Tessa Ariens

Exploring the Integration of Brand Value in Product Design:

A Design Research Approach

A Case Study with the Electric Vehicle Charger Production Company Nieuwe Weme for its Charging Solution Brand Vigor

S2113155

DPM 2099

Industrial Design Engineering

Human Technology Relations

Graduation date: 20.06.2024

Supervision: Maaike Mulder-Nijkamp, Janina Schaumann & Thobias Reerink

UNIVERSITY OF TWENTE.

Preface

During my entire career as an industrial design engineer, I have had a particular interest in understanding consumer perceptions of a certain product. This interest extends to the application of interaction design and the conveying o a message or strong brand identity.

During a coffee break at my previous side job, developing a Human Machine Interface guide, I had the pleasure of meeting Thobias while getting coffee. I shared my passion for design and creating with users in mind, and from that conversation, a challenging and unique project for my master's thesis emerged. I was and am still aware of the exceptional opportunity to contribute to this project at an early stage in its development, and I was committed to making the most of it.

Acknowledgements

Firstly, I would like to thank my university supervisors. Maaike Mulder-Nijkamp started this project by inspiring me with interesting perspectives on design, making me more curious after every meeting. Secondly, I would like to thank Janina Schaumann for taking the time to deepen this research and supporting me during the last stage of my research.

Besides receiving supervision at the university, I spend most of my time in Hengelo at the company NieuweWeme. I am grateful to the employees for participating in multiple focus groups and sharing their experiences. Additionally, I want to thank my company supervisor, Thobias Reerink, for being open to alternative perspectives and ideas. Due to close communication with NieuweWeme employees, I was able to reach out to many stakeholders involved in the context of this research.

I want to give a huge shoutout to my family and friends for their endless support and critical questions, which have helped me make the most of this master's thesis.

Tessa Ariens

Enschede, June, 2024

Abstract

Previous research supports the contribution of strong branding to product positioning in competitive markets. Constructing a brand identity is described by multiple authors in models and frameworks. Kapferer (2004) states that a brand's credibility depends on the persistence and repetitiveness of its proposed values. The brand's relevance should be clear and consistent. To achieve this consistency, a guideline should be addressed linking perceptions of values to physical attributes in design. However, limited to no research has been published on translating associations and values into physical attributes in products. In most cases, research was conducted regarding the recognition of physical attributes, based on a portfolio analysis of existing products. This thesis investigates how pre-specified brand values can be integrated into novel product (portfolio) design. The scope of this research is value congruence with the visual perception of presented products. The products used to implement and test findings are different types of AC charging stations, together forming a product portfolio for the brand Vigor.

A mixed methods approach is applied to research attributes of both shapes (2D) and geometries (3D) and their congruence with four brand values: *innovativeness*, *sustainability*, *high quality*, and *trustworthiness*. Opposite design attributes, labelled by Muller (1997) as ordering characteristics symmetric versus asymmetric, organic versus geometric, dynamic versus static, slim versus robust, and pointy versus rounded, are assessed. Muller divides these characteristics to typify design into categories. Addressing this classification allows for a structured approach to investigating design-association relationships. The positive/negative contribution to value associations in images of these attributes is evaluated. Selected participants were industrial design engineering master's students at the University of Twente. Design guidelines are deducted from results indicating positive contribution to association with the pre-specified values. Focus group sessions are conducted to acquire in-house company knowledge and ensure active participation during development. Validation is done by comparing the rated (on a Likert scale from 1 to 5) congruence of the pre-specified values with both current products and proposed products designed according to deducted guidelines.

This research presents an overview of ordering characteristics that positively or negatively contribute to perceiving the pre-specified values. The different four pre-specified values are found to have varying physical attributes stimulating the perception of the value. Additionally, differences were found between recognising values in 2D shapes and the corresponding 3D geometry with an assigned product category. As an example, for the value of innovativeness, analysing 2D shapes found asymmetric, organic, dynamic, slim, and pointy attributes stimulating the recognition of the level of innovativeness compared to their opposite attributes. Whereas, for that same value of innovativeness, analysing 3D geometries found symmetric, organic, dynamic, slim, and pointy attributes are incentives for the perception of innovativeness compared to their opposite attributes.

A final product portfolio design proposal is developed based on the abovementioned research, user requirements, and results of focus group sessions. Validation of the proposed product portfolio design shows improved congruence with the pre-specified brand values compared to the current product portfolio. This indicates that applying the guidelines generated in this thesis in design positively affects the perception of the products. Based on these findings, it would be beneficial to research other brand values in a comparable manner to develop bottom-up brand attributes.

Future research should include more participants to improve the reliability of the findings. Additionally, the universality of the findings of this research should be investigated further. Since this thesis did not include demographic information of participants, perception can be culture-dependent. Lastly, whether and how the product category affects the perception of attributes and their assigned value should be researched.

Table of Contents

Table of Figures

Table of Tables

1. Introduction

There is a growing demand for electric vehicle (EV) charging stations in various contexts. These contexts include public environments, semi-public environments, and private environments. The shift towards electric passenger cars will ask for approximately 4,3 million charging stations by 2044 in the Netherlands (Elaadnl, 2024). Recent developments dealing with grid congestion have resulted in Vehicle to Grid (V2G) technology, allowing car batteries to be charged and discharged from or to the grid. Whereas the main incentive for charging an EV is increasing the range, incentives for discharging are mainly balancing local demand of the grid and financial benefits (Noel et al., 2019). Vehicle to Grid charging stations, therefore, can play an important role in handling the increasing demand for electricity and balancing peak loads.

This design research focuses on creating a user-friendly and valuable product by examining the lessons learned from existing Electric Vehicle (EV) chargers. In a public context, where standalone products often lack on-site support, thoughtful product design is crucial. By studying EV chargers, this research aims to identify the factors that contribute to their usability and how users perceive their value.

The usability and clear brand value of a product are essential for its success, especially in public environments. Public and semi-public charging stations, typically purchased through business-to-business relationships, are ultimately used by a wide range of end users. Therefore, the successful adoption of a V2G charging station requires the involvement of a diverse group of stakeholders, including new users, experienced users, charging point operators, and installers.

Through this research, we seek to understand and incorporate the perspectives of all these stakeholders to ensure that the V2G charging stations are well-received and effectively utilised. In addition to considering the perspectives of stakeholders in the design process, the perception of the products by consumers should also be considered. While previous research has extensively explored how to build brand identity, limited research investigated how to translate brand associations and values into physical attributes of products.

Most studies on the recognition of physical attributes are based on portfolio analyses of existing product portfolios. However, when developing new products for new brands, a guide to attributes that evoke specific associations could contribute to representing the brand's values. This thesis aims to fill this gap by investigating how specific brand values can be seamlessly integrated into the design of novel products (portfolio), while also taking into account the functional requirements of stakeholders.

Integrating usability for multiple stakeholders and brand value into the design of charging stations is crucial for their daily adoption. Users need to feel confident and comfortable using these stations. A unique challenge for (semi)public chargers is the need to be unobtrusive in their environment while still being easily recognisable as belonging to a specific brand. With the growing number of charging stations, maintaining unobtrusiveness is essential to avoid overwhelming public spaces with excessive stimuli. This design challenge involves balancing unobtrusiveness and ensuring clear usability within a branded product portfolio.

The company used to conduct a case study is NieuweWeme. The company is located in the east of the Netherlands and engineers and produces containerised solutions, charging solutions, and control systems. It also has a manufacturing and assembly department. Their department of charging solutions, producing V2G charging stations, operates under the brand name Vigor. Vigor is used in this design research as a real-life example of a charging station brand.

1.1. Design Question

The abovementioned design challenge of designing a usable, unobtrusive vehicle to grid product portfolio with pre-specified brand values led to the following design question: “How can NieuweWeme, with its brand Vigor, design an applicable portfolio for AC charging stations representing their identity, the set functional requirements, and the target group requirements?"

To answer the abovementioned design question, various findings should be combined and analysed. The desired brand identity should be researched, stakeholders should be addressed to gain insight into needs and wishes leading to requirements, and potential design directions should be developed and validated. Therefore, the sub-questions are divided into themes of brand identity, setting the requirements, and design directions.

Brand Identity

1. What is the current image and identity of Vigor?
2. What is the desired image and identity of Vigor?
3. What is the current market position of the charging station of Vigor compared to competing products?

Setting the requirements

4. What is a gap in this market that can be filled with the value of Vigor?
5. What are the determining factors of the context and stakeholders of the charging station?
6. What are relevant user scenarios, and which factors can be derived from these scenarios?
7. What are the requirements gained from insights of previous sub-questions?

Design Directions

8. What are distinctive Vigor design features representing their identity and the set requirements?
9. What potential design directions represent the Vigor identity and the set requirements?
10. What is the most suitable design direction for a family of chargers representing the identity of Vigor and the set requirements?

1.2. Approach

To answer the design question in a structured manner, the double diamond approach guides and traces the design process (The Double Diamond, 2023). This model describes a design and innovation process by diverging and converging steps (Figure 1). According to the Design Council (2023), a design process can be standardised using two diamonds and four phases (in loops). The first diamond focuses on the correct formulation of the design brief. This part includes the phases discover and define. The second diamond focuses on developing suitable solutions for that design brief. This part includes the phases develop and deliver.

The double diamond approach assists with solving the right problem and delivering a suitable solution. The current research adds to this by complementing the phases and describing corresponding predetermined outcomes. The predetermined outcomes are deducted from the literature study of consumer psychology, innovation, and industrial design research fields. These predetermined outcomes are relevant in translating a certain brand with a certain (desired) position into a certain market into products. The phrases in Figure 1 articulate which outcomes, per phase, are required to be able to diverge (discover and develop) and converge (define and deliver) in a design process in a considered manner. These results are used and combined to answer the sub-questions and design question of this thesis.

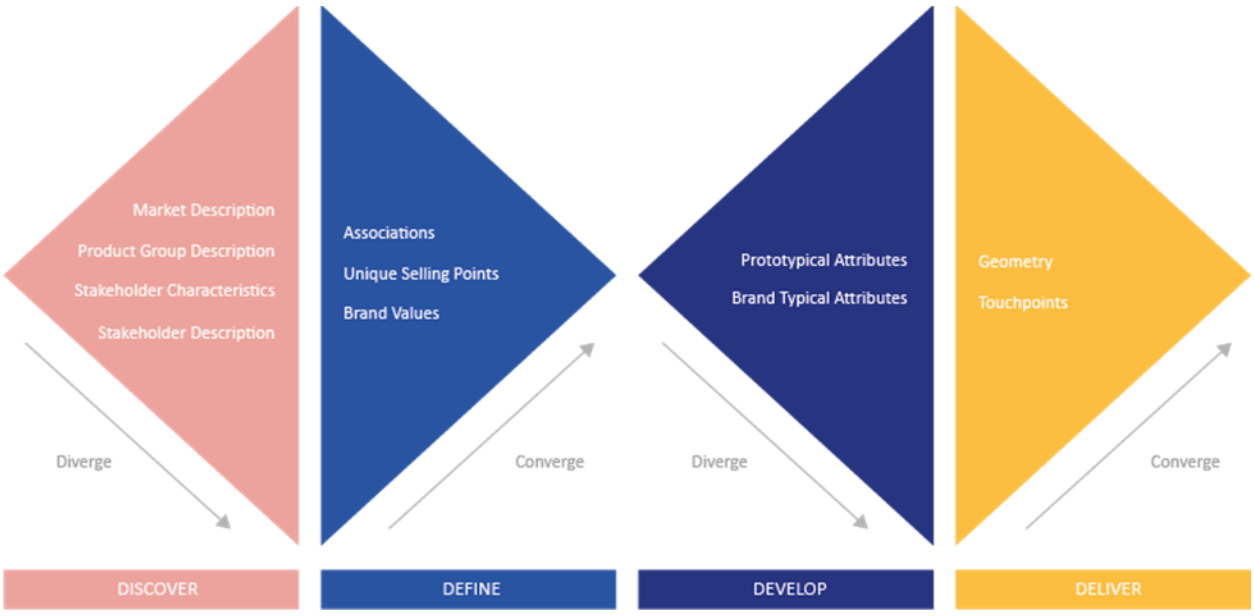


Figure 1 Double Diamond Approach with Predetermined Outcomes

The *brand identity* questions are answered using insight about the stakeholders and positioning (discover) combined with the company's visions about the brand (define).

The sub-questions “What is the current image and identity of Vigor?” and “What is the desired image and identity of Vigor?” are answered in Chapter 4. The sub-question “What is the current market position of the charging stations of Vigor compared to competing products?” is answered in Chapters 2.4 and 2.5.

The questions in the category *setting the requirements* are answered after the develop phase. This phase combines functional requirements acquired from stakeholders' perspectives with product specifications and preferences of the case company (through focus groups) and a design guide in line with findings of brand value associations.

The sub-question “What is a gap in this market that can be filled with the value of Vigor” is answered in Chapter 2.5. The sub-question “What are the determining factors of the context and stakeholders of the charging station?” is answered in Chapter 2.3. The sub-question “What are relevant user scenarios, and which factors can be derived from these scenarios?” is answered in Chapter 2.3.5 The sub-question “What are requirements gained from insights into brand identity, market placement, and stakeholder engagement?” is answered in Chapter 6.

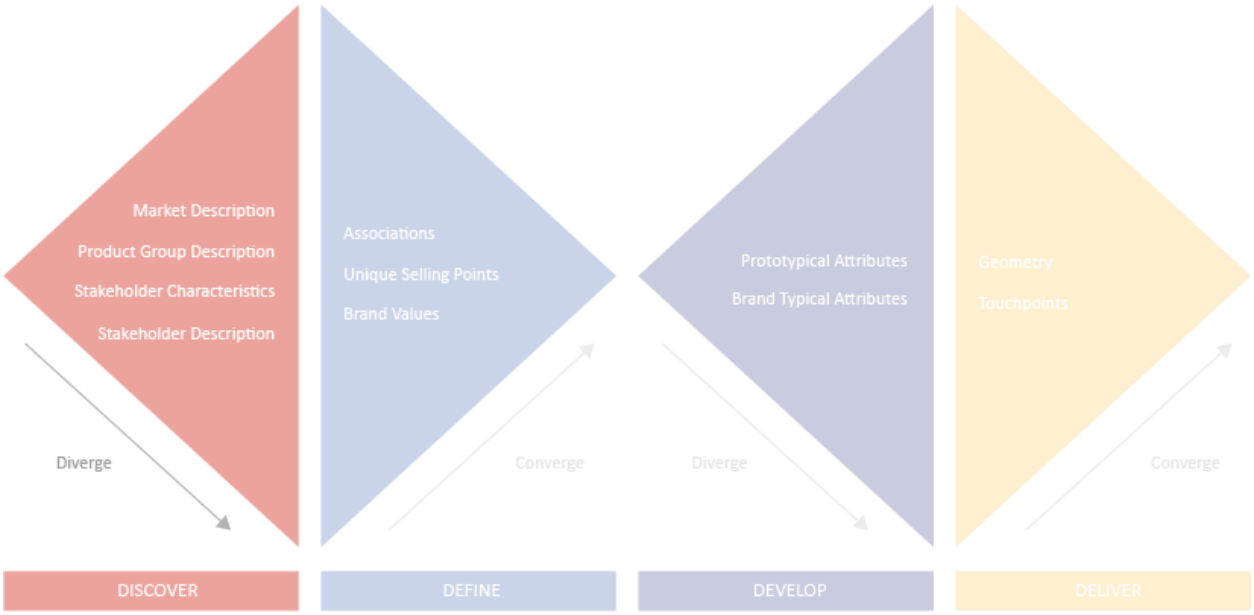
The questions in the category *design direction* are answered after the deliver phase. The design directions consider formulated requirements (develop) and attributes congruent with prespecified brand values. The proposed product portfolio is used to validate research findings.

The sub-question “What are distinctive Vigor design features in representing their identity and set requirements?” is answered in Chapter 5. The sub-question “What are potential design directions representing the Vigor identity and the set requirements?” is answered in Chapter 7. The sub-question “What is the most suitable design direction for a family of chargers representing the identity of Vigor and the set requirements?” is answered in Chapter 8.

DELIVERING

The Design Problem

2. Discovering the Design Problem



This phase of the thesis researches the context of the design problem. Abbing (2010) describes in the Brand-Driven Innovation model that a brand should be built upon internal and external stakeholders. Internal stakeholders will use the formulation of a brand as a foundation of their work, whereas external stakeholders base the perceived value of products and services on the formulation of this brand. Abbing states that by forming a team of stakeholders and researching the brand context, a brand promise can be created.

The design approach, outlined in blocks, sets the course for the research. It includes predetermined outcomes such as descriptions of the product group, stakeholders, market, and target group characteristics. The selection and identification of the product group allow for the exploration of relevant knowledge about the product. Mapping and investigating stakeholders' interests aid in understanding the dynamics between different parties. The exploration of the market in which the product will be positioned helps to identify unique features and learn from competitors. Understanding the target audience's needs and preferences supports a user-centred design approach.

2.1. Theoretic Framework

2.1.1. The meaning of a brand

To design for a specific brand, in this thesis Vigor, it is required to define the meaning of the concept of a brand. Additionally, it is required to define how a brand can contribute to positive associations with presented products. Therefore, literature research is done on brand management, brand innovation, brand equity and value in product design.

The word brand originates from the Old Norse language meaning "to burn”. This refers to how livestock was identified by burning a mark with a hot iron. Identifying products is used to segment markets and distinguish them into product groups (Maurya & Mishra, 2012).

Keller (1993) explains how a brand has positive customer-based brand equity if the reaction to a brand is favourable when evaluated against a comparable product without this brand due to brand knowledge. When a consumer has favourable, strong, and unique associations with the brand in their memory, customer-based brand equity (CBBE) applies. The CBBE model described by Keller (2001) defines the different steps of brand identity, brand meaning, brand response, and brand relationships. The brand identity focuses on deep and broad brand awareness, brand meaning concerns strong, favourable, and unique brand associations. Brand responses include positive and accessible responses, and brand relationships cover intense and active relationships.

Since the scope of this thesis is defining a brand identity and designing in line with this identity, a mere focus is laid on brand *identity* and brand *meaning*. Keller (2001) elaborates that brand identity can be reached by brand salience. Brand meaning can be reached by appropriate brand performance and brand imagery. Brand salience can be seen as the comprehensibility of a brand in its outings. This salience can be pursued when considering the two key dimensions – depth and breadth – of the brand (Keller, 2001). *Depth* is described by the CBBE as the ease of recall and recognition of a brand. Whereas *breadth* is described by the range of situations, the brand is recalled and recognised by consumers.

Kapferer (2008) explains brand identity as a unique set of brand associations, values, personality traits, and symbols. This unique set, in turn, allows the brand to differentiate amongst competitors. The model describing brand identity is Kapferer's Brand Identity Prism. Kapferer identifies six different aspects in his model: physique, personality, culture, relationships, reflection, and *self-image*. A comprehensive definition of the brand can be reached by comparing the formulation of a brand with human traits and relationships.

The aspect of *physique* includes what consumers perceive and recognise about the brand. The aspect of *personality* should describe the human characteristics which are associated with the brand. *Culture* describes values, beliefs, and principles. The *relationship* expresses the relationship between the brand and its consumers and stakeholders. The aspect *reflection* sketches how consumers of the brand identify themselves via the brand. The last aspect of *self-image* covers the ideal image including the visions, missions, and desires.

For this thesis's scope, the goal is to research how to represent brand identity through design. The designed part may be interpreted as the *physique* aspect, whereas the latter should be congruent with the first. To define the other aspects besides physique, a deeper understanding of the brand and development over time can provide insights to design in conformity with this.

Considering Keller's (1993) (2001) theories, creating a brand that is accessible to recall and recognise is vital for a strong brand identity. Additionally, it is rewarding to identify desired situations in which the brand Vigor will be recalled and recognised.

2.1.2. Designing according to a brand

The previous section described which factors contribute to managing brand equity. Product-related attributes can determine the type of brand associations. These types of brand associations lead to a certain brand image, as described by the dimensions of brand knowledge (Keller, 1993).

The next step is to understand better what aspects are researched to lead to a desired association. These aspects can then be implemented into design in the desired manner. Therefore, literature research is done on bridging associations with perceived physical design characteristics. The relationship between associations, abstract images, and physical translations into products is researched.

