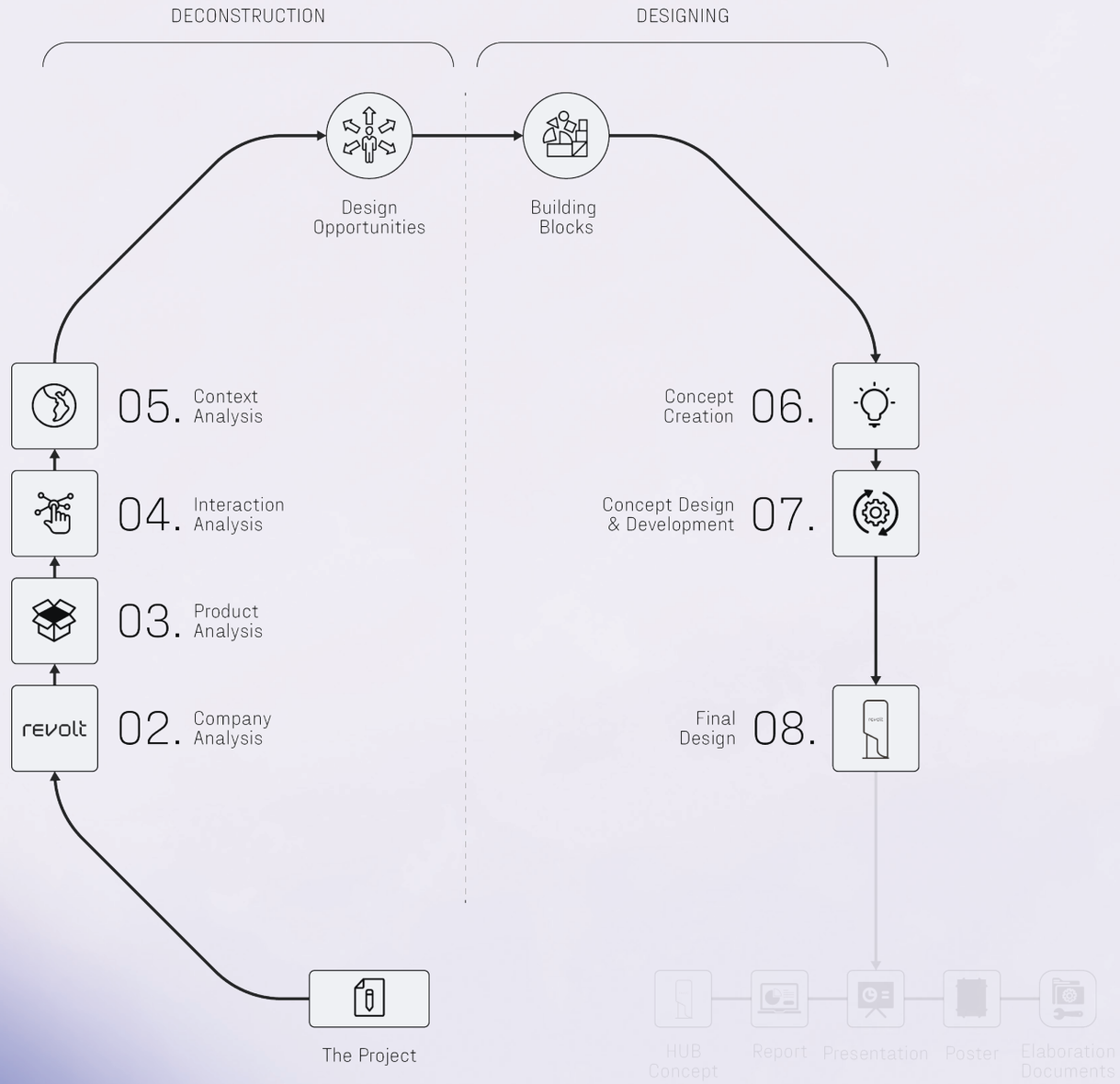


3D proportional reference

It was decided to make interim models in Fusion 360 to evaluate the chosen design. The reason for this is that the redesign is about saving centimetres. Therefore, checking provisional ideas by creating a 3D CAD prototype is essential.

08. Final design

In this final chapter, the exploration of the concept phase has been developed into a final design. The final design includes a general introduction to the design. Hereafter, the final interaction, technical elaboration of the frame, and detailing of the external form will be discussed. Finally, the final design is provided with a technical validation that serves as a briefing for further elaboration.