Kapferer (2008) states that a brand's credibility depends on the persistence and repetitiveness of its proposed values. The brand's relevance should be clear and consistent. A guideline linking perceptions and associations with physical product attributes should be addressed to implement this consistency.

The mere information processed by humans is visual. The visual appearance of brands and products affects humans through triggering emotions. Research shows that 93% of buyers prioritise visual appearance over other factors during decision-making (Trautmann, 2021). Different studies have researched the link between visual perceptions and their effect on associations. An example is how Don Norman (2007) described that “what is perceived as beautiful is often useful, and what is perceived as useful is often beautiful”. Norman developed a framework describing the user-product interaction. This interaction is subdivided into *aesthetic experience*, *experience of meaning*, and *emotional experience*. Additionally, using three levels of design, Norman (2007) simplifies product characteristics into visceral (appearance), emotional (pleasure and effectiveness of use), and reflective (self-image, personal satisfaction, and memories). Visceral design addresses the aspects of design within the scope of this research. This thesis aims to describe the link between the *aesthetic experience* and the *experience* of *meaning with visceral characteristics* instead of dividing it into different concepts in design. The desired brand salience is interpreted as the experienced meaning to describe this link.

The following section investigates specific incentives for associations, in addition to the generic level of product experience.

2.1.3. Geometric shapes and patterns

In a study by Trautman (2021), researching the emotional impact of geometric patterns, it is found that the effect of geometric patterns is highly dependent on the basic geometry and composition of the pattern. Another research conducted to understand associations with geometric shapes addresses a square, triangle, and circle (Frutiger, 1989) (Fogelström, 2013). A square is found to represent the meaning of *stability, trust, honesty, order, conformity, security, equality, masculinity, maturity, balance,* and *stubbornness*. A triangle is found to portray the meaning of *action, aggression, energy, sneakiness, conflict, tension, masculinity,* and *force*. Lastly, a circle is found to depict the meaning of *completeness, gracefulness, playfulness, comforting, unity, protection, childlike, innocence, youth,* and *femininity* (Trautmann, 2021).

These findings about the meaning of geometric shapes can be used as a guideline for design. Though, these findings are based on three specific shapes. Variations in these shapes or integrations into product design could influence the effect of the form.

2.1.4. Meaning of lines

Simonds and Starke (2010) research a more broad-ranging perspective on the meaning of form, describing the effect of 48 so-called mood lines. The designer Rikard Rodin (2015) validates these lines by depicting universally recognised meanings. Implementations of these lines are in typography, posters, and architecture. Figure 2 presents the collection of mood lines.

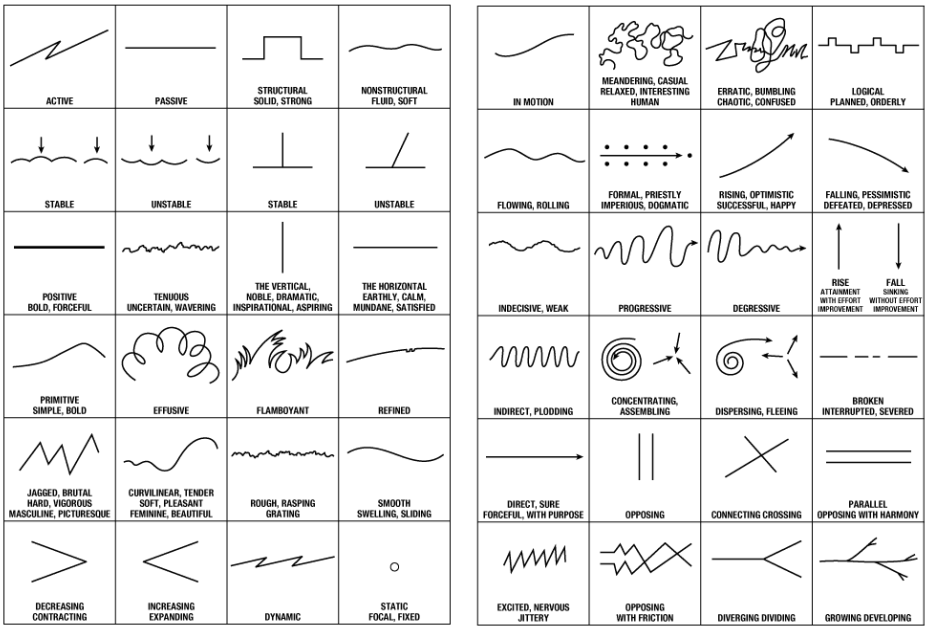


Figure 2 Mood lines

The abovementioned studies focus on basic forms and patterns that can be recognised in designs. An example of a study investigating product appearance perception was done by Blijlevens, Creusen, & Schoormans (2009). The research identified the attributes of *modernity*, *simplicity* and *playfulness*. The researchers aimed at articulating what attributes are seen in durable product appearance. Understanding this perception can contribute to communicating a pre-specified meaning to consumers. This study identifies two steps in product appearance perception. The first step is the products' physical properties (colour, texture, size, etc.), and the second is consumers' perceived appearance attributes (modernity, simplicity, etc.). The most distinguishing aspect of this model is incorporating both the designer and consumer perspectives. Blijlevens, Creusen, & Schoormans (2009) state that most literature on attributes leading to meaning in products originates from design literature. These insights should be implemented but are more valuable when reflected in consumers' responses. Consumers who are not regularly thinking about design find it more challenging to recognise and formulate design attributes (Tanaka & Taylor, 1991). This should be considered while striving for brand salience.

The study by Chang & Wu (2007) explores the types and characteristics of product forms. The research aims at young consumers and their perspective on pleasurable products (e.g. toothbrushes, corkscrews). In-depth interviews with 30 participants showed that the *aesthetics* and *bios* -mimicking animals, natural elements, or humans- of the pleasurable form were most likely to evoke pleasurable responses when included in product design. Chang & Wu (2007) focus on only the visual perception of household products and leave other aspects and products out of scope. Examples of results from this study are that beautiful material, attractive colours, and a delightful shape can be incentives for aesthetic form. Concrete and abstract forms, with interesting movement, contribute to bios form. These types and characteristics can be incentives for a pleasurable perception. However, pleasure poses challenges for effective integration into product design due to the term's breadth.

Karjalainen (2007) suggested value-based design features to use in a brand's product portfolio. This could be done systematically or flexibly. It was proposed that design involves the two aspects of *attractiveness* and *strategic meaning creation*. The latter is the scope of this thesis. Strategic meaning creation can be used to elicit favourable brand recognition. This recognition can occur when consistent design cues evoke references which are closely related to the brand (Creusen & Schoormans, 2004). The paper analyses methods to extract design cues from existing brands and implement them into new products. An example is given for the brand Porsche with design features such as a triangular roof, round front lights and side air intake (Karjalainen, 2007). Related is Warell's (2001) approach of Design Format Analysis. This approach investigates the instances of design cues throughout a product portfolio.

Kongprasert (2009) researched design elements that express brand identity in luxury bags. The method used was based on how Karjalainen (2007) analysed design features into a reproducible guide. Semantic adjectives were extracted from formulations of fashion experts. Additionally, multiple elements of the branded bag are rated on these semantic adjectives. The study gave insight into the impact of each design element of a bag on the semantic adjectives. A comparable analysis of non-products but abstract derivatives can give insights into bottom-up value associations in design.

Communicating attributes through product design can help consumers to understand the product and brand. Additionally, this understanding makes it easier to identify with the product and brand (Janlert & Stolterman, 1997). People tend to assign characters to artefacts to remember how to interact with them. Attributes are valuable in a certain context. By separating these attributes from the context, a designer can apply these attributes in new contexts, creating new designs considering the attributes.

The previous section discussed studies that explore existing and simplified forms and patterns in relation to researched emotions. However, there is a gap in the literature regarding the characteristics of these forms and their interpreted meanings, which could provide valuable insights for designers. Understanding this design-association relationship could enable designers to integrate them into the creation of new, unfamiliar forms, thereby enhancing the relevance and comprehensibility of the brand value of their designs.

Muller (1997), in his piece *Vormgeven*, *ordening en betekenisgeving,* focuses on placing design in a methodological framework, where function, material, and form lead to design. Muller investigated how humans attach meaning to visual elements and how these can be used to communicate a certain message. He elaborates on semantics and visual grammar using examples. Muller (1997) states that for generating and developing spatially and materially coherent form *ordering attributes* apply. He continues explaining that *meaning-giving attributes* apply to evaluating such a developed form. According to Muller (1997), these attributes relate in a goal-means manner to each other, where a certain *order* can lead to a certain *meaning*.

Products with certain typical spatial characteristics are recognised as the same product category. Artefacts for which a specific form indicates the function determine these conventions. Conventional spatial representation develops in products that inherit attributes to ensure familiar usage. Muller labels these attributes based on conventions and typical characteristics as *prototypical attributes*.

By sectioning and selecting different attributes in an overview, these can be assigned to product design. Choosing attributes correlating with the desired meaning can support the brand salience. Muller provides an overview of ordering elements structured per dimension, element and articulation of ordering attributes (Muller, 1997).

Considering the section above, to design for a brand and affect product-related attributes, firstly, desired (positive) associations should be determined for a brand. The set of these desired associations can then contribute to the congruent brand *image* of Vigor. By applying researched incentives for the selected associations into the design, consumers can be assisted in making these associations. A literature gap was identified in how values and associations can be translated into physical characteristics for branded products. The section above elaborates on examples of mood lines and basic geometric shapes which convey a certain association. Additionally, examples of studies researching attributes in product design are evaluated. Lastly, Mullers' manner of depicting form attributes is elaborated on. Considered attributes can be implemented into design to evoke meaning through design.

This study assumes that by implementing ordering attributes that correlate with a product's meaning, desired associations can be aroused and perceived. To research this assumption, a sequence of studies is conducted using a Vigor product case study. The product investigated in this case is a single-socket wall charger for electric vehicles.

Firstly, a general understanding of electric vehicle chargers is required to define conventions leading to *prototypical attributes*. Secondly, it is researched which of the selected ordering attributes are most congruent with the intended brand values. Therefore, the next chapter (2.1.5) analyses the functionalities of EV chargers, relevant stakeholders and their interests, and user experiences and interests.

2.1.5. Electric Vehicle Charging

This section describes the working principles of electric vehicle charging types. Desk research is conducted to gain insight into the specific working principles of charging electric vehicles. Multiple charging technologies, AC, DC, and Vehicle-to-X, are explored to understand possibilities in EV charging. Additionally, the required components for these techniques are researched and noted. This research focuses on the portfolio of AC chargers with Vehicle-to-X functionality.

Alternating Current versus Direct Current

Electric vehicle charging can be performed using different types of electric current. Alternating Current (AC) and Direct Current (DC) can provide a car with electric current. For charging, the biggest difference lies in the place of conversion and charging speed. AC periodically changes direction and, therefore, is referred to as alternating. This AC originated from the grid and is suitable for long-range transport. For EV charging, this alternating current is converted into DC in electric vehicles. DC has a stable voltage and is stored in batteries. For EV charging, DC chargers convert AC from the grid into DC inside the charging station. More powerful converters can be used for DC chargers, which reduces the charging time (EVBox, 2023).

Vehicle to X

Vehicle to X is an umbrella term for functionalities of supplying power from a vehicle to either the grid, another vehicle, homes, or load (Islam et al., 2022). These modes of operation are in the opposite direction compared to the conventional charging being grid-to-vehicle. This operation mode can regulate active power demand, reactive power compensation, compensation of harmonics in grid current, and system reliability, stability, and efficiency improvements. Deducted from the literature, vehicle-to-grid as a mode of operation is most extensively used (Islam et al., 2022).

Communication between EV's and EV chargers

To control and monitor a charging session, an EV must communicate with the EV charger. Connecting the EV into the EV charger requires communication between the two devices. The EV charger, in turn, communicates with the Charging Point Operators (CPO), and the CPOs communicate with the responsible energy suppliers and grid operators. The communication concerns information about required electricity (kWh), charging speed (kW), and costs (Geerts et al., 2019). To be able to communicate, two pins in the connectors are used. The first pin controls whether the car is connected (proximity pin), and the second pin controls whether the charger is charging (pilot pin) (Zamanov, 2023). To realise effective communication between these entities, protocols and standards are set up (OCPP). The mode of charging determined the communication between the EV and EV charger.

2.2. Stakeholder identification

Vigor operates in a network of stakeholders with different types of relationships. Figure 3 presents a map with an overview of the parties involved (Dam & Siang, 2022). Governments aim to reach policy goals related to EV driving for public environments. To realise these policy goals, EV charging stations should be placed on land owned by municipalities. Network operators own the usage data of the EV chargers to monitor consumption and costs. The chargers are installed and maintained by charging point operators. Electric vehicle chargers are designed and produced by production companies such as Vigor (N. Rutten, personal communication, October 10, 2023)

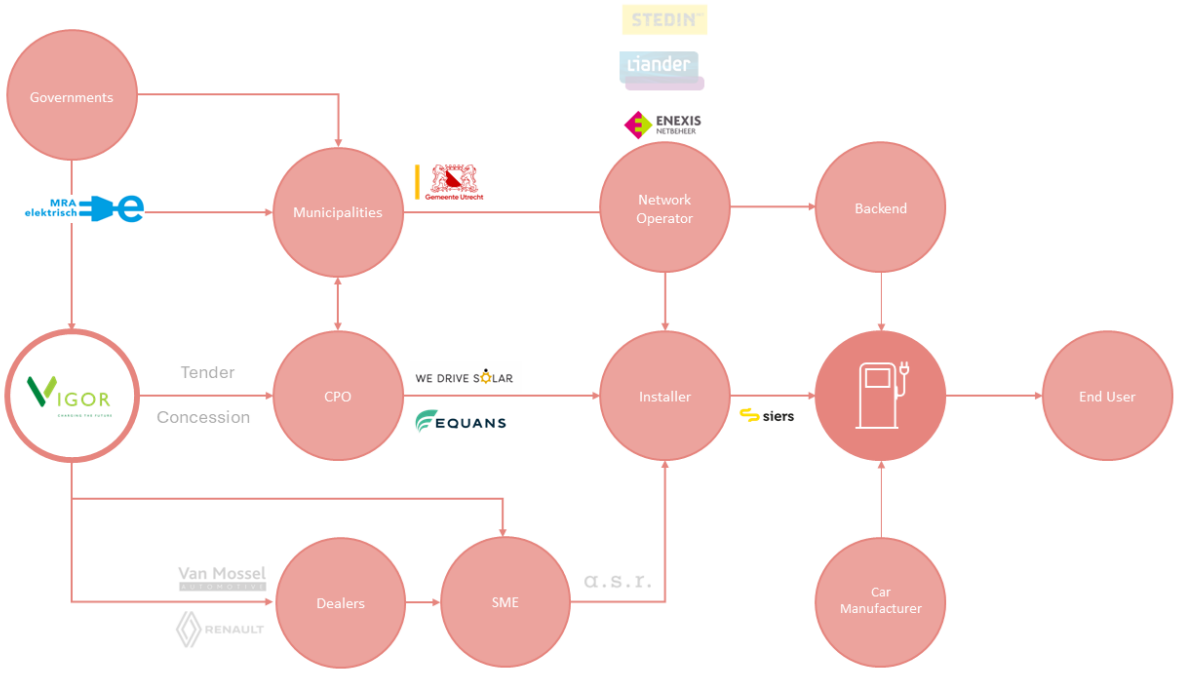


Figure 3 Stakeholder Map Vigor EV Chargers

In consultation with the business developer responsible for Vigor charging, a selection is made for the most relevant stakeholders. It is important to mention that this selection is applicable in the current scenario in which most profit and business is made with Charging Point Operators. Deducted from this, the most relevant stakeholder selection includes a CPO (Equans), experienced users and new users.

The charging point operator (CPO) Equans, cooperating with Vigor, is the world leader in technical services, under which electrical services. Equans operates and maintains charging stations produced by Vigor in the Netherlands. Equans aims to (pro)actively maintain by sending reports via a constant connection with the product (B. Korteweg, personal communication, October 6, 2023).

2.3. Understanding Stakeholders Interests

To create empathy for the most relevant stakeholders (Abbing, 2010), personas of a CPO, experienced user, and new user are developed. Multiple research methods are conducted to research and reveal the interests of these stakeholders. Insights from observations, interviews, and an EV user survey are integrated into these archetypical characters. Additionally, customer experience maps are constructed to address the different steps in interaction.

2.3.1. Observing public EV charger users

During the periods of 7:00 am, 9:00 am, 4:00 pm, and 6:00 pm in the neighbourhood Lombok located in Utrecht, 11 EV charger users are observed. During this observation, it is noted what the total interaction time, facial expression, number of actions during the interaction, and method of localising charger are for users. Additionally, every general step is described in how users behaved while plugging in the EV and EV charger, starting the charging payment, stopping the charging payment, and unplugging the EV and EV charger. These steps are noted using an observation form (Appendix 1 Observation Form). Findings from these observations are firstly that all users live in the same block where the charger is located. This means users were aware of the charger's location and determined to use a specific one. During interaction with the charger, it was apparent that users needed clear confirmation about the charging status. No standard sequence of steps was observed in payment, plugging into EV, plugging into EV charger, plugging out EV and plugging out EV charger and payment. Doubtful body language was noticed between interaction and confirmation. While plugging and unplugging the cable, it was apparent that users experienced hindrance due to the size and weight of the cable.

2.3.2. Talking with external stakeholders

Multiple parties in the stakeholder network are addressed and interviewed to better understand their interests and experiences. Firstly, Robin Berg, as representative of We Drive Solar, was addressed to share expertise about V2G principles. Secondly, the project leader of the public charging networks of Equans was interviewed to understand the main interests of CPOs. Thirdly, ELaadNL was addressed for a conversation about existing chargers with their Chief International Officer. Lastly, MRA-Elektrisch was approached to share experiences.

We Drive Solar cars drive on locally generated solar energy; cars can charge and discharge on the network. Berg (2023) explained how more and more energy storage is required and how cars can function as batteries in the energy system. He envisions that cars will be recognised by the stations in the future without any card or application. And with cars unable yet to do so, that RFID of smartphones replace the cards. Berg mentioned that for public charging stations, the *noticeability* of the stations should be there for the ones looking for the station. He stressed that “the function of the object should be clear” about the public chargers in the field produced for We Drive Solar. This can be achieved by signage on site. Lastly, he elaborated on the communication of the costs of charging. In his opinion, “making this transparent is something parties decide users to want, instead of what users actually want” (R. Berg, personal communication, October 16, 2023).

Equans' project leader for public charging networks, Bart Korteweg, shared his vision on key learnings regarding charging stations. Korteweg stated that the largest friction point, according to his experience, is the unclear reasons for failure. Additionally, he stressed that good maintainability and technical support are determinants for Equans as charging point operators (B. Korteweg, personal communication, October 6, 2023).

The Chief International Officer of ELaadNL, Baerte de Brey, shared his insights. The most important characteristics regarding charging stations are described by him as *availability, trustworthiness, accessibility, and findability*. In addition, he stressed that *ease of installation* can be a distinguishing factor compared to others in the same market. He elaborated that ergonomic standards are not in all instances guaranteed for products currently on the market (B. De Brey, personal communication, September 29, 2023).

Nanet Rutten is the project leader of spatial integration, fast charging, and smart charging at MRA-Elektrisch. Rutten stated that the most common failure is *that cards are not accepted by every charging* station. The cause is that not every CPO has an agreement with every e-Mobility Service Provider (N. Rutten, personal communication, October 10, 2023).

This section summarises the experiences of addressed external stakeholders. Factors contributing to a positive response to EV chargers are good noticeability, availability, trustworthiness and accessibility. A known factor contributing to a negative response to EV chargers are unclear reasons for failures, unaccepted cards and difficult manner of installation.

2.3.3. Talking with internal stakeholders

Three employees were interviewed to gain insight into the stakeholders involved with varying professions within the internal company. The first interview was conducted with the production planner, the second with one of the business developers, and the third with one of the mechanical engineers.

Important findings about the production of the product were about the accessibility of components. Production planner (Dennis Eggert) indicated that the currently used standardised housing is easy to access by installers due to different compartments. These compartments additionally allow for partial maintenance. Another remark was to avoid designs that allow water to remain on the housing. This would cause rust and damage to the product. Lastly, for production, Eggert indicated that the modular design of the housing would contribute to the interchangeability of parts (D. Eggert, personal communication, September 15, 2023).

Joost Groothuijs, a business developer, explains that the current products are developed with the idea of not standing out in their environment and being pleasant to install. Overall positive remarks are made about the functioning of produced products, whereas the design was said to be less appealing. The products are easy to disassemble, maintain, and repair. The charging stations succeed in blending in the context due to their unobtrusive appearance. He indicated that payment methods are increasingly important for charging stations. As a distinguishing value, he explains the relatively small market of charging stations for public spaces compared to charging stations at home. Additionally, the customizability of the housing, circularity, and V2G-proof are pointed out to be unique selling points (J. Groothuijs, personal communication, September 8, 2023).

Product production is stressed to be kept in mind when developing the product portfolio's design. For production processes and engineering, it is advised to avoid welding and aim at injection moulding for large production numbers. This process allows for a larger scale of geometries and neat finishing (J. Oude Weernink, personal communication, October 2023).

Considering the above, modular design and sloping edges would contribute to a more durable product. During designing the production method of injection moulding could be considered. An improvement of the overall design of the products is desired. Lastly, customizability of the housing, circularity, and V2G proof unique selling points according to internal research.

2.3.4. Conducting user survey

To get a deeper understanding of users' perspectives on the usability of EV chargers, a user survey is conducted. The survey is distributed via Facebook through the Vereniging Elektrische Rijders page. Members of this Facebook page are EV drivers or interested in developments regarding EV driving. In total, 56 participants filled out the online questionnaire. The average age was 56.8 years old, and 80% of the respondents had EV driving experience of 1 year or more.

It is important to mention that the questions asked in this survey are explorative. A wide range of topics and types of charging is asked for regarding preferences. The aim is to find points of improvement based on the end user's perspective. The topics are recognition, factors for good usability, bottlenecks for public space chargers, preferences in public space chargers, preferences in residential area chargers, and preferences in home chargers.

For the different topics, the most common factors are described below. Due to the explorative manner of questioning, various answers are given that are out of the scope of this design research. These are interesting to understand the user's perception in context but filtered to converge to EV charger products. An example is how users recognise an EV charger by the (traffic)sign. This aspect lies outside the design of a charger and is therefore left out of scope. Figure 4 presents per topic, which factors are indicated by users that are determining. The size of the circles represents the frequency of being mentioned within all answers given.

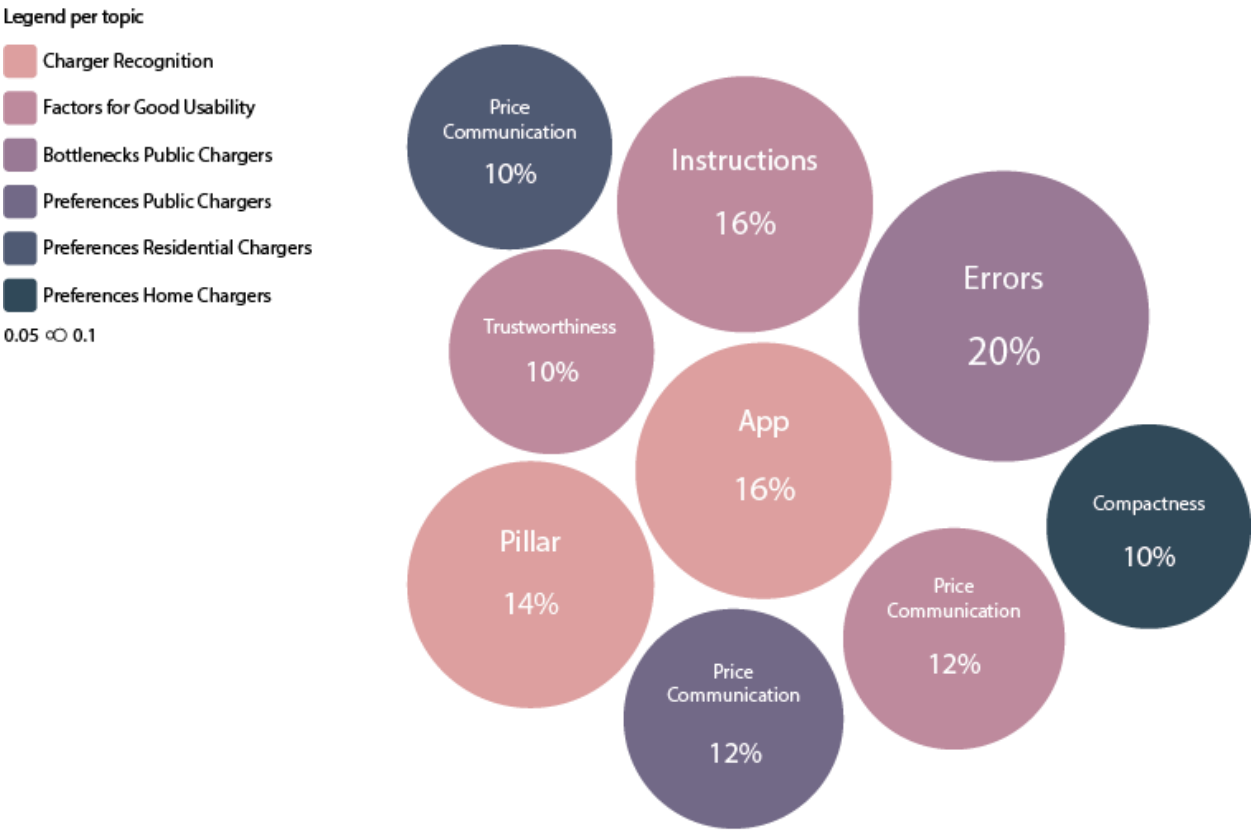


Figure 4 Contributing Factors to Usability of Electric Vehicle Chargers

Recognising an EV charger is mostly mentioned to be dependent on visibility in a mobile application (16%) and the pillar-shaped appearance of the product (14%). Factors for good usability are instructions (16%), price communication (12%) and trustworthiness (10%). The most common bottleneck in public space chargers was the occurrence of an error (20%). The most common preference in public charging is price communication (12%). The most common preference in residential charging is entered to be price communication (10%). Lastly, the most common preference in home charging is small-sized products (10%). In conclusion, users indicated overall that clear instructions, price communication, lack of errors and subtle design are factors perceived contributing to good usability of EV chargers. The findings and most common factors represent the user's perspective. These will be taken up into the requirements list.

The survey's last section compared the rated importance of usability and aesthetics with the rated current level of usability and aesthetics. Participants could rate the importance and current situations on a scale from 1 to 5. With 1 being unimportant, low usability, or unesthetic and 5 being important, high usability, and aesthetic. The importance of high usability of EV chargers is rated with an average of 4,6, compared to the current situation, rated with an average of 3,5. The importance of good aesthetics is rated with an average of 2,3, compared to the current situation, rated with an average of 2,9. This shows a perceived higher importance for good usability in EV chargers than is currently achieved. Additionally, the importance of aesthetics in EV chargers is lower than in the current situation. As a result of this study, it can be stated that there is room for improvement in the field of usability.

2.3.5. Personas and Experience Maps

Personas are developed based on the abovementioned insights from internal and external stakeholder research (Abbing, 2010). These personas summarise the interests and characteristics of three types of real stakeholders: charging point operators, experienced users, and new users. The abovementioned personas can be used to evaluate proposed design solutions from the perspective of multiple stakeholders (Appendix 2 Personas).

Representative customer journey maps have also been set up (Akdag & Ergen, 2021). A distinction is made between the journey map for the design experience of end users (Figure 5) and businesses (Figure 6). These customer journeys are constructed using insights from observations, interviews, and user surveys. These journeys can contribute to a coherent link between the brand and consumers. According to Varnali (2017), customer experience is how a company sees human interactions. When customers find their experience meaningful and enjoyable, it benefits the brand.

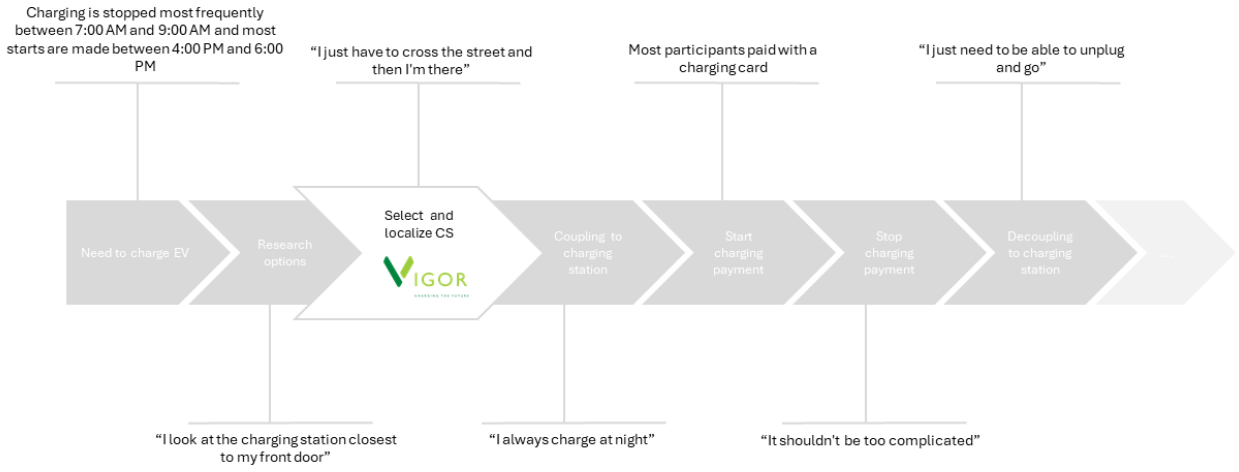


Figure 5 Experience Map End User

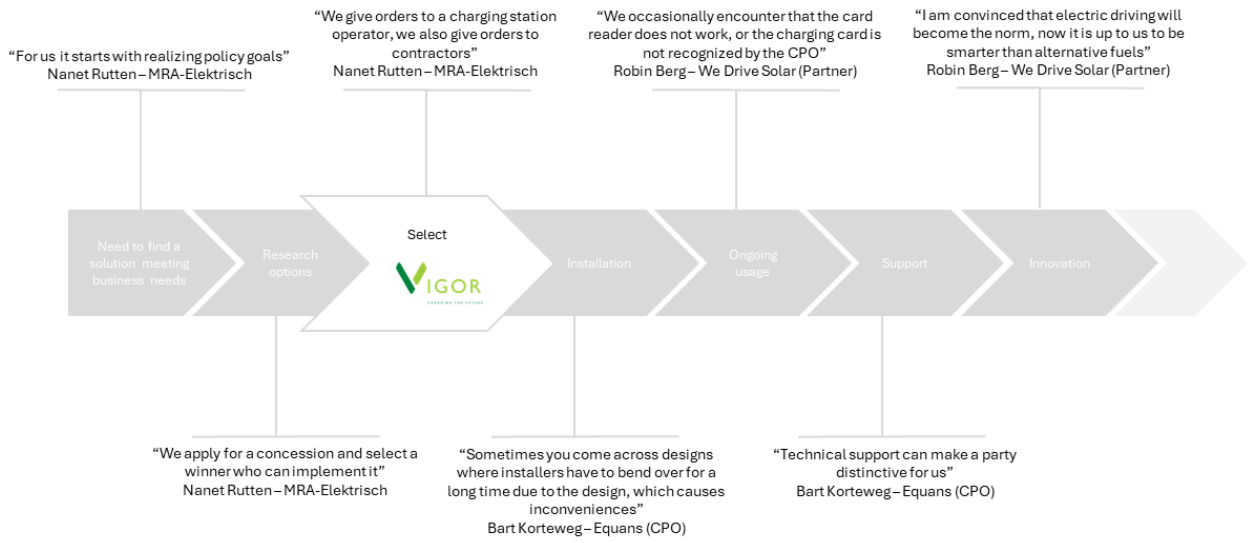


Figure 6 Experience Map Businesses

The presented experience maps include quotes from EV charger users and stakeholders. The focus of this design research is addressing customers in the highlighted arrows, where the first perception of the product has a central role.

2.4. Comparing Competitors

Vigors ' current product portfolio includes a single-socket wall charger, a double-socket wall charger, a double-socket pillar charger, and a direct-current (DC) fast charger (Figure 7). This design research focuses on alternating current (AC) chargers. This section explores and compares Vigor's current products with those of competitors on the market.

Figure 7 Current Vigor Electric Vehicle Chargers (AC)

2.4.1. Existing AC and Vehicle to X EV chargers

The subsequent step in placing the design in the right context is researching existing products with comparable functionality. First, an explorative search is conducted for single-socket wall chargers. Second, a more detailed search is conducted for these products with vehicle-to-X functionality. It is important to state that Vigor is most interested in wall chargers. Therefore, this step focuses mainly on this category of charger.

In the complete charging station market, Vigor has many direct and indirect competitors. Additionally, potential, future, and replacement competitors exist. Table 1 presents an overview of these different types of competitors.

Table 1 Competitors Types Classification

Competitor Type	Competitors
Direct	*Wallbox, **Alfen**, **EcoTap**, Hypercharger, Shell Recharge, EVHub, Webasto, Tesla, Ionity, Electrify America, Mennekes, Chargepoint Europe, Newmotion, Zappi, Blue Current, **EVBox**, Easee, Legrand, Efacec, Schneider Electric, Hager, ABB, ABL, AeroVironment, StarCharge, Siemens, Eaton, Blink, Tritium, Circontrol, SK Signet, Sinexcel, eLoaded, BP pulse, Fastned*
Indirect	*Shell, BP, OK, tango, Total, Esso, Texaco, NS, Blauwnet, Connection, Breng, Arriva*
Potential	*Hydrogen cars*
Future	*Coil Chargers, solar cars*
Replacement	*Shared vehicles, optimised public transport infrastructure*

Figure 8 Electric Vehicle Chargers on the Market

Figure 8 presents multiple wall chargers of comparable functionalities. It is apparent that most of the products are produced using polycarbonate, steel, or stainless steel. LEDs are often used to give a status indication with colouration. RFID readers are used to identify the user and fulfil payments.

2.5. Solution Space

After extensive desk research and consultation with Vigor's business development department, three relevant competitors are selected to elaborate on in more detail. These are all labelled as direct competitors with comparable products on the market. The three selected parties are Alfen, EcoTap, and EVBox. Table 2 provides a more detailed comparison, elaborating on target groups, product groups, and sales channels.

Table 2 Direct Competitor Comparison

	Alfen	**EcoTap**	**EVBox**	**Vigor**
Target Group	Consumer, business, public	Consumer, SMEs, large enterprises, gas stations, public, public transport	Consumer, SME	SMEs, business, Governments, logistics sector, installation companies
Product Groups	Smart Girds, Energy storage, AC and DC charging stations	AC and DC charging stations	AC and DC charging stations	AC and DC charging stations
Sales Channels	Distribution channels (home and SME), CPO's	Distribution channels (home and SME), CPO's, international	Distribution channels (home and SME), CPO's	CPO's, dealers,

2.5.1. Market Placement

The market placement of Vigor Charging was formulated based on interviews with internal business developers and a digital marketing strategist. The focus of Vigor Charging is mainly on public spaces, followed by semi-public spaces and working locations, referred to as small medium enterprises (SME). Charging at home is left out of scope in this stage of development.

The novel nature of Vigor as a brand allows a thorough analysis of priorities in values and strategies. To structure this approach, Value Disciplines are mapped. The typology of Treacy & Wiersema (1993) is applied during this mapping. They divide into three value disciplines: operational excellence, customer intimacy, and product leadership. Successful companies excel in one of these three disciplines and meet industry standards for the other two disciplines.

In accordance with Vigor's business development, the three disciplines were rated on a scale from 1 to 5. Product leadership received a value of 3, operational excellence received a value of 2, and customer intimacy received the highest value of 5. This aligns with their current focus on intensive customer and stakeholder engagement.

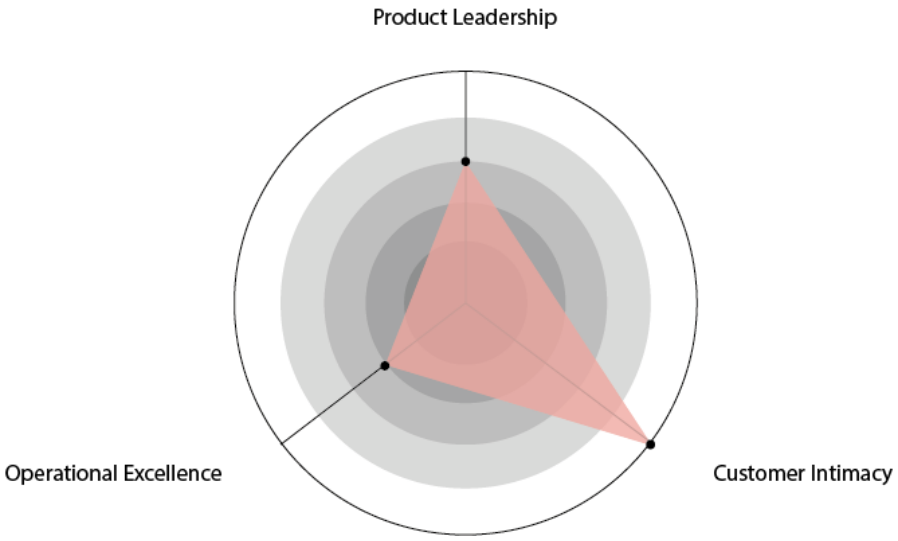


Figure 9 Spider map of Desired Value Strategies

Related to this focus on customer intimacy (Figure 9) is the awareness of investing not only in single transaction profit but investing in the long-term relationship with a customer. According to Treacy & Wiersema (1993), not only should products radiate the chosen focus on customer intimacy, but the whole company should implement responsiveness and flexibility in its departments. Management teams should be consistent in how they practice the customer's lifetime value throughout the company (Treacy & Wiersema, 1993). For outer design and usability, this would mean that the end users and businesses, which are direct customers, should be directly involved in product development.

3. Methods

3.1. Literature research

Literature is studied on brand management, brand identity research, translating brand values into design, describing design attributes, and researching perceptive determinants for brand values to investigate existing theories qualitatively. This study provides insights into brand identity and management facets to include in product requirements and design.

3.2. Background research

Qualitative observations are done for research on the usability of current Vigor products and user-product interactions. 11 users are observed in the residential area of Lombok in Utrecht. Note-taking was selected as the recording method to minimise the disruptiveness of the recording. A form is constructed to take notes in different instances (Appendix 1 Observation Form) consistently. Recorded actions are interaction time, facial expressions, number of actions, localising charger, plugging and unplugging cable and payment.

To research internal stakeholder relations and interests, qualitative personal communications were conducted. Internal stakeholders, employees of Vigor and NieuweWeme, were asked to share experiences based on their expertise. The addressed are employed as digital marketing strategists, mechanical engineers, business developers, engineer managers, production planners, and electrical engineers.

To research extern stakeholder relations and interests, qualitative personal communications are conducted. With varying perspectives, Extern stakeholders were asked to share knowledge and interests regarding charging stations. Firstly, Robin Berg, initiator of We Drive Solar, participated as a business partner of NieuweWeme and Vigor. This company has been the frontrunner in delivering electricity back to the grid, the so-called V2G principle, since 2019. Their EV charging stations are produced by NieuweWeme and sold by Vigor Charging. Secondly, Equans is a charging point owner (CPO) of charging stations produced by NieuweWeme and sold by Vigor Charging. Thirdly, ELaadNL is addressed and interviewed at their business location in Arnhem. ELaadNL is a knowledge and innovation centre in the Netherlands focusing on smart and sustainable EV charging.

A survey is distributed amongst EV users to understand positive and negative experiences with different charger categories and incentives for the perception of good usability and recognition. The mixed method survey consists of open questions. Labelling is used during data interpretation to depict predominant answers per topic. The user group is approached using Facebook as a communication channel. Via the page of the Vereniging Elektrisch Rijden association, the survey is distributed. In total, 50 respondents filled out the online survey. Vereniging Elektrisch Rijden is an association for people who are currently driving electric vehicles or are interested in doing so in the future.