08.01 Final design
08.02 HUB interaction
08.03 Frame architecture
08.04 Colour, material & detailling
08.05 Technical development

revolt

BASE

The encompassing foundation to start building


CHARGE
THE
FUTURE
revolt

08.1 BASE design

Revolt BASE

The re-naming of the product is perhaps the first thing that stands out about the redesign of the HUB. The meaning of HUB is an effective centre of an activity, region, or network (Oxford Languages, 2020). The word HUB is therefore appropriately chosen but does not contribute to the established core values of the redesign to the desired extent.

Revolt helps to build an ecosystem that provides customers with the required energy in the desired form. In addition, this unique product is seen as the flagship model within the product portfolio. Ideally, every Revolt customer has one or more HUBs, creating an exciting network for Digital Out Of Home advertising (DOOH). BASE has been chosen because it is essential to install as many BASE stations as possible to expand this network. The BASE serves as the encompassing foundation of the charging infrastructure, which can be expanded with multiple ONEs to create the desired amount of charging points.

The versatility of the redesign will be explained by its features ordered among the three established main categories: interaction, frame and form.

BASE

Modular user interface

The BASE station is equipped with a modular interaction panel allowing all necessary information to be displayed via a 7'' touchscreen. In addition, scanning the card ensures that a charging session can be started through a satisfactory interaction incentive stimulating various cognitive senses.

Modular ONE integration

As an optimal sustainability factor of this project, the interaction column of the can also serve as a new ONE. Because the AC charging facility is located inside the column, all the necessary technology is included. An accurately measured seam ensures that only a back plate is needed to complete the new ONE. The back plate is designed to accommodate the AC module.

1 Possibility of DC charging

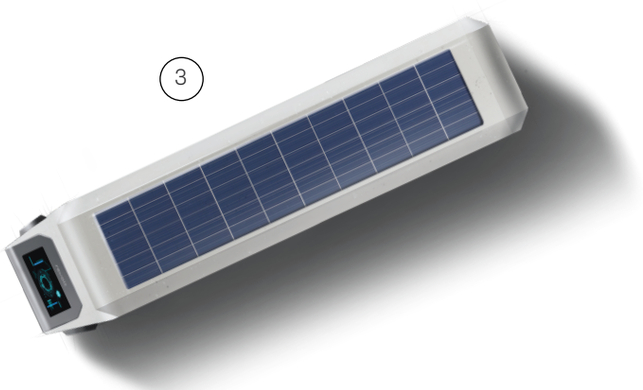
The redesign offers the possibility of placing four DC modules of 20 kW in the HUB. This means that it is possible to charge 80 kWh with one EV. Fast charging with two EVs is also possible. However, the space of one DC module is then occupied by a converter for the DC charging cable. In this case, it is possible to charge 60 kWh with two EVs.

2 Recognisability

The AC charging facility on the side to increase visibility and recognition that it is a charging station. Due to the increased viewing angle, users can now also see the charging sockets when approaching the rear of the BASE. In addition, repositioning reduces confusion about whether the BASE is a charging station or an advertising column.

3 Solar panel roof

Energy compensation for the modular user interface is provided by the solar panel that is placed on the flat top. Both the top and the rear side offer the possibility to mount solar panels.



08.2 BASE interaction

1

Surprising entrance

Behind the panel are multiple LEDs that communicate through multisensory signals that a transaction is started. The colour of the LEDs enhances the recognisability of Revolt by incorporating the gradient of the new brand identity. The movement of the gradient gives a satisfactory image which makes the start of a charging transaction feel less burdensome.

2

No required knowledge

The interface tells which steps to take and also caters for experienced users who are familiar with the procedure. This is made possible by the interactive display that allows the user to go through the interaction at their own pace.

Visual and textual confirmation

The text and visuals on display will show the user that the charging session has started correctly. In addition, the LED indicator will be an extra visual confirmation. This will remove any fears that come with charging the EV completely and correctly for an optimal charging experience.

Leaving confidently

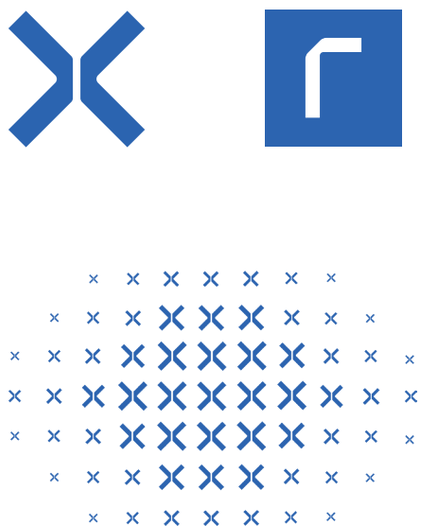
Get to an appointment or work confidently by having received all the necessary information. The display shows if the EV is correctly connected, the speed of charging, the battery percentage and the associated costs. As a result the user never misses any information and the EV can be parked in complete confidence.

Hit the road happy

After the plug is disconnected, the user will be informed in the same way by a summary of the charging session. This allows the user to continue the journey satisfied, increasing the chance of reuse. Building a loyal customer base is essential in a saturated market.

Brand driven design

The distinction and recognisability of the interaction is enhanced by an RFID scanner designed from the new brand identity. Its own pattern, derived from the ‘r’ of Revolt, will be the basis for further expansion of current and future products and concepts.



Responsive LED indication

The LED indicator is derived from the shape of a battery. By increasing the experience of meaning, users can unconsciously associate the LEDs with everyday experiences. For example, the LEDs will pulsate from left to right when the battery is charging. When the battery is fully charged, an all-green bar will be visible. Suppose the battery is 54% charged, only the last two LEDs will pulse from left to right. This makes it possible to have a remote indication of the battery percentage.

Guiding surfaces

A conscious distinction has been made between the colours of different surfaces. The border of the interface is made of a dark material to reduce distraction during interaction. The textured surface at the bottom also ensures that it is not distracting and the user's eyes are focused on the lighter surface or the interface.

08.3 BASE frame layout

Function-based component architecture

The new combination of components offers excellent possibilities for the architecture of all components on the frame. All internal components are grouped together according to function and requirements. This enables targeted repair and maintenance.

Pre-manufactured modules

The component layout makes it possible to produce the AC facility, Media components, DC facility and the modular user interface as pre-manufactured modules.

1 AC charging facility

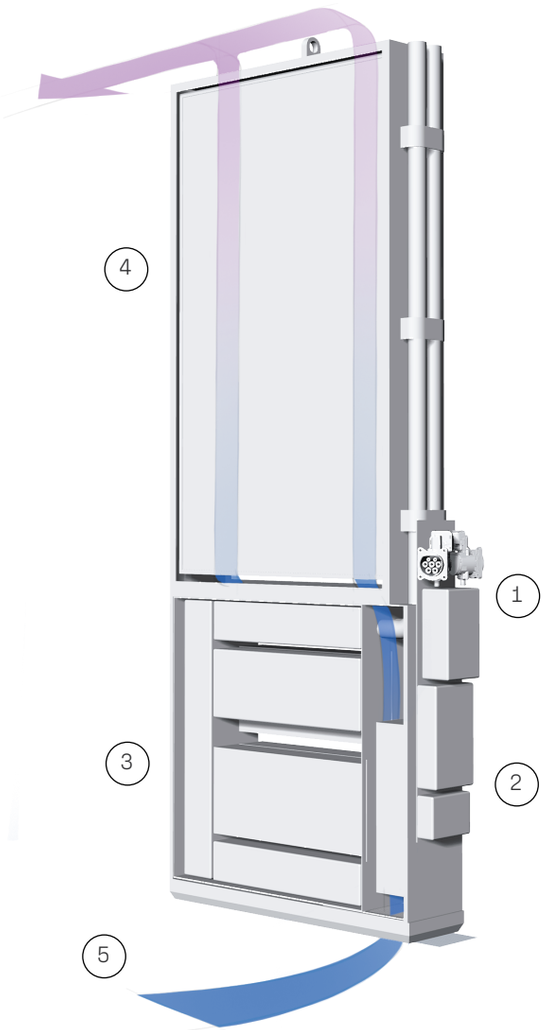
The AC charging facility is completely isolated, making it possible to use it for the ONE. The charging facility requires no cooling or heating and is therefore independent.

2 Media components

The media components are positioned in a separate area that is easily accessible for repairs and maintenance. The components generate their own heat and therefore do not need to be part of the climate management system. The amount of heat cannot cause overheating, so there is no need for cooling.

3 DC charging facility

Many technological developments are made to the DC modules and Revolt also wants to offer the customer customisability about the number of modules. For this reason, a choice was made to make a pre-manufactured casing containing all the necessary parts for the DC charger. It is possible to charge up to 80 kWh for one EV or 30 kWh for two EVs.