3.2.1. Case study

To concretise research and brainstorming, a case study is done with a realistic company NieuweWeme. This case study focuses on one product category out of the to-be-developed product portfolio of NieuweWeme's charging solutions brand, Vigor. Due to this selection, more detailed research and stakeholder conversations could occur. The selected product includes a single socket wall charger for electric vehicles. The findings implemented in this case are translated into other product portfolio products at a later stadium. To acquire information from internal NieuweWeme employees, focus groups were conducted with the Vigor project team.

3.2.2. Focus Groups

A series of focus group meetings with the project team responsible for EV chargers are used to bridge team members' scientific knowledge and local experience (Cornwall & Jewkes, 1995). Multiple sessions are organised to collect qualitative data and input and formulate assumptions with the brand. Participating employees function as a soundboard of underlying brand knowledge (including beliefs, attitudes, values, perspectives, and ideas). The research uses a real-life case study to identify and create relevant, context-dependent brand value (Ridder, 2017).

Focus group 1, Defining Brand Values, was held to formulate and collect existing perspectives and focus points of the brand Vigor. This meeting was attended by a population of three employees (two business developers and one marketing strategist) as part of the project team charging solutions. Firstly, brand elements are rated on a scale from 1 to 10 for the current and desired situation. Secondly, the brand identity prism (Kapferer, 2008) is used to formulate more specifically, what a desired identity of Vigor would include according to the population.

Focus group 2, Specifying Value, was held to unify insights of multiple professions. A population of 9 employees attended this meeting as part of the project team charging solutions. The represented professions are mechanical engineer, electrical engineer, marketing strategist, business developer, technical writer, production planner, and department leader of charging solutions. The value proposition canvas (Osterwalder et al., 2015) is used to structure the output for different facets of brand value. The canvas aims at clarifying customer understanding and a plan to create value. The goal is to summarise knowledge using this framework, to identify points of improvement and additions.

Focus group 3, Formulating Brand Associations, was held to concretise visual and textual associations with the brand and generate partial solutions. This meeting was attended by a population of 5 members of the project team charging solutions. Firstly, images and phrases (Ashby, 2008) were presented to stimulate discussion and picturing emotions, associations, and values. Secondly, idea generation was done using the lotus blossom method (Shen et al., 2016) and a variant of the 6-5-3 method (Method 635, 2024). These ideas could identify potential unique selling points.

Focus group 4, Formulating Prototypical and Brand-Typical Attributes, was held to define prototypical and brand-typical attributes. A population of 7 employees attended this meeting. Hand-drawn sketches and AI-generated images are used to open discussion and match with unspoken brand assumptions. Participants could “match” and “mismatch” sketches and images with their perceived brand language of Vigor by indicating with either a green or an orange arrow sticker. Subsequently, these aspects were summarised collectively into prototypical attributes and brand-typical attributes.

Focus group 5, Concept Rating, was held to rate concept directions. These concepts are elaborated on for the product type of a single socket wall box. Multiple communication methods, basic design elements and interaction options are included in the different concepts. The presented concepts were rated on the factors of sustainable design, usability, design & styling, and innovativeness on a scale from 1 (lowest rating) to 5 (highest rating). These factors are deducted from the requirements list. The rates are filled in a decision matrix (Yin, Qin, & Holland, 2011). High-rated (aspects of) concepts are iterated in a subsequent design phase.

Focus group 6, Model Rating, was held to converge towards a design direction for the final design proposal for a single socket wall box charger and subsequent design for the product portfolio. Nine concepts were presented in the morphological matrix (Fargnoli, Rovida, & Troisi, 2006), combining three iterations of previous concepts and three opportune researched design features supporting pre-specified brand values. The goal is to agree on an overall design to develop in more detail.

3.3. Researching shape-value and geometry-value relationship

This thesis collects cross-sectional data from two different variations to research the relationship between design attributes and congruent values. It researches this relationship on 2D and 3D levels. The first study conducted in this thesis researched the relationship between 2D shapes, including ordering attributes extracted from Muller's (1997) methodological framework of design and brand values. The second study researched the relationship between 3D geometries with prototypical attributes, including ordering attributes extracted from Muller's (1997) methodological framework of design and brand values.

3.3.1. Shape-attribute Relationship

A study is conducted to research the link between pre-specified values and ordering attributes in design. The first part of the study investigates the relationship between ordering attributes and congruence with the core values in 2D shapes. Data is acquired via a survey distributed among Industrial Design Engineering master students. Inclusion criteria are determined to be industrial design students due to their experience in evaluating design. 22 IDE students participated in this part of the research. A collection of 10 2D shapes is presented in a survey. These 10 shapes implement ordering attributes as described by Muller (1997). Opposite attributes are represented equally to analyse the most congruent attributes with the pre-specified brand values. By comparing means of rated congruence of the 2D shapes with the pre-specified values, input for a style guide can be retrieved.

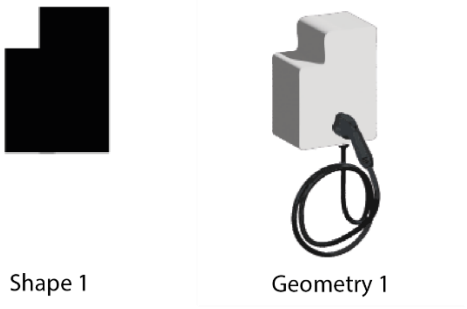


Figure 10 Example Samples of Translating 2D Shape into 3D Geometry

3.3.2. Geometry-attribute relationship

The second study builds on the samples of the first by translating the 10 researched 2D shapes into simplified product representations. These simplified representations are developed by extruding the shape samples into geometries and complementing these with the prototypical attribute of a socket with a connected cable (Figure 10). For this case study, the product type single socket wall box electric vehicle chargers are researched. The goal is to research the effect of the product category on the attribute-value relationship. Data is acquired via a survey distributed among Industrial Design Engineering master students. Inclusion criteria are determined to be industrial design students due to their experience in evaluating design. 11 IDE students participated in this part of the research. A collection of 10 3D geometries with prototypical attributes of a single socket wall box electric vehicle charger was presented in a survey. These 10 shapes implement ordering attributes as described by Muller (1997). Opposite attributes are represented equally to analyse the most congruent attributes with the pre-specified brand values. By comparing the rated congruence of the 3D geometries with the pre-specified values, input for a style guide can be retrieved.

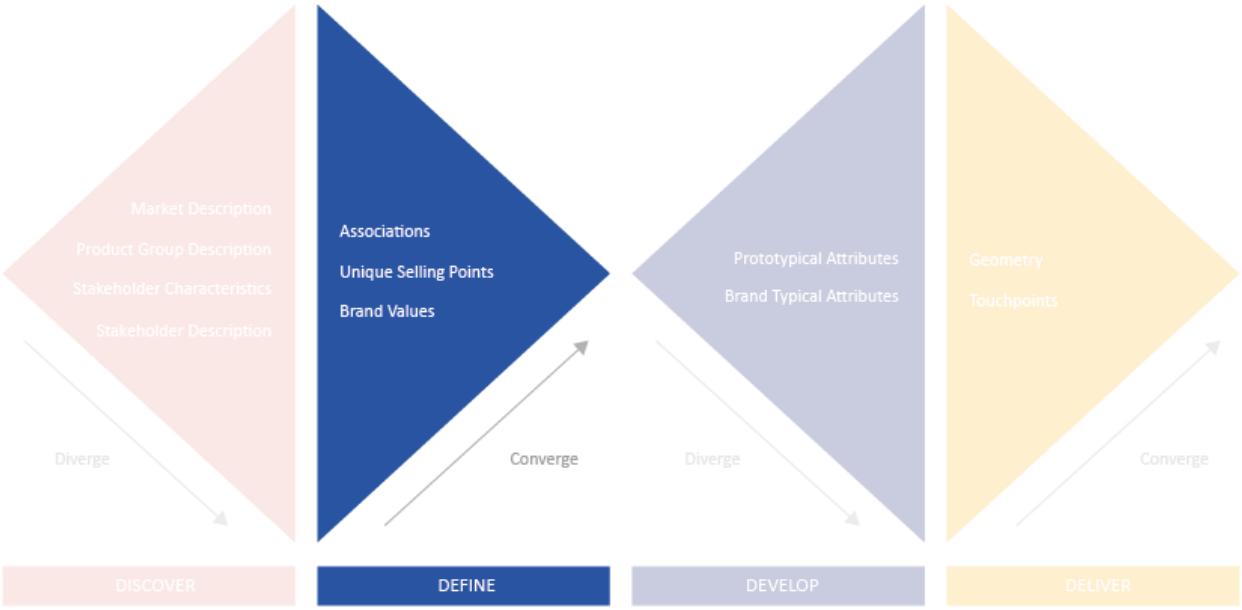
3.3.3. Validation of implementation of stimulating attributes in design

The proposed design is validated by comparing identical product types of the current and proposed electric vehicle chargers. Three different product types are included in the survey: single socket wall box, double socket wall box, and double socket pillar. The proposed design of a single socket pillar product type is disregarded since the current product portfolio has no comparable product. The goal is to research the effect (positive or negative) of implementing design guidelines retrieved from the design-value relationship studies. A within-subject method is used to analyse 6 included product representations in their congruence with the pre-specified brand values. 40 participants responded to the validation survey, distributed via LinkedIn and WhatsApp. No exclusion criteria were defined to get a generic insight into the perception of the presented products.

DEFINING

The Design Problem

4. Defining Vigors Brand Identity



This phase of the thesis researches the definition of the brand value of Vigor. Literature on building brand equity (Keller, 2001) and positioning a brand (Aaker & Shansby, 1982) is used as a base to define predetermined outcomes. The define phase articulates which brand values represent the brand and how these can be implemented into design guidelines. Additionally, functional requirements are formulated based on findings from the previous discover phase. These requirements focus on providing good usability and representing the map of stakeholders.

Predetermined outcomes, as indicated in the blocks in the design approach, include desired associations, unique selling points of the brand and products, and brand values. In-house focus groups are used to get insight into existing knowledge and opinions on and perceived and targeted customer value of the current products. Company employees are included in researching and formulating brand values. These brand values are used as a starting point for investigating how these implicit values can be translated into explicit design characteristics.

4.1. Focus Group 1 Defining Brand Values

The aim of this focus group was to identify values and aspects of Vigor's identity. The first part was conducted by rating a list of brand elements (on a scale from 1 to 10). With 1 representing the brand element as insufficient and 10 representing the element of the brand as highly sufficient. The participants rated these elements or both the current situation and the desired situation of Vigor. The elements rated were *innovation, reliability, brand awareness, marketing, distinctiveness, value for money, design (aesthetic), quality, product portfolio, and in-house knowledge*. By comparing the current situation with the desired situation, focus points can be determined to build upon during development. The second part used Kapferer's (2008) Brand Identity Prism. The desired aspects of the brand's *physique, personality, relationship, culture, reflection,* and *self-image* were discussed.

A set of brand values was developed from this session and communication with business developers. These values summarise ideas and visions representing the aim of the current brand. These values will be used to conduct further research and conversations. The brand values of Vigor are set to be Innovativeness, Trustworthiness, high quality, Circularity, and Expertise.

A modification of this set is made due to the design scope of this thesis. Circularity and expertise are radiated through customer contact, internal knowledge, and experiences over time. To design with and validate desired values, the set used in this design research (aiming to radiate the brand through design) is adapted. The values addressed in this study include **Innovativeness**, **Sustainability**, **High quality** and **Trustworthiness**.

4.2. Focus Group 2 Specifying Value

This focus group session was done to unify experiences and knowledge of multiple professions. The first reason for including multiple professions is to collect and understand a more complete overview of existing knowledge. The second reason is that an open environment and shared interest can be created by complying with varying professions contributing to this project. The value proposition canvas generates insights into the customer profiles (pain, gains, tasks) and the value map (gain creators, pain relievers, products, and services).

Summarising the results of this session, different aspects of the product are aimed to create value according to participants' experience. The bidirectional charging functionality should be working and easy to understand and use. The product should be recognisable as an implication of Vigor but blend into the environmental scene. Payment should be enabled to perform contactless and transparently. The interface and design of the product should be insightful, and information should be presented at the right time. Using the innovative technology of bidirectional charging should be comprehensive, and the product should be intuitive. Lastly, the product should present clear information about the costs, payment method, support, and errors. Insights of this session are partly included in requirement formulation and as inspiration for concept creation.

4.2.1. Researching incentives of pre-specified brand values

This section describes the determinants of Vigor's selected core values. A literature review provides insights into researched aspects contributing to meaningful design that is congruent with the brand's core values. This research focused on determinants that affect the desired values. In the case of Vigor, the values to be designed with are innovative, sustainability, trustworthy, and high quality.

Determinants are researched throughout interface design and product development. As a result of this, the brand value expertise is eliminated from the list, which will be included in the requirements of the future product portfolio. Expertise as a value can't be separated from both trustworthiness and quality. Including this would cause undesired dependency between the factors. Additionally, circularity is replaced by the factor of environmental sustainability. This term is more specific and, therefore, better to use in requirements. Circularity is seen in this research as part of the factor of environmental sustainability, and therefore, its perspective is considered.

The perception of **innovative** products is described by Flight et al. (2011) as products that radiate relative advantage, compatibility, and the effects of social pressure. Relative advantage is enhanced by unique features, higher quality, better meeting needs, reducing costs, and uniquely completing tasks (Cooper, 1979) Compatibility, in this context, can be explained as to which extent the product fits in with the existing life of an adopter. Social pressure is determining, which means that new developments can feel obligated due to peer pressure from the adopter.

The perception of (environmentally) **sustainable** products is described by (Simpson & Radford, 2012) as long-lasting, durable in time, reducing consumption, and quality to enhance durability and reliability.

The perception of **trustworthy** products can be divided into the perception of new users and the perception of experienced users, according to Riegelsberger & Sasse (2001). The first group interprets products as trustworthy when status bars, visibility, tracing, possibility of cancellation, recommendations, brand familiarity and reputation can be recognised. The latter group interprets products as trustworthy when costs are communicated, breadth and depth of offerings are communicated, absence of errors, speed, consistent graphics, good usability, and similarity to comparable products (Riegelsberger & Sasse, 2001).

(Agyekum, Haifeng, & Agyeiwaa, 2015) describe determinants in the perception of **qualitative products** as price, physical cues, place of origin, type of distribution channel, packaging, and brand and manufacturer name. Price is specifically decisive when other information is not provided to the adopter. Physical cues in this context include taste, smell, and size of the products.

The abovementioned researched incentives of the selected brand values are included in the requirements list. The following section describes further research to investigate the perception of brand values in product design.

5. Researching Distinctive Brand Features

In the discover phase, different studies describing the relationship between shapes and associations are reviewed. The objective of this research is to integrate these findings into design features. The identified literature gap regarding shape and product characteristics that can enhance associated values is intended to be addressed in the subsequent sections. Ordering characteristics, as depicted by Muller (1997), are used to test and evaluate. Muller divides these characteristics to typify design into categories. Addressing this classification allows for a structured approach to investigating design-association relationships. The ordering characteristics are integrated into shapes and complementary geometries. These shapes and geometries are then rated in congruence with the brand values of Vigor *innovative*, *trustworthy*, *high quality* and *sustainable*. Approaching internal employees could limit the objectivity of the results. Therefore, IDE students were approached to conduct this research due to their expertise in assessing and evaluating design at an abstract level. A selection of ten ordering characteristics ensures that students can share insight without mastering the theory of Muller (1997).

Focus groups are used to acquire qualitative data about existing assumptions about the brand Vigor. The selected participants are project team members responsible for developing EV chargers with V2G functionality. Kapferer (2004) describes that a brand's continuity lies in both external and internal organisation. Internally, functions and occupations should be aware of and work according to the brand. This coherence contributes to the production of consistent output and to customer relations (Kapferer, 2004).

5.1. Shape Association Study

Addressing this issue solely with internal staff might result in a limited perspective, as these employees primarily work as engineers, focusing predominantly on ensuring the functionality of the charging station. To include an expert view on how certain shapes elicit associations, Industrial Design students are approached, in addition to the internal view on product design. The survey aims to understand how certain values can be assigned to and recognised in product design. The survey presents shapes (2D) in their most basic state to investigate whether certain shapes elicit specific associations and, if so, which shapes are most effective. By testing this on this simplified level excluding prototypical attributes, the findings can be applied to multiple levels of detail. This method is inspired by the semantic differential method used by Kongprasert (2009).

5.1.1. Association measurement

The survey presented ten different ‘shapes’ (Figure 11). These shapes vary in the ordering characteristics (Muller, 1997) *symmetric* versus *asymmetric*, *organic* versus *geometric*, *dynamic* versus *static*, *slim* versus *robust*, and *pointy* versus *rounded*. A general open question about the interpretation of the visual is asked. Additionally, every shape is presented after which associations are asked to be rated. The associations are based on the core values of Vigor; *innovative, sustainable, high quality*, and *trustworthy*. These can be rated on a scale from 1 to 5, with 1 strongly disagreeing and 5 strongly agreeing with the association above. In line with the survey's objectives, the survey results are analysed comprehensively to determine the extent to which various ordering characteristics align with specific associations.

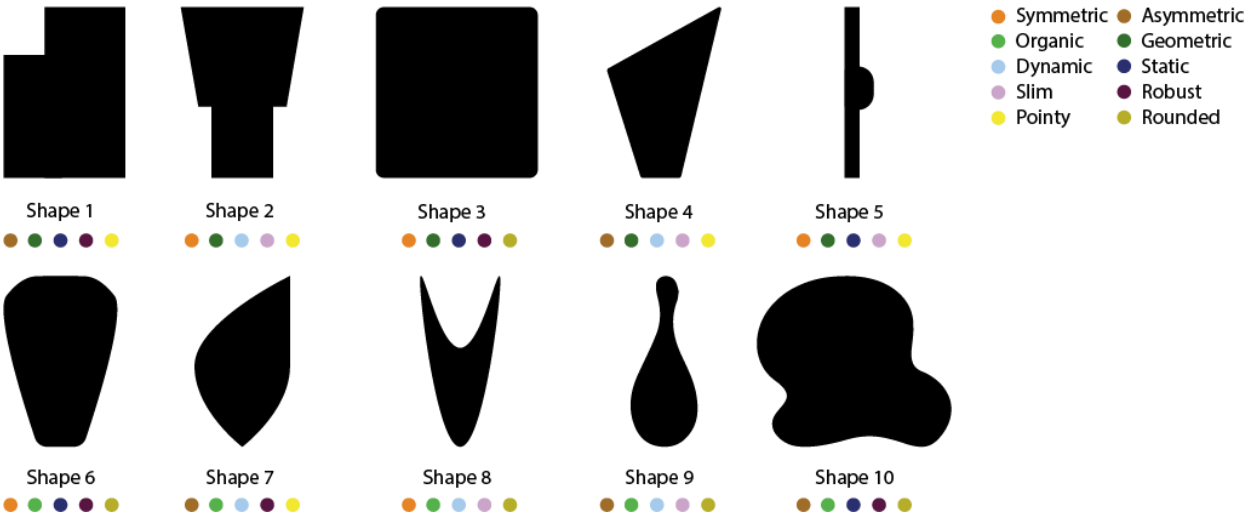


Figure 11 2D Shapes Included in Shape Association Survey

In total, 22 Industrial Design Engineering students participated in the shape association study. These students are experienced in examining and interpreting shapes; therefore, their input is of great value. The abovementioned ordering characteristics are implemented in the shapes of Figure 11. After analysing the results of the perceptions of the participants, a correlation between their ordering characteristics and brand values is researched. The means of the ratings per shape and association are compared. The shapes leading towards the most extreme associations are used to formulate design guidelines. Additionally, the remarks acquired from the open question are summarised.

The ten rated shapes with varying ordering characteristics are analysed by looking at the averages of student ratings per shape. The ten shapes included in the survey represent ten articulations of ordering characteristics. Every characteristic is integrated into 5 of the 10 researched shapes. For example, 5 out of 10 shapes are symmetrical, and 5 out of 10 are asymmetrical. This approach has been consistently applied to all shapes and ordering characteristics. The equitable distribution enables recognising relationships between the ordering characteristics and desired associations. Figure 12 presents the ratings per shape on a scale from 1 to 5 and ordered from lowest to highest rating. The ratings represent the mean values of all four brand values rated on congruence. For example, shape 1 (S1) is rated with a 2,16 on innovativeness, 1,72 on sustainability, 2,94 on high quality, and 3,78 on trustworthiness. The mean rating of these four values is 2,65, and this result is presented in Figure 12.