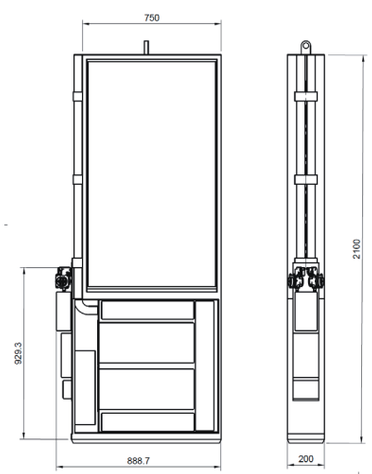


4 Screens

The two screens are attached to a central panel in the middle of the frame. Besides the fact that this makes the HUB much thinner, the panel replaces the function of the lifting beam by ensuring that the frame does not twist. The screens are suspended in an enclosed space, allowing a controlled airflow to dissipate the heat from the screens via a fan at the top.

5 Optimised climate management

The impact of the climate management system has been reduced to the technical minimum. Insulating the screens ensures that a cooling unit at the bottom of the BASE supplies cold or warm air and a fan inside draws the air out of the BASE. Sensors in the BASE regulate the intensity of the system, so overuse no longer occurs.



08.4 BASE material, colour & detailing

By taking into account the possible development of sustainable and environmentally friendly materials, the decision was made to provisionally choose a production method. This choice was made on the basis that it is not the specific composition of sustainable material that is the most important, but the method of production. In the coming period, there will be a lot of development in finding the right composition for the right properties, but little will change in the production method.

Material

In the future, production methods will hardly change, but the composition of a material will be constantly optimised or completely renewed. This makes it more secure to design the sheet metal parts for a specific production process than for a specific material.

1 *Main body*
For the main body, the choice was made to manufacture it from a bio-composite of the company NPSP. The material consists of bio-based and circular raw materials that can be reused after a long life. The natural fibre-reinforced plastic demonstrably reduces the environmental impact. The fibres are visible in the material, which makes it easy to establish a link with the sustainability of the HUB. Further technical explanation of the possibilities and manufacturer validation can be found on page 124.

2 *Interactive body*
The material on which the modular user interface is mounted is a biochar that permanently locks in carbon, making it carbon negative. The material is injection-moulded into the desired shape by the company Made of Air (MoA). The fact that this part is also incorporated in the ONE makes it possible to have higher investment costs than other parts. When the sales of the HUB are sufficiently high, the possibility of producing the entire HUB from this material can be examined. Further technical explanation about the possibilities and validation of the manufacturer can be found on page 124.

3 *Textured body*
For the textured body, just like the interaction panel, MoA's carbon negative material was chosen. The texture on the panel makes it possible to add more carbon to the composition of the material. The more carbon is added to the material, the more brittle the material becomes. In some places, the texture creates a larger diameter of the material, allowing it to withstand higher impact levels.

08.5 Technical validation

The final section evaluates the research to enable further development of the concept in the future. In this section, the most important parts are outlined based on the validation and recommendations of the companies involved in the project. The components that will be discussed are the frame, the enclosure, and the modular user interface. The actual next steps for power consumption, brand-driven innovation, testing, and rough prototyping are outlined in the recommendations on page 129.

Frame

The frame consists of a large number of parts that are necessary for the product to fulfil its function. Streetplug and Verborg Engineering have extensively validated the configuration of the layout. The amount of fans in the BASE is sufficient, however, no definitive solution has been found for the air-conditioning unit. This is partly because it is unclear whether the DC module needs a cool or heated air supply. It is therefore essential to work out the DC modules' technical properties to subsequently place a matching module for cooling.

On the recommendation of Verborg Engineering, the frame will be built from 3 mm sheet steel to create the required strength and stiffness. The enclosure and the frame are completely independent in design, but the enclosure will need fixing points on the frame. The frame will therefore need an initial prototype to check that the internal components meet all functional requirements. After that, we can look at how the design should be adapted to allow for the attachment of the body parts as well.

Enclosure

Main body parts

As mentioned before, the large main body parts will be made of a bio-composite. After a meeting with the manufacturer NPSP, a lot became clear about meeting all the requirements to prepare the production design. One of the first concerns the production number. It depends on the production number which of the two bio-composites will be used for the enclosure: long or short fibres. The long fibres have the advantage of having a great natural visual appearance. However, the freedom of form is limited. With the short fibres, there is the possibility of creating sharper corners and curves and a greater choice of colours. The final selection is limited to 1500 pieces as MOQ between both materials.

Accent body parts

The dark body parts are manufactured similarly to plastics: injection moulding. The decision to make the background of the interaction panel out of this material is not only of visual importance. However, it can also be produced relatively cheaply due to many ONEs. Further elaboration of the design is possible in cooperation with MoA since they have in-house application engineers who are occupied with optimising designs for their production method. Therefore, the design must be in a state where an application engineer can examine whether it is possible to take it into production. Revolt's task is to determine the design early on and ensure that it moves towards a manufacturable 3D model. The engineer indicated that it is not his job to design the product but only to optimise it.

MoA indicated an interest in cooperation since they have been looking for a company to design EV charging stations for a long time. Currently, the company is in a phase where they are conducting pilot studies, but this will have no further consequences if cooperation is established. So it may not only be an option for the BASE and ONE to use this material, but it offers potential for the entire product portfolio. An NDA has been drawn up to ensure that further collaboration takes place smoothly.

Modular user interface

The modular user interface consists of a pre-manufactured part that is assembled externally. One company that could do this is Dytos. The interface is made up of three different layers with a total thickness of 4.7 mm. The first layer is 2.0 mm chemically hardened glass, protecting the touchscreen and scanner from impact. The second layer is 0.7 mm thick Infrared (IR) and Ultraviolet (UV) resistant film. The film protects the display from overheating and reduces the reflection of sunlight. In addition, the film incorporates a sensor that indicates when an interface is broken, thus minimising the number of broken interfaces. The final layer is again 2.0 mm glass. It is possible to produce this from chemically hardened glass, but the manufacturer has indicated that this is not necessarily required. The interface has a bend between the display and the RFID scanner. It is possible to make the bend as long as it has a minimum radius of 25 mm.

The concept is to mount the interface on the enclosure and make it watertight with VHB (Very High Bond) tape. VHB tape is the easiest mounting method and ensures the highest degree of water tightness (Dytos, 2022). Because electronic components

are used, they must comply with explosion safety standards (ATEX). All components of the modular user interface comply with the ATEX standard. The MOQ for the displays is 500 pieces. Dytos has indicated to be open to cooperation and to take on the full production and assembly. The result is a complete user interface that can be placed directly on the BASE stations.

Overall planning

A planning has been created to ensure that the remaining steps to be taken are transparent to all stakeholders. The planning can be found in Appendix 18 and focuses particularly on creating a prototype and test phases. The redesign must move into the test phase early to avoid further problems this time. In the planning, there is a distinction between three critical test phases: interaction-focused user tests, frame prototyping, and Minimum Viable Product (MVP).

The interaction-focused user tests must show whether the designed interaction meets the requirements defined in the list of requirements. During the tests, the ergonomic placement of all components and the actual completeness of the interaction will be examined. The user may not lack anything to ensure that the interaction is perceived as positive and that brand loyalty can be developed.

The placement of the components on the frame has been validated, but a prototype of the frame will have to show whether the climate management system can provide the BASE station with the correct airflow. The airflow of the screens is easy to test because they are placed in separate formwork. This means that only a prototype of the formwork containing two screens attached to a central plate needs to be made.