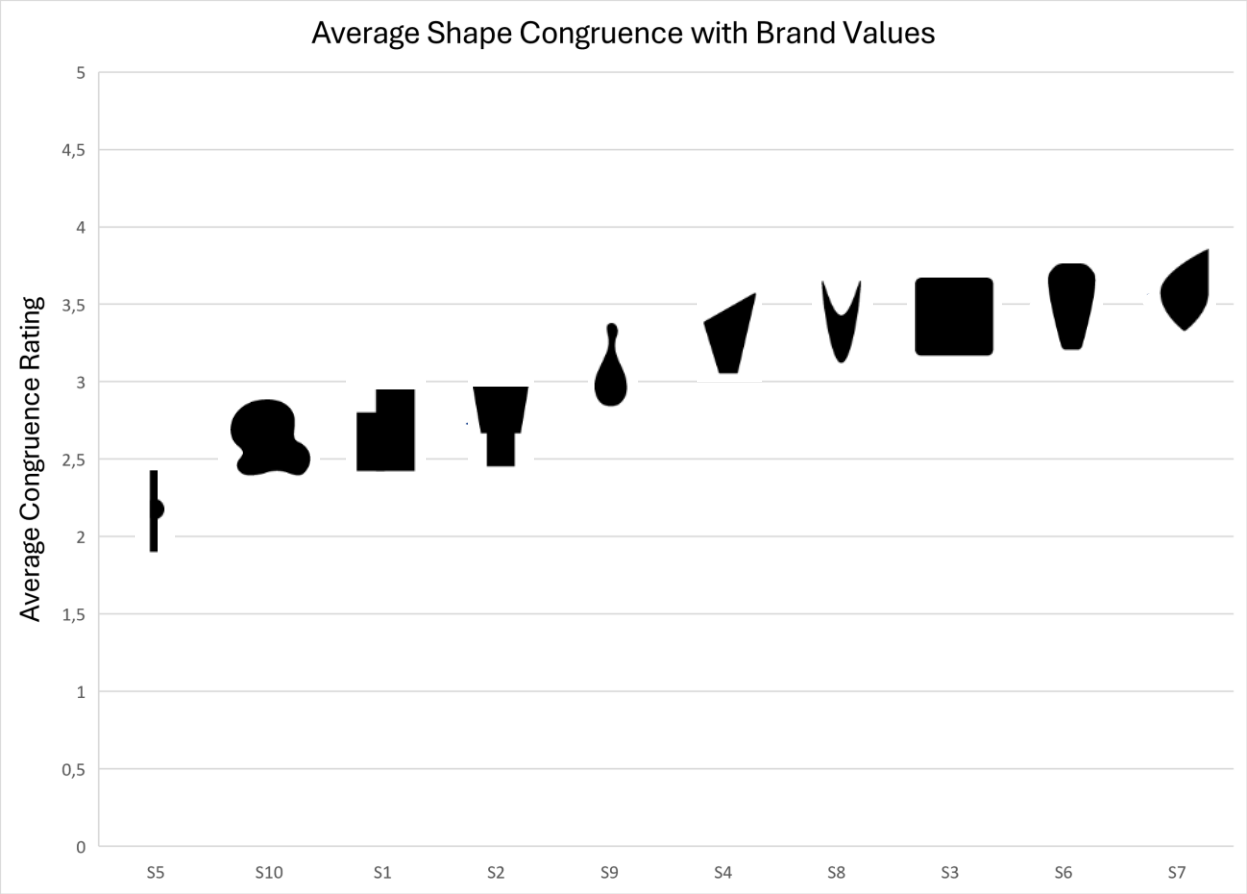


Figure 12 Ratings per 2D Shape on a scale from 1 to 5

Firstly, conclusions are drawn based on the average rating of all values combined per shape. Secondly, per core value the ratings are analysed. By separating the ratings of each value, a certain weight can be assigned to a value if desired. Appendix 9 Average Shape Congruence Ratings with Brand Values presents ratings per shape and value.

Rates below 3 are seen in this research as negatively affecting the core values association. The rate of 3 is seen in this research as not increasing or decreasing the core values association. Rates above 3 are seen as positively affecting the core values association. The shapes 5, 10, 1, and 2 are rated on average with lower than 3. This means that their shape does negatively affect core values association. The shape 9 is rated with a 3. This means its shape does not positively or negatively affect core values association. The shapes 4, 8, 3, 6, and 7 are rated above 3. This means that their shape positively affects core values associations.

Furthermore, the research examines which of the two contradicting ordering attributes is more congruent. This is concluded in the case of a higher rating for a certain value association for shapes with one ordering attribute, compared to a lower rating for that value for shapes with the other ordering attributes (e.g. symmetric versus asymmetric). In the case of no or neglectable difference in rating between two contradicting ordering attributes, this is not seen as significant. Table 3 shows, per core value, the ordering attributes which cause the association with this value more than the contradicting ordering attributes. Appendix 10 Average of Brand Values Congruence with Shape Ratings, shows the average ratings and ratings per core value.

Table 3 Overview of Core Values and Correlating Ordering Attributes

Core Value	Ordering Attributes (Muller (1997))
Innovative	Asymmetric, Organic, Dynamic, Slim, Pointy
Sustainable	Asymmetric, Organic, Dynamic, Robust, Round
High Quality	Symmetric, Organic, Dynamic, Robust, Round
Trustworthy	Symmetric, Static, Robust, Round

Additionally, the analysis of the results reveals that shapes displaying a decreasing measure from top to bottom are consistently rated as more innovative than other shapes.

The open questions about the reason for association led to insights about the perception of the type of shapes. The participating industrial design students generally described asymmetrical shapes predominantly as more arbitrary than symmetrical shapes.

These findings can be applied to designs that should adhere to the brand's desire to radiate these values. The following study explores these findings further and extends them to another level. It aims to translate the ordering characteristics into a product-related shape, considering the product's prototypical attributes.

5.2. Geometry Association Study

This geometry study is a specified version of the described shape association study above. In contradiction to the shape association study, this survey research associations with the product type given. The initial study was conducted by mentioning product design in general as the application. This study, regarding geometry, evokes associations when being aware of the EV charging function of the geometry.

The survey presented ten different geometries (Figure 13). These geometries vary in the ordering characteristics (Muller, 1997) *symmetric* versus *asymmetric*, *organic* versus *geometric*, *dynamic* versus *static*, *slim* versus *robust*, and *pointy* versus *rounded*. A general open question about the interpretation of the presented geometry is asked. Additionally, every geometry is presented, after which associations are asked to be rated. The associations are based on Vigor's core values: innovation, sustainability, high quality, and trustworthiness. These can be rated on a scale from 1 to 5, with 1 strongly disagreeing and 5 strongly agreeing with the association above. The aim is to map with the survey results which ordering characteristics can be matched to which association to which extent.

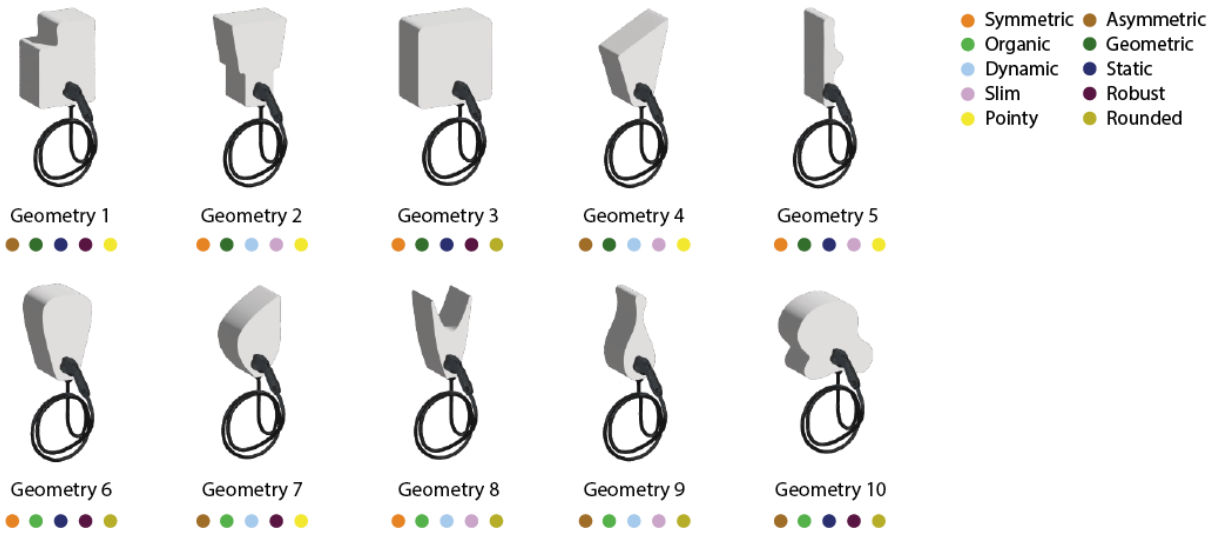


Figure 13 3D Geometries Included in Geometry Association Survey

In total, 11 Industrial Design Engineering students participated in the geometry association study. After analysing the participants' perceptions, a correlation between their ordering characteristics and values is researched. The aim is to find evident differences in ordering attributes per core value so that these can be implemented in the design guidelines. Additionally, the remarks acquired from the open questions are summarised.

Identically as for the shape association study, the ten rated geometries with varying ordering characteristics are analysed by looking at the ratings per geometry. The ten geometries included in the survey represent ten articulations of ordering characteristics. Every characteristic is integrated into 5 of the 10 researched geometries. This equitable distribution enables recognising relationships between the ordering characteristics and desired associations. Figure 14 presents the ratings per geometry on a scale from 1 to 5 and ordered from lowest to highest rating.

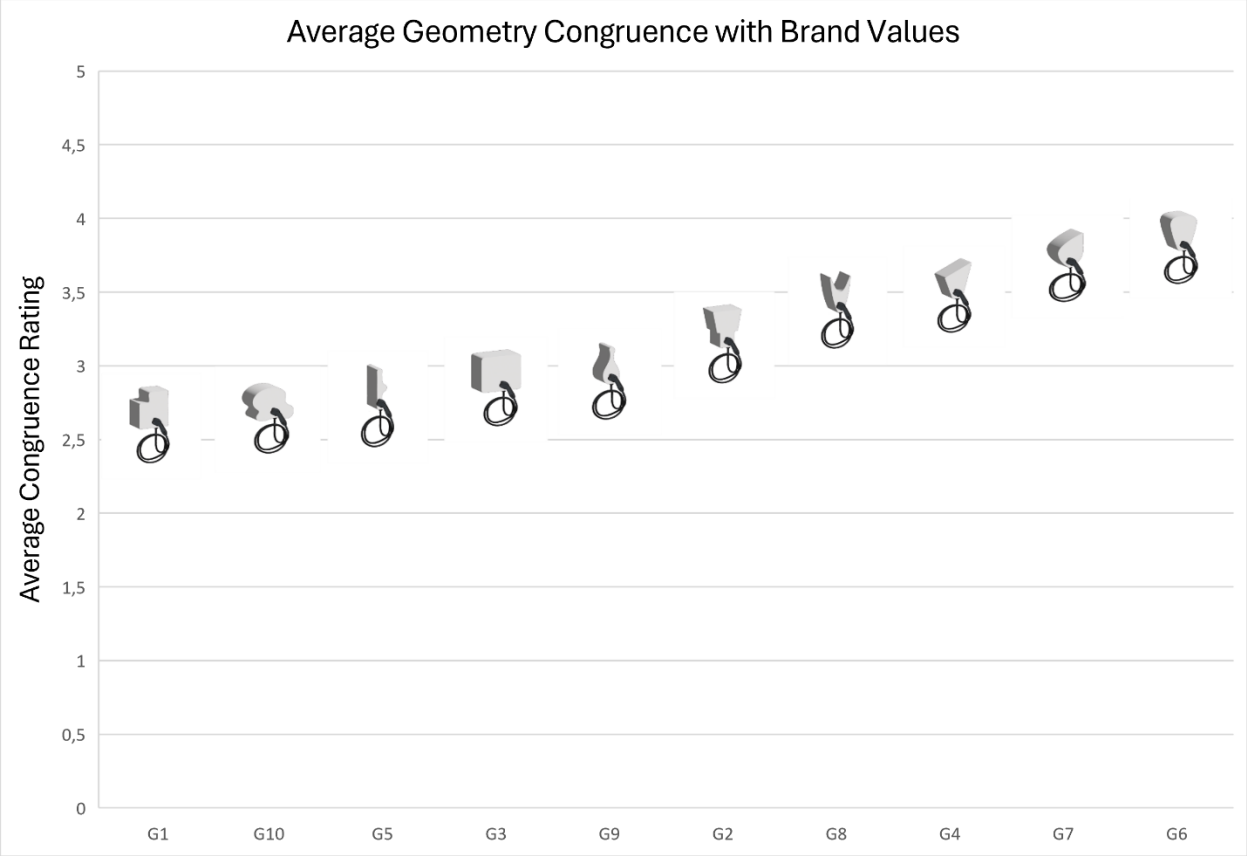


Figure 14 Ratings per 3D Geometry on a scale from 1 to 5

Firstly, conclusions are drawn based on the average rating of all values combined per geometry. Secondly, per core value the ratings are analysed. By separating the ratings of each value, a certain weight can be assigned to a value if desired. Appendix 11 Average Geometry Congruence Ratings with Brand Values presents the rating per shape and value.

Rates below 3 are seen in this research as negatively affecting the core values association. The rate of 3 is seen in this research as not increasing or decreasing the core values association. Rates above 3 are seen as positively affecting the core values association. The geometries 1, 10, 5, 3, and 9 are rated lower than 3. This means that their geometry does negatively affect core values association. The geometries 2, 8, 4, 7, and 6 are rated above 3. This means that their geometry positively affects core values associations.

Additionally, is researched per core which of the two contradicting ordering attributes is more congruent with all four brand value associations. This is concluded in the case of a higher rating for a certain value association for geometries with one ordering attribute, compared to a lower rating for that value for geometries with the other ordering attributes (e.g. symmetric versus asymmetric). In the case of no or neglectable difference in rating between two contradicting ordering attributes, this is not seen as significant. Table 4 shows, per core value, the ordering attributes which cause the association with this value more than the contradicting ordering attributes.

Table 4 Overview of Core Values and Correlating Ordering Attributes

Core Value	Ordering Attributes (Muller (1997))
Innovative	Symmetric, organic, dynamic, slim, pointy
Sustainable	Asymmetric, organic, dynamic, robust, rounded
High Quality	Symmetric, Organic, Dynamic, Slim
Trustworthy	Symmetric, Geometric, Static, Robust, Rounded

Initially, the difference in rating from the averages of the four core values per study is compared. The top three geometries are selected based on rating congruent values and considering trustworthiness. Table 5 presents the differences in rating the recognised brand values of the shapes and corresponding geometries.

Table 5 Means and Mean Differences of Congruence Rating with Brand Values

AVERAGE RATING	1	2	3	4	5	6	7	8	9	10
A Shape	2,66	2,73	3,4	3,26	2,18	3,48	3,56	3,36	3,08	2,62
B Geometry	2,62	3,2	2,87	3,55	2,75	3,93	3,73	3,46	2,96	2,72
Difference (B-A)	-0,04	0,47	-0,53	0,29	0,57	0,45	0,17	0,1	-0,12	0,1

The three selected geometries are with increasing congruence 3, 4, and 6 (Figure 15). Geometry 3 is rated with an average of 2,87 and a negative difference of 0,53 compared to the corresponding shape. The trustworthiness is rated relatively high (4,09) and is a determinant factor in perceiving the main shape of the product. Geometry 4 is rated with an average of 3,55 and a positive difference of 0,29 compared to the corresponding shape. Geometry 6 is rated with an average of 3,93 and a positive difference of 0,45 compared to the corresponding shape. Geometry 6 is rated with an average of 3,93 and a positive difference of 0,45 compared to the corresponding shape. All separate brand value associations are rated relatively high between 2,87 and 4,18.

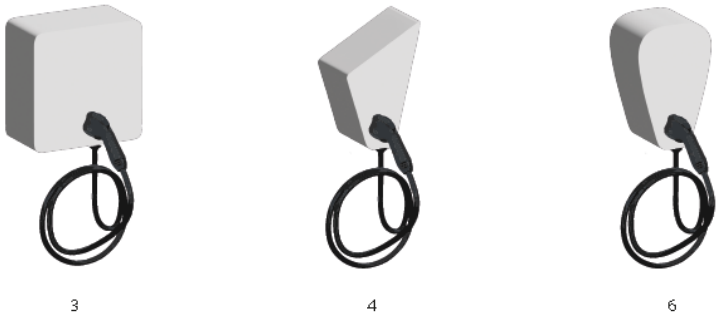


Figure 15 Selected Geometries for Design Development

Geometry 8 is rated with an average of 3,46 and a positive difference of 0,1 compared to the corresponding shape. This geometry is rated relatively high (4,45) on innovativeness and relatively low (2,91) on trustworthiness. An explanation could be that the unfamiliarity of the shape making is new and innovative in the electric vehicle charger context. This unfamiliarity could, at the same time, cause a relatively untrustworthy association. Trusting a product's main shape is required in order to adopt a new technology, such as vehicle-to-grid. Therefore, in this study the geometry is left out of scope. Geometry 7 is rated with an average of 3,725 and a positive difference of 0,17. This geometry is left out of scope due to its literal association with the leaf from a tree. The scope of this research is about how to assign certain ordering characteristics to cause desired associations. Not to call on existing geometries from a literal context.

Significant differences in ratings per core value (>1) are geometry 5 for *innovativeness*, rated with a 3,55 and a positive difference of 1,23. Additionally, geometry 6 for *sustainable*, rated with a 4,00 and a positive difference of 1,09. A geometry with significant negative differences for a certain core value (>0,8) is 3 for both *innovativeness* and 3 for high quality. Geometry 3 for the value *innovativeness* is rated with a 1,82, and a negative difference of 0,86. Geometry for the value of *high-quality* is rated at 2,82, and a negative difference of 0,95. Appendix 14 Differences in Rating Shape versus Geometry per Brand Value presents the comparison per brand value for the rating of the first and second studies.

The open questions about the reason for association led to insights about participants' perceptions of the geometry type. For example, robust geometries lead to non-sustainable perceptions, and geometry's simplicity evoked unfinished, clean, durable, and comprehensive perceptions. Table 6 presents an overview of additional associations retrieved from the open questions.

Table 6 Additional Shape Associations

Shape Characteristics	Additional Associations
Robust	Non-sustainable
Simplistic	Unfinished, clean, durable, comprehensive
Increasing to the top	Progressive, retro, speed
Sharp-angled	Progressive, modern, futuristic
Slim	Elegance, modern, fragile, inefficient
Round & Symmetric	Friendly, timeless, aesthetically pleasing
Leaf-like	Leaf, tree, sustainable, innovative
Dynamic & Symmetric	Powerful, fragile, distinctive
Drop-like	Irrelevant, organic, sustainable
Blob-like	Decorative, inefficient, arbitrary

For further development of the EV charger design, geometries 8, 4, and 6 are considered. Besides that, the ordering characteristics, as shown in Table 3 and Table 4, are taken up into design guidelines. These attributes are implemented in implicit and explicit product information (Chapter 6.1).

6. Requirements and Guidelines

To evaluate and control design proposals, a list of requirements is constructed. As a result of the literature study, interviews with internal and external stakeholders, observations, an online VER survey (EV drivers), and a survey with industrial design experts, requirements are set up. Additionally, the personas and scenarios are used to reason requirements. A distinction is made between functional and performance requirements. Functional requirements describe what the product is expected to do, while performance requirements describe how a certain function is expected to be done. These requirements function as a tool to validate proposed design solutions to the problem. The two types are implemented into the requirements listed below in Table 7.

The right column indicates the origin of the requirement. Letters are used to assign codes to certain sources for requirements. Several requirements are supported by multiple of the sources consulted in this research. The letter “I” indicates that the requirement originates from insights gained from internal stakeholders, the letter “E” indicates that the requirement originates from insights gained from external stakeholders, the letter “O” indicates that the requirement originates from observations, the letter “V” indicates that the requirement originates from the online survey amongst EV drivers, the letter “D” indicates that the requirement originates from the survey amongst industrial design master students, and the letter “L” indicates that the requirement originates from included literature in this study. The performance requirements section also which functional requirement is addressed.

This list of requirements is based on Noriaki Kano's KANO model, which is described in his theory of attractive quality (Kano, 2001). The model proposes a classification of must-be requirements, one-dimensional requirements, and attractive requirements (Figure 16).

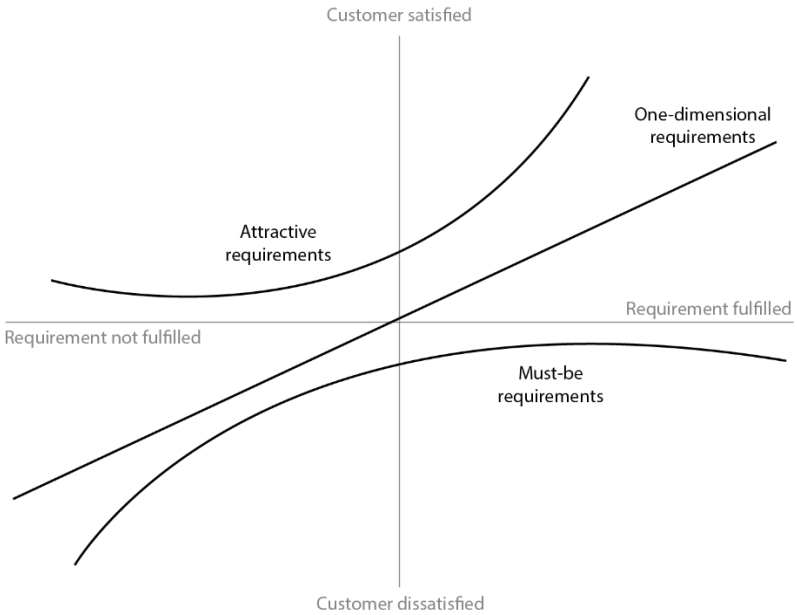


Figure 16 Kano Model Classification

Must-be requirements are categorised as requirements a product cannot exist without. Meeting these requirements does not contribute to product satisfaction. One-dimensional requirements are in relation to the extent to which achievement and satisfaction are fulfilled. Attractive requirements are unexpected and highly affect user satisfaction. However, when these requirements are not met it is not harmful to customer satisfaction (Nascimento et al., 2012)

It is important to acknowledge that the list of requirements below focuses on those that follow up on the research conducted in this project. General guidelines and requirements are left out of scope but should be considered later in the development of the products. A report of Nationale Agenda Laadinfrastructuur can be addressed for general requirements regarding smart charging and vehicle-to-X charging (Smart Charging Requirements, 2021). These additional requirements are left out of scope since this design research focuses on the outer design of electric vehicle chargers. To structure the list, different sections are included ranging from general requirements to requirements regarding usability, interface requirements, and design requirements.

Table 7 Functional and Performance Requirements Listed

Functional Requirements		Origin	KANO	Performance Requirements		Origin	KANO
General							
G1	Be recognizable as a charging station	I	M				
G2	Be an unobtrusive product	O	M				
G3	Be a compact product	V	M				
G4	Be a durable product	I,E,L	M	**G4.1**	Use sustainable materials	I,E	O
Usability							
U5	Inform the user about the payment method	I,E,V	O	**U5.1**	Should have a smart card reader	I,V	M
U6	Instruct steps to take in occasion of error	I,E,V,L	A				
U7	Be convenient to install	I,E	O	**U7.1**	Be intuitive to install	I,E	O
U8	Be comfortable approaching from the left and right side	I,V	O	**U8.1**	Assist/support the user in handling the cable	I,O	A
U9	Fit in the existing life of the adopter	L	O				
Interface							
I12	Inform the user about the charging status	I,E,O,V,L	O	**I12.1**	Use light indication to communicate charging direction	I	A
I13	Instruct intuitively and comprehensively user in an action sequence	I,E,O,V	O	**I13.1**	Show only the required information to perform the charging action	O,I,E	A
				I13.2	Guides user in steps to take and which order	O,V	A
I14	Communicate the V2G function	I,E	O				
I15	Be transparent in price (if possible)	V,L	O				
Design & Styling							
D16	Be applicable as white label implementation	I	O	**D16.1**	Be flexible in appearance	I,E	O
D17	Represent Vigor as a brand in its geometry	I	A	**D17.1**	Is designed according to the design guide of Vigor	L	A
D18	Has a distinctive appearance	L	A				
For specific functional requirements for general charging stations, address Smart Charging Requirements (SCR), Nationale Agenda Laadinfrastructuur							

6.1. Vigor Design Guidelines

This section describes how the implicit brand identity of Vigor can be implemented into explicit product design. The requirements list refers to Vigor's style guide. This guide is retrieved from findings of how Vigor's pre-specified brand values correlate positively with ordering characteristics in the design of forms and geometries. Table 8 presents an overview of ordering characteristics with a positive effect of brand value associations deducted from the studies described in Chapter 5. The prespecified values (innovativeness, sustainability, high quality, and trustworthiness) result from in-house focus groups. These brand values are used as a manner to describe Vigor's brand identity.

Table 8 shows the results of the first study, which researched 2D silhouette shapes, and the second study, which researched 3D geometries with prototypical charging station attributes. The results of the 2D silhouette study are retrieved without informing participants about the product type. Therefore, these insights and positively affecting attributes can be implemented more broadly. The 3D geometry study results are retrieved by explicitly mentioning the product category of electric vehicle chargers. Therefore, these insights and suggested attributes can be explicitly implemented in designing electric vehicle chargers.

These guidelines are constructed to design artefacts in line with Vigor's brand identity. A recognisable design language can be built by considering **symmetric, organic, dynamic, robust,** and **rounded** attributes in developing design directions. The selection of attributes is based on positively affecting value association and seeing the electric vehicle charger context of the second geometry study. The described guidelines are used to design with while developing recognisable brand features in this design research.

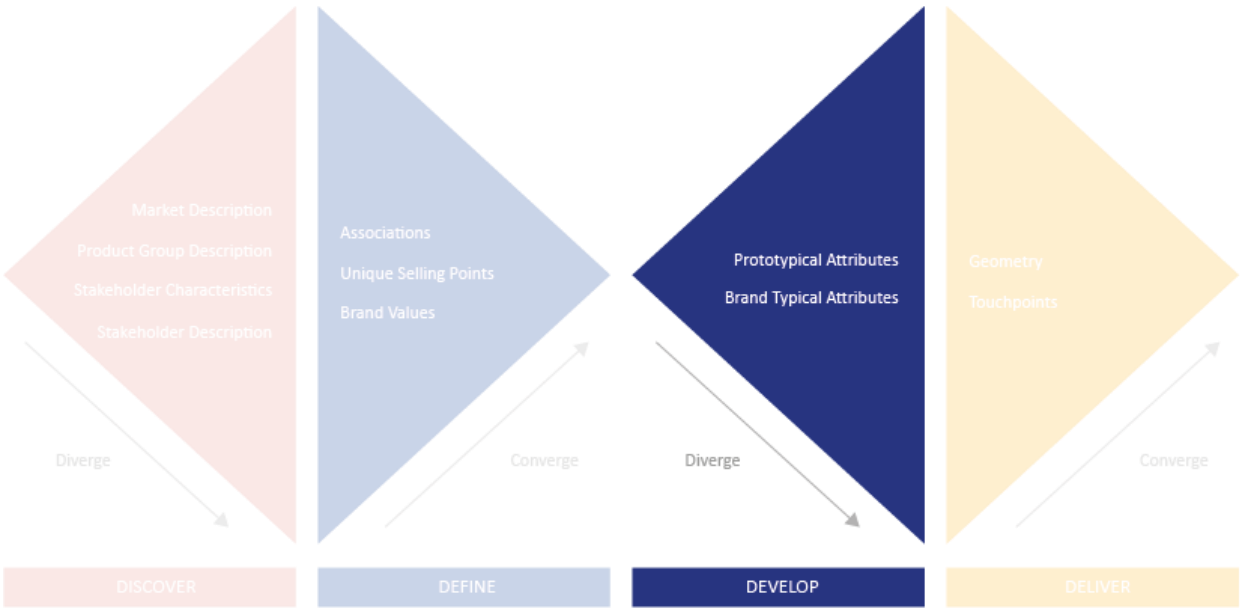
Table 8 Overview of Brand Value Congruent Ordering Characteristics

Brand Value	Congruent Ordering Characteristic (2D)	Congruent Ordering Characteristics (3D in context)
Innovative	Asymmetric, Organic, Dynamic, Slim, Pointy	Symmetric, Organic, Dynamic, Slim, Pointy
Sustainable	Asymmetric, Organic, Dynamic, Robust, Round	Asymmetric, Organic, Dynamic, Robust, Rounded
High-Quality	Symmetric, Organic, Dynamic, Robust, Round	Symmetric, Organic, Dynamic, Slim
Trustworthy	Symmetric, Static, Robust, Round	Symmetric, Geometric, Static, Robust, Rounded

DEVELOPING

The Design Directions

7. Developing Vigor Brand Features



This phase of the thesis focuses on developing design features and concepts for the brand adhering to the functional requirements and style guidelines described in Chapter 6. Literature describing design in a methodological framework is used to formulate the predetermined outcomes (Muller, 1997). The develop phase allocates design characteristics for the electric vehicle chargers and diverges into multiple design concepts considering the style guidelines. In-house focus groups are utilised to conduct concept evaluations and incorporate expertise.

As indicated in the triangle, predetermined outcomes are prototypical and brand-typical attributes. As depicted in the theoretical framework in Chapter 2.1, prototypical attributes are based on conventions and typical product category characteristics. Brand typical attributes are in this thesis defined as characteristics in line with brand value association. Considering these two types of attributes provides a structure for designing a product with good usability and recognizability due to brand value implementation.

7.1. Focus Group 3 Formulating Brand Associations

As described in Chapter 1, the brand Vigor faces the challenge of articulating values and associations and integrating them into product design. To effectively communicate these elements and ensure alignment with existing ideas, this focus group with internal employees was conducted to make these aspects explicit. The aim of the third focus group session was to gain insights into existing brand and product associations among employees about the brand Vigor. First, images and phrases were selected to match existing associations (Ashby, 2008). Second, the lotus blossom method (Shen et al., 2016) and 6*3*5* method (Method 635, 2024) were used to generate partial solutions for the different sections of the requirements of Chapter 6. These sections used as topics in this focus group include general, usability, interface, design & styling. The first exercise tries to pinpoint relatable aspects to open a broad conversation about existing implicit assumptions among participants. The lotus blossom method was selected to use participants' expertise for concept directions as inspiration. The 6*3*5* method was used as an exercise to build on each other's ideas and cooperate to create shared ownership and understanding.

Interesting partial solutions resulting from this idea-generating activity are, for example, a transformable casing, dynamic lights to indicate charging directions, interchangeable elements to blend in with the environment, confirmation by sound and light, cable management support, and recyclable and modular panels for casing. The abovementioned ideas are used as sources of inspiration for concept generation.

7.1.1. Ideation

The initial sketches, AI-generated images, and clay form explorations were created. These were inspired by competing products, innovative methods of presenting information from different product categories, the pre-specified brand values, existing associations, and mood lines from Simonds (2010), as depicted in the theoretical framework. Figure 17 presents the filtering approach from ideation towards attributes.

Sketching

As a first step, sketches of silhouettes and basic geometric shapes were designed. These implemented multiple sources of inspiration to diverge as much as possible and explore beyond existing familiarities.

Ai-generated Images

Handmade sketches and the AI tool Bing Create were also used to generate inspirational images. The input for this application was deducted from the defined core values of Vigor and desirable product features. The inserted prompts are “unobtrusive”, “blending in the environment”, “dot matrix”, “sustainable design”, “Volkswagen styling”, “Ferrari styling”, and “simplistic” (Bing, 2023). The aim of generating these images was to concretise certain elements and associations in the context of an EV charger. These images were used to inspire and motivate critical thinking during initial focus group sessions.

Clay models

Clay models are created and inspired by sketches and shape features from literature depicted in the theoretical framework. Using clay instead of 2D sketching allows for another perspective on generating possible product geometries.

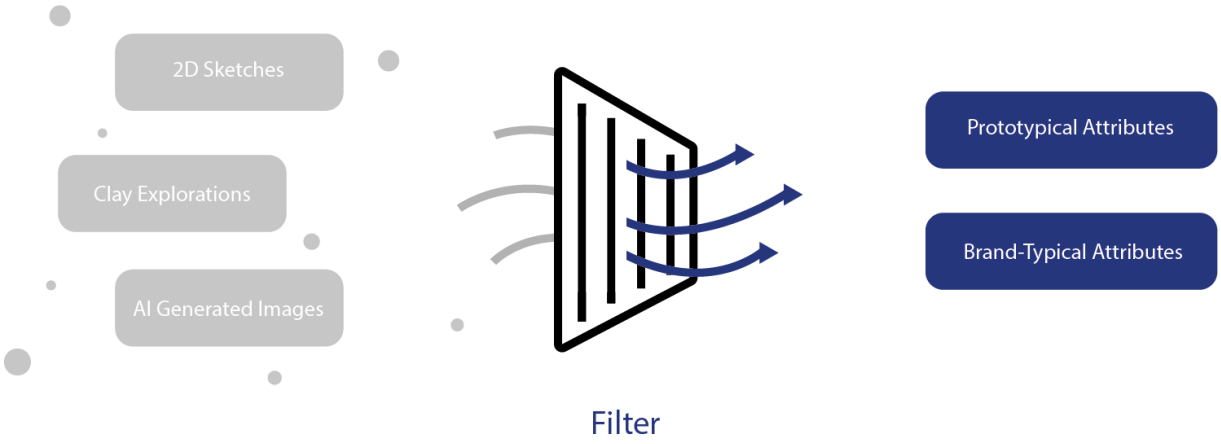


Figure 17 Filtering Approach from Ideation towards Attributes

7.2. Focus Group 4 Formulating Prototypical and Brand-Typical Attributes

Understanding the differences between product category-specific and distinctive brand characteristics and defining this division is important in this design research. This step is particularly important for developing a design proposal for a product portfolio rather than a single product, as it could inform subsequent design developments. This focus group meeting aims to define and assign prototypical (Muller, 1997) and brand-typical attributes. Prototypical attributes include aspects that define a certain product group. In this research, the product group is single-socket wall chargers, specified to participants in this session in advance. Brand-typical attributes refer to the brand identity. An example of a prototypical attribute would be a seating area for the product type chair, referring to the function of sitting. An example of a brand-typical attribute would be a pointy design feature leading to an innovative perception of the product (Table 8).

A collection of comparable chargers and design aspects were presented to allow detailed discussion about the attributes. Deducted from this discussion and knowledge about in-house chargers, prototypical attributes are described. These attributes are a socket (1), a user interface (2), an RFID scanner (3), and a cable (4) for private usage (Figure 18).

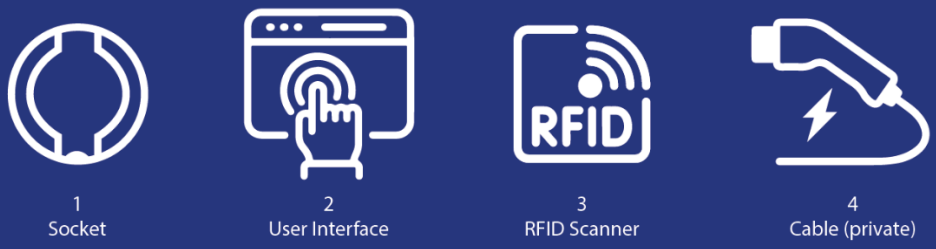


Figure 18 Prototypical Attributes Single Socket EV Wall Charger

A discussion was started to determine and formulate brand-typical attributes representing recognizable attributes in line with Vigors brand values. This discussion was initiated using ideation materials as presented in Appendix 17 Focus Group 4 Report. A common direction can be concluded by evaluating the perceived correspondence of discussed images with the formulated brand identity and perceived differences with the formulated brand identity. The visuals are used to discuss what participants see instead of describing fictive and conceptual ideas.

Cooperatively, drawings and images are divided into corresponding, “suiting”, or not corresponding, “not suiting”, with the formulated brand identity. Found trends and patterns of suiting design aspects are subsequently appointed as brand-typical attributes. The suiting aspects as a result of the discussion were appointed as a dark base, matte finish, simple, rounded, elegant and dynamic. Not suiting design aspects according to the brand identity were described as too much light, too much information, too detailed, too organic, not functional, and too decorative. As a final summary of this session Figure 19 was made as an overview. The left side presents prototypical attributes, and the right side presents the resulting brand's typical attributes.

Figure 19 Classification of Prototypical and Brand-Typical Attributes

7.2.1. Conceptualization

During this phase, requirements and literature findings are considered. The main insights deducted from Chapter 6 include manners of communication without hindering the surrounding environment, design and styling according to Vigor's core values, space for customization and innovativeness. Therefore, to create concepts the following aspects are taken into consideration: sustainable design, usability, design & styling, and innovativeness of information provision.

Features of products with different interfaces inspired sketches, leading to the developed concepts. Examples are interfaces on bike frames and projection of status on the group of a dishwasher (Figure 20). These sources of inspiration are selected due to the subtle information provision to minimise hindering the surrounding environments. Additionally, realistic proportions are considered while designing by considering the internal components.

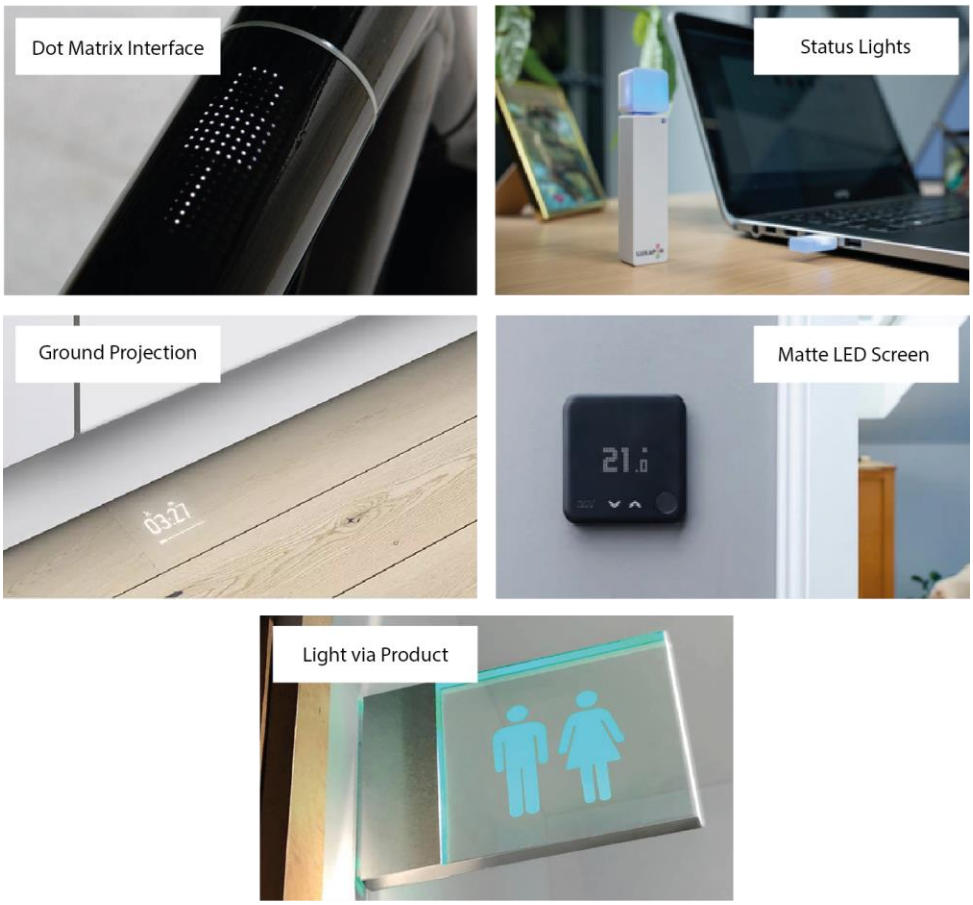
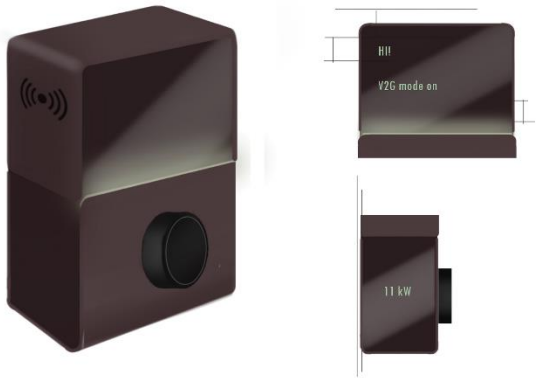


Figure 20 Inspirational Products with Subtle Information and Status Provision

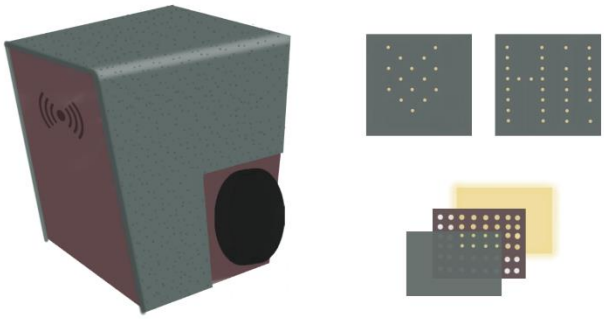
Introducing the concepts

This phase diverged into five concepts with varying interfaces and geometries. A focused and critical evaluation could take place by developing different working principles in specific concepts with a certain geometry. All explored working principles are integrated into the different geometries. This section presents and evaluates different concepts by explaining the advantages and disadvantages of each concept.