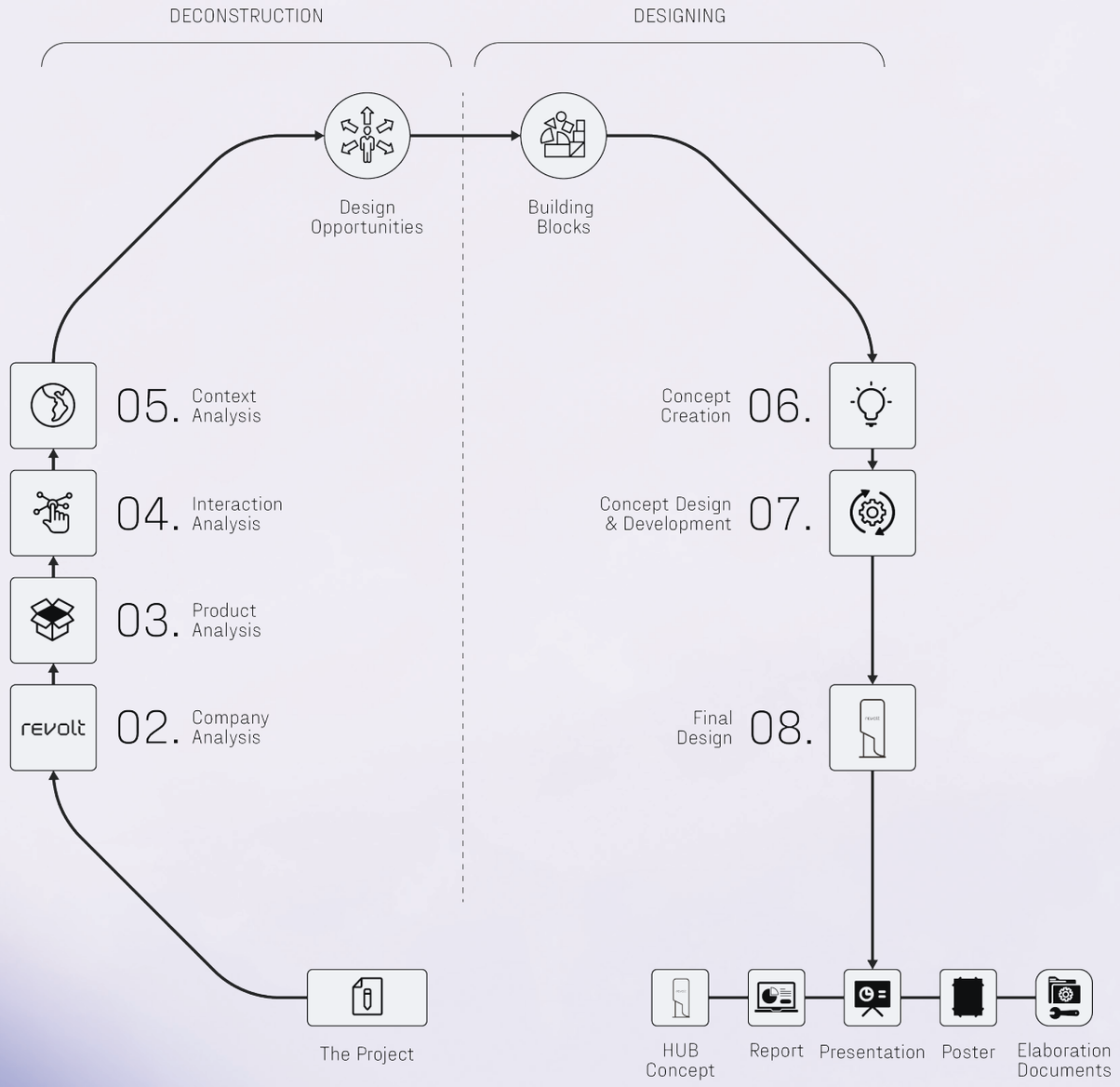
Once both tests have been completed, it is possible to move on to the next test phase. If both the technical components and the interaction meet the requirements, an MVP can only be produced.

Technical documentation

An extensive list of requirements has been drawn up for further elaboration and user testing. Further elaboration of the steps can be found in the recommendations section. The list can be found in Appendix 17.

09. Conclusion

The company analysis consists of six parts to understand Revolt accurately and make the reader acquainted with the company. Firstly, the brand values and operations are analyzed to understand why they exist and how they want to bring this into practice. An overview of the product portfolio will clarify which products they use in operation. The focus group will explain whom Revolt is targeting after the product portfolio indicates with what products they want to do this. Then, the current stakeholders are labeled to include them in the process. Lastly, contemporary competitors are described to understand Revolt's market position.stakeholders are labeled to include them in the process. Lastly, contemporary competitors are described to understand Revolt's market position.



09.1 Discussion

For this graduation project, four different areas were investigated to what extent adjustments to the current HUB could be applied to create an optimal strategic market positioning. The results of the research were converted into design opportunities that were clustered into relevant design directions. Three different concept levels were created based on the design directions, which, in increasing order, were in line with the ultimate market positioning. The final design direction was determined by a discussion with all relevant internal stakeholders.

The research showed that implementing minor modifications to the HUB was generally not feasible. This was caused by the fact that the product is an accumulation of interdependent components. Therefore, implementing adjustments is difficult since it results in a chain reaction of other adjustments needed to achieve the desired result.

A possible explanation for the result is related to the development of the product. The context analysis shows there was insufficient time to develop a well-considered design since a functioning concept had to be launched on the market quickly. After the first design, several iterations were applied. However, these were added components each time instead of a fundamental approach with a future view.

Another important finding was that the user research identified the interaction as the most crucial aspect and users wanted to eliminate the fear of not being fully charged. These results were in line with the results of the National Charging Survey (2020 and 2021) and EV Driver Survey Report (2020 and 2021). The research also shows that building a loyal customer base could be essential for further mass acceptance of the product. It is crucial to ensure that users have a positive experience with the brand to build brand loyalty and maintain subscribers.

As a consequence of these crucial findings, it was decided to investigate further opportunities to build brand loyalty by investigating the interaction of current best-selling charging stations. Combining the company analysis, interaction analysis and literature review findings concluded a theoretical future vision of the product portfolio. The reader should bear in mind that this thesis is based on combinations of theoretical findings which are not physically tested by the user group.