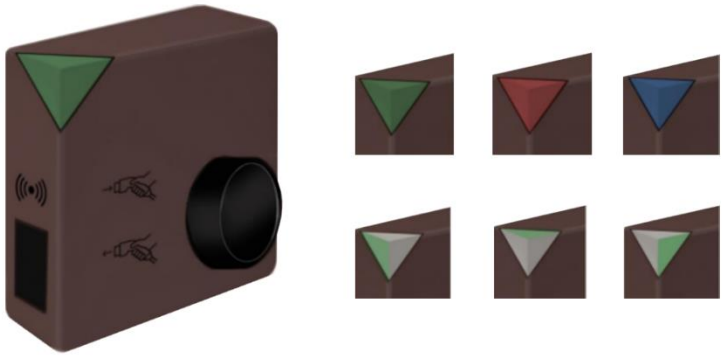
Concept 1 *E-fold* has a rounded, symmetric, and robust geometry and uses a horizontal LED strip to indicate the state of charge.

Concept 2 *Connecting Dots* has a dynamic, symmetric, and top-heavy geometry and uses a dot matrix to indicate the state of charge.



Concept 3 *ProjectionPillar* has a rounded, slim, and symmetric geometry and uses projection on the ground surface to display the state of charge.

Concept 4 *Electricube* has a robust, symmetric, and geometric geometry and uses lighting with diffuse light up the different faces of the product to guide user actions.



Concept 5 *HueCharge* has a rounded, robust, and symmetric geometry and displays the charging status by projecting it on a shell on the bottom of the product.

Appendix 18 Concept Description elaborately presents the concepts. The project team consulted and rated each concept, considering its advantages and disadvantages regarding the communication method and outer design.

7.3. Focus Group 5 Concept Rating

The aim of this brainstorming session was to rate the five developed concepts according to a rating matrix (Table 9). Factors to rate the concepts were deducted from the preliminary set of requirements. These factors are *sustainable design*, *usability*, *design & styling*, and *innovativeness*. Before assigning a rating to each factor per concept, the participants discussed and compared the concepts. The section below elaborates on this discussion's potential pitfalls and blessings with participants (elaborate summary in Appendix 20 Outcomes Focus Group Session 5 Concept Rating). Realizability and manufacturability are considered by the project team consisting of one mechanical engineer, one electrical engineer, and one technical writer of NieuweWeme.

Simplistic geometries with flat surfaces and limited parts contributed to high ratings on the factor *sustainability* due to applicable manufacturing and assembly. Designs with sharp corners and surface transitions are rated low due to a higher chance of water damage and higher manufacturing costs.

Relatively large interfaces (screen or projection) allow for flexible information provision and are therefore rated high. Guiding users by highlighting relevant areas of the product simplifies actions and is rated as an incentive for usability. Indirect light is highly dependent on the environment and is therefore rated low for usability. Implementing dot matrices would require an increased development time before production and extensive user testing.

Subtle and dynamic lights providing information about charging status suit the simplistic but high-tech vision and are therefore rated high for design & styling. A distinctive feature, such as the cutout, would contribute to the recognition of the product and is therefore rated as high. Too abstract geometries do not have enough prototypical attributes to communicate charging functionality and are therefore rated low for design and styling.

The focus group participants rated simple LEDs, projecting information, and using indirect light in a recessed shell as innovative. Conversely, basic, static geometries were rated as less innovative.

Table 9 Concept Rating Outcomes

	Sustainable design	Usability	Design & Styling	Innovativeness	Average (total)
Concept 1	4	5	5	2	4
Concept 2	3	5	2	4	3,5
Concept 3	4	3	3	3	3,25
Concept 4	5	3	4	4	4
Concept 5	4	5	4	3	4

Considering the set requirements and outcomes of the focus group the concept principles developed into a more detailed stadium are *projection on a product*, *dot matrix* and *action guidance*.

7.3.1. Interaction

The action sequences should be determined to design an intuitive and user-friendly interface for EV drivers. In consideration with the project team, an applicable and desired action sequence is developed. The bordered actions are relevant except for home charging. The horizontal sequence is chronological, and the vertical sequence indicates the interchangeability of actions.

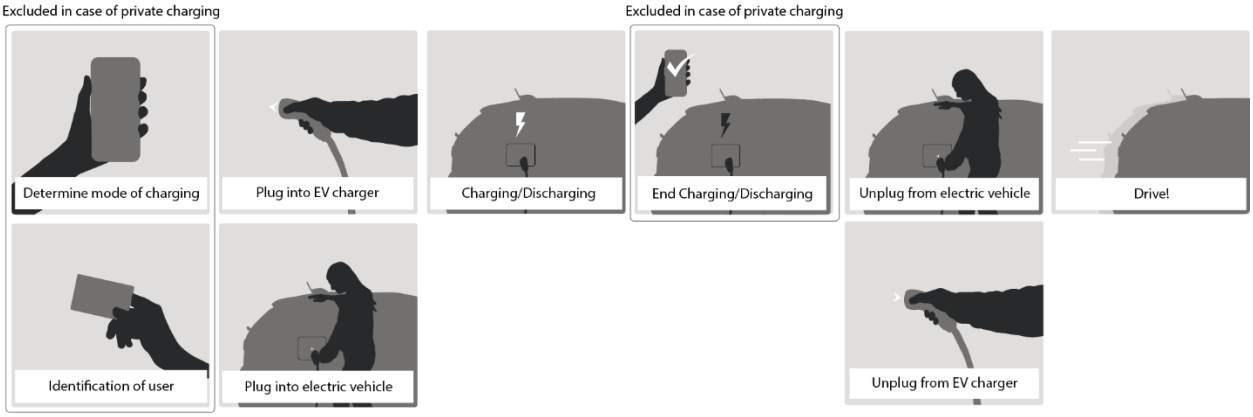


Figure 21 Action Sequence for AC Vigor Chargers' Interaction

7.4. Developing Concepts

Based on the outcomes of the abovementioned concept rating and style guidelines, three design directions and three interface principles were selected. Geometry directions are deducted from the outcomes of the abovementioned conducted shape and geometry studies supporting Vigor's core values: rounded *cube*, *shield,* and *dynamic* (Chapter 3.3). The interface methods selected were *projection on* a *product*, *dot matrix*, and *surface guidance*. These six directions are set out into a matrix which matches each possible design direction with each possible interface principle. Table 10 presents the nine concepts matching every combination of design direction with interface principles.

Table 10 Concept combination matrix

	Projection on product **1**	**Dot matrix** **2**	**Surface guidance** **3**
Rounded cube **A**	1A	2A	3A
Shield **B**	1B	2B	3B
Dynamic **C**	1C	2C	3C

The table presented above is used to develop realistic variations of models. These models combine one of three geometries with one of three ways of storing interface principles information. Table 11 below shows an overview of developed models. *Appendix 22 Model Description* contains enlarged versions of the models.

Table 11 Concept Combination Models

	Projection on product 1	**Dot matrix 2**	**Surface guidance 3**
Rounded cube A			
Shield B			
Dynamic C			

7.5. Focus Group 6 Model Rating

The aim of this focus group session is to converge towards a design direction for the final design proposal of this design research.

The presented models were first rated on their appearance, which was complementary to Vigor's brand identity. All participants could assign three different types of ratings: a very positive congruence with brand identity (+2), a positive congruence with brand identity (+1), and a negative congruence with the brand identity (-2). Table 12 presents an overview of the ratings for this rating.

Table 12 Model rating outcomes

	1	2	3
A	0	5	-6
B	-4	2	3
C	2	0	-2

This first rating results in the four highest ratings for models 2A, 2B, 2C, and 3B. The more extreme geometries of 3A (rounded) and 3C (dynamic) are rated low due to insufficient product volume usage. The projection of product (column 1) models is rated lower due to cavities that could allow dirt to be collected.

A subsequent rating was done with example interfaces visualised on the identical models of the first rating. Table 13 presents an overview of the second rating's rating results.

Table 13 Model with interface rating outcomes

	1	2	3
A	1	3	-6
B	1	5	5
C	-1	-1	-6

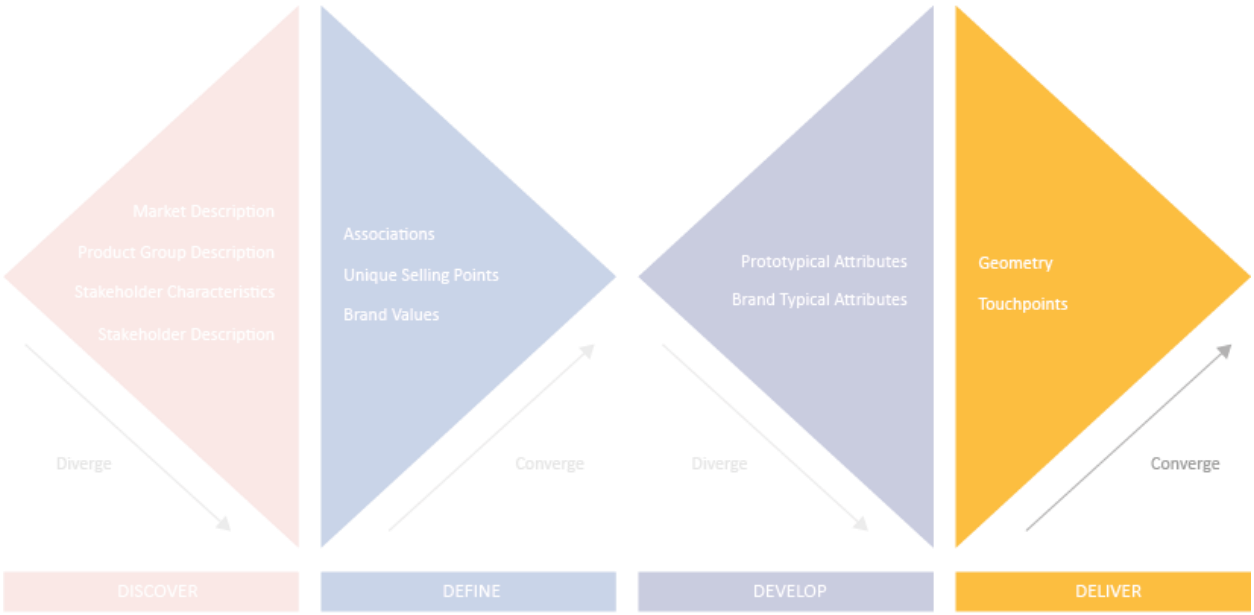
The second rating has the highest ratings for models 2A, 2B, and 3B. Projections on the product would be too dependent on the environment and are therefore rated low. Concepts using a strip indicating status and movement are rated high due to the functionality of bidirectional charging.

As a result of the discussions, combining the considered concepts will be finalised into one. Due to the efficient use of space, flexibility in casing graphics design and room for varying information types, model 2A is used as a foundation. Other features from concept rating are integrated and adapted in the final model. This would include guiding the user's attention subtly integrated into a model with a simplistic appearance. This model should allow for flexible information provision over time.

DELIVERING

The Design Proposal

8. Delivering the Design Proposal



This phase of the thesis focuses on delivering a proposal for an applicable product (portfolio) design for the brand Vigor. Based on the concept evaluation of the previous development phase, a final design direction is presented. Literature describing touchpoints for branded products is used to formulate the predetermined outcomes (Abbing, 2010).

As indicated in the Double Diamond, the predetermined outcomes in the deliver phase are geometry and touchpoints. First, the details of the design are elaborated on. Second, the translation of the case study design to the other product types of the portfolio is presented. Third, prototyping is depicted and presented. Lastly, white-label examples for familiar brands are developed to illustrate the potential applications.

8.1. Details and assembly

The geometry of the final model is symmetric, organic, dynamic, robust, and rounded, adhering to the style guidelines deducted from the research. Figure 22 shows how the attributes taken up in the style guide for Vigor are implemented in the proposed designs. The attribute is labelled, and the corresponding perceived brand values due to this attribute are listed in yellow. The modular construction of different parts allows for interchangeable parts throughout the product portfolio.

Figure 22 Implemented Design Attributes with Corresponding Brand Values

The intersection of the surfaces of the case and the front panel is provided with an LED strip. This strip guides the user through every action in the use case. Different use cases are indicated with colours and areas of light. Figure 23 presents the different use cases. The LED strip is covered with a matte tube to provide diffuse light instead of direct light. A slot in the front panel is implemented to create a light barrier for the LED lights on the front screen. The front panel is a screen embedded in a semi-gloss black plate with an LED slot on the borders. The casing embeds two types of back plates. The first with mounting holes for the wall box types, and the second without mounting holes for the pillar types.

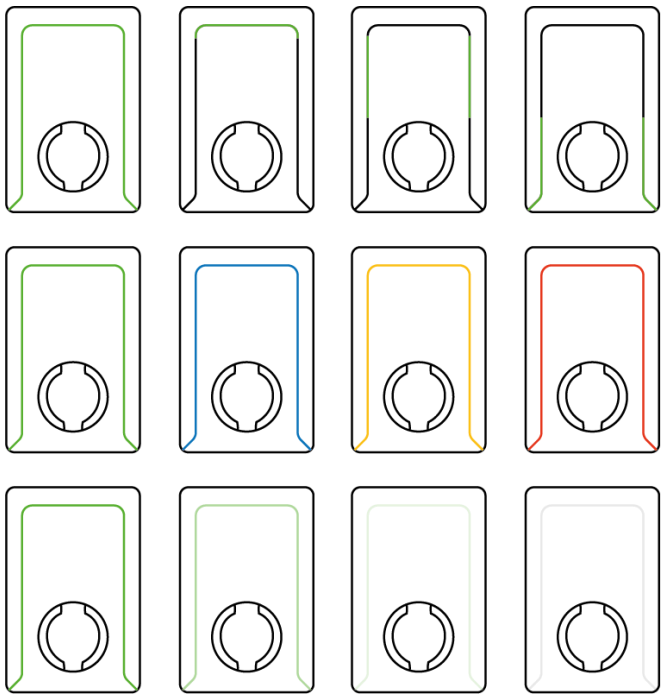


Figure 23 Use Cases for LED Strip Modi

The colour of the lights indicates the charger's status, and the location of the light indicates the relevant action to take. The whole strip represents the available product in its general status. The top part of the strip provides information about the payment. The middle part of the strip provides information about the screen to interpret. The bottom part of the strip provides information about the socket or charging. Lastly, the LED is dimmable to decrease light pollution.

8.2. Translation to product portfolio

Throughout the design research, a case study of a single socket wall station was selected. The aim of this study is to research design features representing Vigor's brand values and implement these on multiple product types. Figure 24 presents the different product types of the proposed product portfolio. Two variations of the top body for both a single and double variant allow for four product types. A lid on the bottom can be assembled for wall boxes, and pillars can be realised by interchanging the lid with a pillar stand.

Figure 24 Overview of Product Portfolio

8.3. Prototyping

The final models are prototyped to demonstrate the use cases and proportions of the designed products. Therefore, a CAD model is constructed in SolidWorks of the variations. This enables a realistic perspective on the designed products. The multiple types, single socket wall box, double socket wall box, single socket pillar, and double socket pillar, are 3D printed on a reduced scale. Human figures with the same reduced scale are used to indicate proportions.

The single socket wall box is 3D printed on a 1 to 1 scale. This enables the assembly of existing sockets and internal components in the mock-up. Additionally, a single socket wall box is printed on a 0.75 scale with working LED lights to demonstrate the use cases.

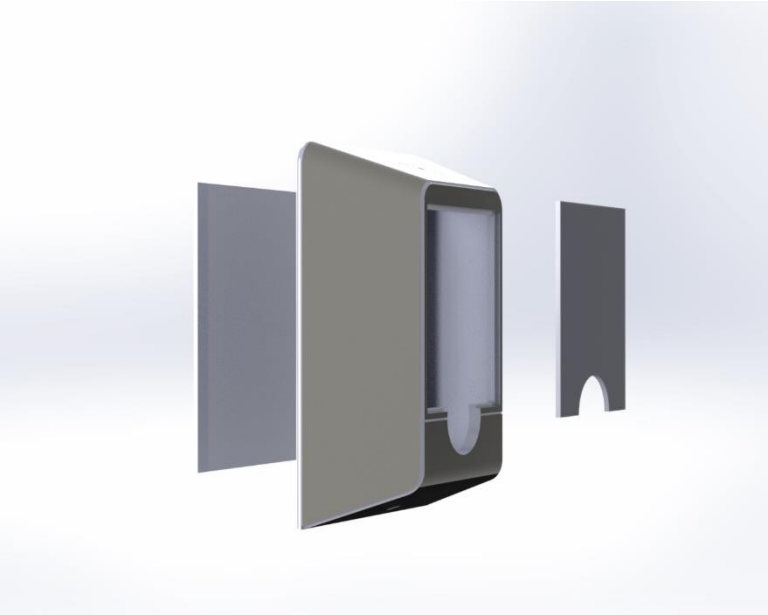


Figure 25 Exploded view of Single Socket Wall Box

8.4. White label examples

A requirement was to market the proposed product as a white-label product. This means that the design would allow other brands or parties to customise it in a certain manner. The simple yet recognizable geometry selected is suitable for graphic styling, as presented in three examples in Figure 26. The three examples include graphics for the existing brands Renault, Coca-Cola, and Vigor. The polycarbonate material can be painted and coated in large-scale RAL colours and prints.

Figure 26 Examples of white label implementations for single socket wall box

9. Validation

A survey is distributed to validate the proposed design for the product portfolio described in the previous chapter. The survey is via multiple social media platforms. Given that the assessment of the product against their intended brand values is based on visual perception and a first impression disregarding interaction with the product or context, a group without any specific demographic specification was approached. In total, 40 participants filled out the online questionnaire. The survey presents six different EV chargers. All three product types include the original (existing) and proposed designs. These product types are a single socket wall box, a double socket wall box and a double socket pillar.

All products are presented in an image showing the same orientation. Every product was asked to be rated congruently with innovativeness, trustworthiness, quality, and environmental sustainability. A Likert scale measures respondents' perceptions of the products (Nemoto & Beglar, 2014). A 5-point scale sets a range from strongly disagree (1) to strongly agree (5) with the product having an innovative, trustworthy, high quality, or environmentally sustainable appearance. By comparing the survey outcomes, conclusions can be drawn on the perception of the presented product and its level of congruence with the pre-specified brand values.

The mean scores per product for each value are summarised. The vertical axis presents the product version and types (original and proposed). The horizontal axis represents the four core values. Table 14, Table 15, and Table 16 show mean scores representing congruence per product per value.