Based on these results, it was decided to rebuild the HUB apart from the frame. However, the interdependency of the frame itself caused consecutive major constraints in implementing the redesign. Consequently, the decision was made to build an entirely new frame by integrating all new and improved components. In addition, this design direction offers the possibility to integrate the Revolt brand values comprehensively, to let the interaction lead and manufacture the enclosure from more sustainable material.

Further research should be carried out to establish the validity of the theoretical future vision. Developing a prototype can verify the desirability and validation of the actual user interaction. The concept is a practical translation of band values, theoretical findings and the established vision. Therefore, generating feedback is crucial for the further development of the concept so that the strategic market position can be consolidated and an accumulation of unexpected defects can be prevented. The interaction with the user is leading and should therefore be extensively tested. Based on the feedback, possible adjustments to the modular user interface, the placement of the sockets, or the design of the LED indicators can be applied.

09.2 Recommendations

The research showed that it was necessary to redesign the HUB completely to guarantee a strategic market positioning and an optimal future perspective. The redesign of the HUB then became the physical embodiment of the theoretical findings of the research. Based on the findings and redesign, recommendations were formulated.

Being a Brand-driven innovator

It is essential to ensure a clear division of tasks regarding product innovation. Providing charging solutions is the core of the business, so Revolt must understand this importance. This project is about the HUB, but the theory about brand-driven innovation applies to all current and future products since this is about the company's organisation. In addition to outsourcing the design, development and production of the entire product portfolio, it is recommended to put more people on product development in the long run to gain a strategic position as a company in a vacant market. A first step could be that one person is responsible for creating all the designs. In addition, it would be preferable to have a person responsible for the technical developments in the market to work with to speed up the further development of products.

Energy compensation

The most important thing for a company is credibility, especially for a start-up. Decisive action must be initiated quickly to ensure the entire product portfolio is aligned with the brand values and statements. The energy consumption of the HUB is a major concern related to the established vision of Revolt. Using a solar panel on top of the HUB provides some form of sustainability. Nevertheless, the question arises whether this is the direction the company wants to go. The replacement of energy-efficient LED screens can be a step toward reducing energy consumption. In addition, the light sensor and a possible 'screen off at night mode' will reduce energy.

Testing with users

Targeted testing with users will lead to insights about the completeness of the interaction. It is essential to pay attention to the order and ergonomics of the steps during testing. There is a difference between new and experienced users. The physical parts are the same for both, but how they interact with the display can differ. In addition, optimisation of the positioning of the components is desirable to increase the ease of use. For testing with the users, use can be made of the list of requirements compiled from the intended interaction. The list can be found in Appendix 17.

Rough prototyping

Several components had not yet been developed to a concrete stage during the project, causing some delays in development. The fluctuating flow of information caused interim adjustments to, for example, the dimensioning and quantities of the DC modules. Enabling user tests through rough prototyping is essential for further developing the concept. In addition, it will be necessary to ensure that a choice of final components is made. A decision between DC converters of 20 or 40 kW is crucial.

Manufacturer collaboration

The research showed that the construction of the frame with the placement of the components had been technically validated, and further technical elaboration and specification of the components on the concept can be performed. In addition, the technical feasibility of the modular user interface has been confirmed by an external manufacturer named Dytos, which has indicated the ability to realise the concept. As far as the enclosure is concerned, it is more complicated. Production methods are complex, and the design requires further production-related elaboration. Nevertheless, an agreement has been given on the manufacturability of the main body from the bio-composite of NPSP. The exploratory contact with MoA has aroused their interest, and they want to see whether or not the complete product can be realised from the carbon-negative biochar. Nevertheless, it is recommended to contact MoA as soon as possible. In addition to the known information, it is necessary to have a clear idea of the requirements that must meet to guarantee further elaboration. This company has the highest expectations and best matches Revolt's vision. Co-creation can efficiently lead to developing the first product because many design choices are production-dependent.

Water resistance is a major requirement. Therefore it will be necessary to collaborate with the material manufacturers to develop the design. Co-creation will increase efficiency and lead to a first concept. As soon as the first concept is available, an alternating collaboration will occur between the further development of the frame and the enclosure. Both components are interdependent, as security in terms of fixing and waterproofness must be ensured. For a first concept, it is

recommended to develop an MVP so that it can be assessed by performing tests for waterproofness and climate management.

Own UI building brand loyalty

When using a user interface, the software must address a complete user experience. By designing a customer journey, it is possible to see which exact steps on the interface a user goes through. Based on these results, a user interface can be designed to meet the users' requirements and wishes. Combining an interface with an application can be a strategic move in building loyalty. An overview with useful information can be interesting for both the customer and the user.

Testing with passers-by

Another group that needs to be tested is the passers-by. This was not done because of the time pressure behind the project and the small amount of influence. However, for an optimal result, it is recommended to check how passers-by experience the HUB and how this affects the advertisement's visibility. These outcomes can be compared with the survey results in this project.

Person recognition for advertisement specifications

Research showed that some digital signage Abri's use facial recognition. During this project, there was no opportunity to investigate the possibilities and regulations. For targeted advertisements, it is recommended to investigate the possibilities of increasing the sale of advertising slots.

09.3 Personal reflection

By doing the project at a real company, I had the opportunity to experience how a start-up operates. I experienced many benefits, such as the freedom to make decisions, the informal atmosphere, and the development of completely new ideas. All these experiences made me reconsider what would work best for me. And while I had a pretty fair idea at the start of the project, it has been greatly refined since then.

My initial plan turned out to be very ambitious. It should be noted that the subject's complexity and scope were unknown at that point. Initially, the idea was to explore small adjustments to HUB through improvements. This would mainly be meant for the choice of materials and the interaction.

Soon, however, my eagerness forced me to face the facts. Under the guise of 'do not judge a book by its cover', discoveries were made that turned my project scope into a diffuse lens. The desire to end up with a 3D model to create publishable renders was far out of reach. Now I have to admit that I do not mind working on technical projects. It allows you to proudly tell your friends how many solar panels are needed to offset the HUB's energy consumption. However, working with many uncertainties constantly kept me from making decisions. And if a choice was sometimes made, a finding two weeks later rectified the earlier decision. A real design process, you could say.

Personally, the project was too early to achieve the desired end result. Some people may find this the way to go, but I prefer more specific theoretical and practical guidelines for product design. There was much uncertainty about, for example, the dimensions and final decisions regarding essential components.

Because of this, the final concept is a mix between a concept that can be further developed technically and a concept in which the necessary conceptual choices have been made. I have to admit that I feel it is a pity that the project turned into a kind of pinball machine because of this. The bouncing back and forth between a fully technically developed HUB ready for further development and a conceptual design that meets all the ideals became annoying. In my opinion, the project falls exactly between two directions in terms of elaboration, which makes it feel incomplete. The learning objective about decision-making was put to the test.

It is common knowledge that the entire project was not a smooth ride. I think I speak for everyone that the start of my project caused me to lose track. The messy start on my part and the status of the project's developments were a difficult combination. I would like to say that I think it is brave of Nicole to be Chair for the first time in a project that has already started. Let us hope this did not have a frightening effect on future graduation projects.

During the study, you develop yourself as an industrial designer. The study offers directions, and it's up to you to decide exactly what kind of designer you want to become. My interests have been in mobility throughout my studies, which has only increased in the past project. However, the role I want to play as a designer within this sector has always been a little vague. Because during the project, I was part of the brand refresh, I was the liaison point between different companies, determined a vision based on market research, did the technical elaboration of the frame, and developed the general design. I have had the opportunity to get a taste of many different areas, which positively impacted my learning objectives.

One of the most enjoyable experiences was developing the new brand refresh. Working with an external company, generating a vision and feedback and brainstorming with employees gave a feeling of satisfaction. In addition, combining different trends, developments and principles with the new brand identity was a milestone in the project. I was able to look together at a design direction by presenting this milestone to the stakeholders. Mapping out routes like this gives me much energy and is something to keep in mind in the future for me as a designer.

That I became less enthusiastic about the detailed elaboration of the concept somehow surprised me. Perhaps it has to do with the type or length of the project, but drawing the final concept became a big mountain to climb. My apologies, Gianni. Where I always enjoyed designing and finalising products, you could say that this has shifted to designing design directions.

The most unfortunate decision is adapting the project so that it is possible to pick everything up quickly and continue development. Because of this, I started working in a much more technical and goal-oriented way, so an experimental ideation phase never took place. For example, making a mock-up to understand the dimensions and interaction. I consider this a shortcoming because these kinds of spit models provide a great variety of feedback and make it tangible for everyone. If the project had been worked out conceptually, there would have been more time for this because a lot of time went into the technical development and validation of the concept. I probably should have realised this myself, but the scope, the pressure and all the dependent parties made it difficult for me to keep an overview. Do I regret this? No, I do not. But would I do it differently next time? I certainly would.

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