Table 14 Validation data Single Socket Wall Box

	Single Socket wall box	**Innovativeness**	**sustainability**	**High quality**	**trustworthiness**
Current product	**Mean**	2,25	2,4	3,075	3,4
	Most Frequent Answer	2	2	4	3
	Range	5 (1 to 5)	5 (1 to 5)	5 (1 to 5)	4 (2 to 5)
Proposed product	**Mean**	3,9	3,275	4,075	4
	Most Frequent Answer	4	4	4	4
	Range	4 (2 to 5)	5 (1 to 5)	4 (2 to 5)	4 (2 to 5)
	Mean difference (P-C)	1,65	0,875	1	0,6

Table 15 Validation data Double Socket Wall Box

	Double socket wall box	Innovativeness	sustainability	High quality	trustworthiness
Current product	**Mean**	1,975	2,575	2,35	2,825
	Most Frequent Answer	2	2	3	3
	Range	5 (1 to 5)	5 (1 to 5)	5 (1 to 5)	4 (1 to 4)
Proposed product	**Mean**	3,925	3,325	4,1	3,975
	Most Frequent Answer	4	3	4	4
	Range	4 (2 to 5)	5 (1 to 5)	4 (2 to 5)	4 (2 to 5)
	Mean difference (P-C)	2	0,75	1,75	1,15

Table 16 Validation data Double Socket Pillar

	Double socket pillar	Innovativeness	sustainability	High quality	trustworthiness
Current product	**Mean**	2,725	2,85	3,075	3,2
	Most Frequent Answer	3	2	4	3
	Range	5 (1 to 5)	5 (1 to 5)	5 (1 to 5)	5 (1 to 5)
Proposed product	**Mean**	4,125	3,5	4,4	4,125
	Most Frequent Answer	4	3	5	4
	Range	4 (2 to 5)	5 (1 to 5)	3 (3 to 5)	3 (3 to 5)
	Mean difference (P-C)	1,4	0,65	1,325	0,925

As presented in the tables above, validation data show positive differences comparing the current and proposed product portfolios. Pre-specified brand values are more congruent with the perception of the proposed product portfolio compared to the current portfolio. This implies that the values are perceived to a higher extent when designing according to the guidelines described in Chapter 6Vigor Design Guidelines.

10. Conclusion

This design research aims to clarify the link between brand values and product design with good usability. This thesis aims to fill this gap by investigating how pre-specified brand values can be seamlessly integrated into the design of a product portfolio's novel products while also considering the functional and usability requirements of stakeholders. The design question to solve is formulated as “How can NieuweWeme, with its brand Vigor, design an applicable portfolio for AC charging stations representing their identity, the set functional requirements, and the target group requirements?". Firstly, a gap in the literature is bridged by researching the translation of formulated implicit brand values (*innovative, sustainable, high quality, trustworthy*) into explicit design features. Secondly, the implementation of this design identity through design attributes is validated by evaluating the design proposal specifically for the product portfolio of electric vehicle chargers.

This research involves two studies to identify the relationship between implicit brand values and corresponding explicit design features. For example, how can the implicit trustworthiness value be translated into explicit features such as a symmetric and robust main body with rounded corners? It researches two different levels of characteristics: 2D silhouettes without specified product-related context and 3D objects with prototypical attributes of a single-socket EV charger. These subsequent two levels of research enable a wider application of research findings. The findings of the 2D study can be implemented into various product categories or details due to the exclusion of prototypical attributes. Whereas the findings of the 3D study apply to the product category of EV chargers due to the consideration of prototypical attributes. For defining explicit features, ordering attributes as described by Muller (1997) are utilised (*symmetric* versus *asymmetric, organic* versus *geometric, dynamic* versus *static, slim* versus *robust, and pointy* versus *rounded*). These ordering attributes are found to affect value associations compared to their opposite positively.

An online survey is conducted amongst 22 industrial design engineering students to research positively affecting attributes in relation to the four brand values. This research resulted in guidelines Vigor can use to provoke recognition of the values of *innovativeness*, *sustainability*, *high quality*, and *trustworthiness* in their product portfolio. For instance, when a design pursues an innovative character, asymmetric, organic, dynamic, slim, and pointy attributes positively affect the perception of this value. Furthermore, when a single-socket electric vehicle wall charger design aims for a high-quality character, symmetric, organic, dynamic, and slim attributes positively affect the perception of this value (Table 8). The comparison of the two studies reveals a difference in brand value recognition between shapes (excluding prototypical attributes) and geometries (including prototypical attributes).

To test the abovementioned study, a realistic case study is conducted to design a single-socket electric vehicle charger in cooperation with internal employees of Vigor. This brand is used to define brand values and validate design choices in a realistic context. In-house focus groups, interviews, and personal conversations with external stakeholders provided insights on important points for achieving good usability (E.g., unobtrusive design and informing users about charging status). A requirements list was developed by researching the wants and needs of various stakeholders in the case of (semi)public charging stations.

The design proposal has been validated, derived from requirements identified through focus groups and stakeholder research, and style guidelines established from the explicit characteristics reflective of our brand values. Validation of the proposed, designed product portfolio for Vigor shows improved congruence with the pre-specified brand values compared to the current product portfolio. This indicates that considering the guidelines in design has a positive effect on the perception of the products. Adhering to these found attributes in product design contributes to brand salience (Keller, 2001), by consistently implementing brand values throughout the product portfolio.

Considering the findings of this thesis, electric vehicle chargers designed with symmetric, organic, dynamic, robust, and rounded attributes have a positive effect on association with Vigors brand identity. Adhering to these guidelines and the functional requirements; unobtrusive design, recognizable functionality, information provision about status, and flexibility in appearance allows for applicable product portfolio design.

11. Discussion

The design research of this thesis presents new insights into implementing brand values into product design. The aim of the study was to design an applicable portfolio of products representing the brand identity, and functional and usability requirements. In previous literature a gap exists on how brand identity can be translated into real product features. This thesis used a Double Diamond approach with complementary predetermined outcomes based on literature from research fields of consumer psychology, innovation, and industrial design. Separating these phases and drawing interim conclusions per phase enables structured design research. This approach ensures that decisions are well-documented and repeatable. Describing interim findings enables the findings to be applicable to various brands with similar values and that the same method can be used to test other values in a compatible manner.

The results of the conducted stakeholder analysis in the first phase indicate that factors contributing to good usability for EV chargers are noticeability, availability, trustworthiness, and accessibility. Internal stakeholders stressed the advantage of the customizability of the housing of the product. Users indicated that perceived good usability is dependent on clear price communication, instruction, and unclear causes of errors. In addition, existing research on building brand equity and the value association of product perception is explored. This research revealed a significant gap in the literature, particularly on how implicit brand identity can be effectively implemented into explicit novel product design. Therefore, the next phase focused on developing a brand identity using brand value articulation.

In the second phase, the following brand values were formulated: innovative, sustainable, high-quality, and trustworthy. The brand values are formulated by focus groups with internal stakeholders to represent their vision of the brand. The focus groups are a tool to incorporate and align knowledge of multiple professions of different departments of the company. The application of focus groups as a step to inform the design process this method retrieved a broad collection of information. The requirements and guidelines, as gathered and presented in Chapter 6, reflect the aspirations of both internal and external stakeholders, with a strong emphasis on functionality and usability. These requirements and guidelines serve as a roadmap for future product developments, ensuring the consistent integration of brand value in designs. This realistic context with internal employees enables the creation of relevant and context-related brand value (Ridder, 2017).

In the third phase, prototypical attributes and brand-typical attributes are formulated. Prototypical attributes are characteristics defining the product category. Brand-typical attributes in this thesis are design features referring to the brand identity. Prototypical attributes for the single socket EV wall charger are a socket, an user interface, a RFID scanner, and a cable for private usage. Brand-typical attributes are researched by testing specific design elements to see which associations they evoke, ensuring these associations align with the brand's four core values.

The four brand values and a way of explicitly communicating these through design is researched by evaluating contradicting design characteristics. For this study, four brand values are focused on deducted from the case study company NieuweWeme and its brand Vigor. Muller (1997) described how design could be depicted within a theoretical framework, part of which involves labelling distinguishing ordering characteristics. A selection of these characteristics is made so that participants can assess them without needing an in-depth understanding of Muller's (1997) literature. Examples include the contradicting characteristics of symmetry and asymmetry, and organic and geometric.

This thesis researches the link between implicit brand values and explicit ordering characteristics. Two levels of ordering characteristics were included, and 2D silhouettes and 3D geometries with electric vehicle attributes were researched. For both levels, the results are evaluated separately (Chapter 3.3). Comparing the results of these studies gives insight into the effect of the product category in association with a certain value. Table 5 presents the differences between the means of all rated values of the first study (2D) and the means of all rated values of the second study (3D). A positive difference indicates a positive effect and a negative difference indicates a negative effect of the design in the context of a single-socket electric vehicle charger. For this design implementation and selected samples, dynamic attributes contribute most to innovative associations. Organic attributes contribute most to sustainable associations. High-quality associations are evoked by rounded, robust, symmetric, and organic attributes. Robust and rounded attributes in design contribute to trustworthiness.

Evaluating the results of the abovementioned studies led to insights into associations and their origin. The open questions from the studies gave information about which existing experiences provoke the associations. Results showed that a strong association with a leaf was an incentive for sustainability, and arbitrariness was an incentive for innovativeness. This research focuses on abstract recognition of values; therefore, shape and geometry 7 are not considered to develop further into design directions.

Besides the origin of associations, the formulated brand values are recognised at different levels than others. Innovativeness and trustworthiness can be recognised at an abstract level, whereas high quality merely depends on surface finish and detailing. Lastly, sustainability is a value that is challenging to make explicit through design. This association is merely evoked by the choice of materials and the end-of-life approach. However, relatively high ratings on sustainability show that design features can contribute to a sustainable perception of products.

Relating previously discussed research about associations with 2D geometric shapes back to the findings of the shape study is complex (Frutiger, 1989) (Gogelström, 2013) (Trautmann, 2021). The existing literature does not contradict the associated values of this design research but has researched other associations than the brand values in scope. Therefore, comparing the research findings of this thesis would not give valuable insights. Additionally, this study evaluates attributes of shapes instead of complete geometric shapes in existing knowledge.

In the fourth phase of this design research, the design proposal is extended to a product portfolio and validated. The design proposal elaborates on the design guidelines deducted from shape and geometry studies. The brand values and their corresponding associations are assigned to the final design. To test the perception of the four values in the final design a validation study is done. This validation is done by comparing the existing product types with complementary proposed products of the same type. In line with the assumptions the validation results show a positive effect of implementation of the design guidelines. Therefore, this design research can be interpreted as an extension of existing literature on formulating and building brand equity (E.g. Keller, 2001).

The executed research is a contribution to work towards implementing values into product design. Focus groups were used as a research method to involve employees in the decision-making process. Multiple focus group sessions at decision points throughout the project enabled employees to be involved. Based on the effect measurement in the validation (Chapter 9), the selected Double Diamond approach resulted in an effective alternative design proposal.

12. Limitations and Further Research

The scope of this thesis is the representation of brand values in form and geometry. It is assumed in this research that a desired association is elicited when the response confirms this, purely based on visual perception. This means focusing on the physical representation of the brand through a product, excluding aspects such as relationship, reflection and self-image (Kapferer, 2004). Realistic and more thorough research would investigate and test other aspects of product design, such as materialization, interface design, and interaction. After production, the brand response and relationships should be evaluated to aim for consumer brand resonance (Keller, 2001). Additionally, the CBBE model is partially addressed in this thesis; further research with Vigor as a brand should be conducted to develop the whole Brand Consumer resonance (Keller, 2001)

Including more participants in the shape and geometry studies would increase the significance of the data. The current number of participants makes the conclusions drawn less indicative. Including demographic information would contribute to a more universal insight into the interrelationships between answer and respondent characteristics. Further research could investigate differences in perceived design-value relationships for different demographic groups.

The developed and rated samples implement variants of researched forms and geometries. These adaptations could affect the perceived value of the designs. The product group of electric vehicle chargers is closely linked to specific functional requirements in their design, which in turn influences the underlying associations and perceptions of the users. The usability of the product and its interface should be developed and tested in further research by conducting prototype tests.

The dynamic nature of focus group discussions may have limited this study. The interaction among participants could have influenced their responses, potentially leading to conformity or dominance effects. Additionally, the composition of the focus groups was not consistent due to resource constraints, which may have impacted the continuity and comparability of the discussions. Furthermore, the facilitator's influence and the participants' prior knowledge and design experience significantly shaped the behaviour and topics explored during the sessions. These factors could have biased the findings and limited the generalizability of the results.

The order of questions in the validation form could affect the answers. Participants could get familiar with the proposed brand and rate more positively. Additionally, the respondents could know the research goal and affect the given answers. This could be improved by randomising the sequence of questions. It is chosen to disregard this step due to the extended length of the survey due to randomization. Additionally, the validation of the proposed designs would be more significant if the group of respondents had been larger. Therefore, a larger respondent group would allow for analysing response patterns.

Lastly, it would be an interesting additional contribution to design knowledge to a broad selection of pre-specified values than the four researched in this thesis should be researched. This database can contribute to knowledge about the general relationship between associations and product design.

13. References

Aaker, D. A., & Shansby, J. G. (1982). Positioning your Product. *Business Horizons*, 52-62.

Abbing, E. R. (2010). *Brand Driven Innovation: Strategies for development and design*. Ava publishing.

Agyekum, C. K., Haifeng, H., & Agyeiwaa, A. (2015). Consumer Perception of Product Quality. *Microeconomics and Macroeconomics*, 25-29.

Akdag, S. G., & Ergen, A. (2021). Customer Journey Maps for Physical Expierience Design: Conceptual Design Case of a Gas Station. *New Design Ideas*, 172-184.

Ashby, M. F. (2008). Materials and Product Design. *Granta Material Inspiration*.

Blijlevens, J., Creusen, M. E., & Schoormans, J. P. (2009). How consumers perceive product appearance: The identiication of three product appearance attributes. *International Journal of Design*, 27-35.

Chang, W.-C., & Wu, T.-Y. (2007). Exploring Types and Characteristics of Product Forms. *International Journal of Design*, 3-14.

Cooper, R. G. (1979). The Dimensions of Industrial New Product Succes and Failure. *Journal of Marketing*, 93-103.

Cornwall, A., & Jewkes, R. (1995). What is Participatory Research? *Social Science & Medicine*, 1603-1738.

Creusen, M. E., & Schoormans, J. P. (2004). The Different Roles of Product Appearance in Consumer Choice. *Journal of Product Innovation Management*, 63-81.

Dam, R. F., & Siang, T. Y. (2022, May 2). *Stakeholder Mapping: The Complete Guide to Stakeholder Maps*. Opgehaald van Interaction Design Foundation - IxDF: https://www.interaction-design.org/literature/article/map-the-stakeholders

Elaadnl. (2024, Februari 12). *Versnelling groei elektrische auto's na 2030 verwacht*. Opgehaald van Elaadnl: https://elaad.nl/update-elaad-outlook-personenautos-versnelling-groei-elektrische-autos-na-2030-verwacht/

EVBox. (2023, April 14). *EV charging: the difference between AC and DC*. Opgehaald van EVBox: https://blog.evbox.com/difference-between-ac-and-dc

Fargnoli, M., Rovida, E. G., & Troisi, R. (2006). The morphological matrix: Tool for the development of innovative design solutions. In Proc. ICAD (pp. 1-7).

Fernandes, S., Rosa Cencic, M., Queiroz, C., & Rozenfeld, H. (2018). An Initial Prototype of a Tool for Defining Value Proposition in the Product-Service System (PSS) Design. *Design Support Tools* (pp. 281-292). Sao Carlos, Brazil: Design 2018.

Flight, R., Allaway, A., Kim, W.-M., & D'Souza, G. (2011). A Study of Perceieved Innovation Characteristics Across Cultures and Stages of Diffusion. *Journal of Marketing Theory & Practice*, 109-126.

Fogelström, E. (2013). *Investigation of Shapes and Colours as Elements of Character Design (Dissertation)*. Visby. Opgehaald van https://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-208203

Frutiger, A. (1989). *Signs and Symbols*. London: Studio.

Geerts, F., Kaathoven, E., Wargers, A., & Broos, P. (2019, May). *Smart Charging Guide*. Arnhem: ElaadNL.

Islam, S., Iqbal, A., Marzband, M., Khan, I., & Wahedi, A. A. (2022, September). State-of-the-Art Vehicle-to-Everything Mode of Operation of Electric Vehicles and its Future Perspectives. *Renewable and Sustainable Energy Reviews*.

Janlert, L.-E., & Stolterman, E. (1997). The character of things. *Design Studies*, 297-314.

Kano, N. (2001). Life Cycle and Creation of Attractive Quality. *4th International QMOD Quality Management and Organisational Development Conference*. Linköping University, Sweden.

Kapferer, J.-N. (2008). *The new strategic brand management: Creating and sustaining brand equity long term*. London: Kogan Page Publishers.

Karjalainen, T.-M. (2007). Educational Approaches to Designing for Visual Brand Recognition. *International Journal of Design*, 67-81.

Keller, K. L. (1993). Conceptualizing, Measuring, and Managing Customer-Based Brand Equity. *Journal of Marketing*, 1-22.

Keller, K. L. (2001). *Building customer-based brand equity: A blueprint for creating strong brands*. Cambridge: Marketing Science Institute.

Kongprasert, N., Brissaud, D., Bouchard, C., Aoussat, A., & Butdee, S. (2009). How to design and process brand identity through an integrated innovative approach. *2008 IEEE International Conference on Industrial Engineering and Engineering Management* (pp. 753-757). Singapore: IEEM 2008.

Maurya, U. K., & Mishra, P. (2012). What is a brand? A Perspective on Brand Meaning . *European Journal of Business and Management*, 122-133.

Method 635. (2024). Opgehaald van Design Methods Finder: https://www.designmethodsfinder.com/methods/method-635

Muller, W. (1997). *Vormgeven: Ordening en betekenisgeving*. Lemma.

Nascimento, P., Aguas, R., Schneider, D., & Souza, J. (2012). An approach to requirements categorization using Kano's model and crowds. *2012 IEEE 16th International Conference on Computer Supported Cooperative Work in Design*.

Nemoto, T., & Beglar, D. (2014). Developing Likert-Scale Quationnaires. *JALT2013*. Tokyo: JALT.

Noel, L., de Rubens, G. Z., Kester, J., & Sovacool, B. K. (2019). Beyond batteries: An examination of the benefits and barriers to plug-in hybrid electric vehicles (PHEVs) and a vehicle-to-grid (V2G) transition. In L. Noel, G. Z. de Rubens, J. Kester, & B. K. Sovacool, *The Potential Benefits of V2G* (pp. 33-64). Palgrave Macmillan, Cham.

Norman, D. (2007). *Emotional design: Why we love (or hate) everyday things*. Basic books.

Osterwalder, A., Pigneur, Y., Bernarda, G., & Smith, A. (2015). *Value Proposition Design: How to Create Product and Services Customers Want*. Wiley.

Riegelsberger, J., & Sasse, M. A. (2001). Trustbuilders and Trustbusters: the Role of Trust Cues in Interfaces to Ecommerce Applications. In B. Schmid, K. Stanoevska-Slabeva, & V. Tschammer, *Towards the E-Society: E-Commerce, E-Business and E-Government* (pp. 17-30). Boston: Springer.

Rodin, R. (2015, January 11). *Mood Lines: Setting the Tone of Your Design*. Opgehaald van ZevenDesign: https://zevendesign.com/mood-lines-giving-designs-attitude/

Shen, T.-l., Lai, J.-c. M., & Tsai, M.-C. (2016). The performance and impact of applying lotus blossom technique in teaching on creative problem solving. *2016 International Conference on Advanced Materials for Science and Engineering (ICAMSE)*, 614-617.

Simonds, J. O., & Starke, B. (2010). *Landscape Architecture, Fourth Edition*. McGraw Hill.

Simpson, B. J., & Radford, S. K. (2012). Consumer Perceptions of Sustainability: A Free Elicitation. *Journal of Nonprofit & Public Sector Marketing*, 272-291.

(2021). *Smart Charging Requirements*. National Program for Charging infrastructure.

Stange, R., Schiele, H., & Henseler, J. (2022). Advancing purchasing as a design science: Publication guidelines to shift towards more relevant purchasing research. *Journal of Purchasing and Supply Management*, Volume 28, Issue 1. doi:https://doi.org/10.1016/j.pursup.2022.100750.

Tanaka, J. W., & Taylor, M. (1991). Object categories and expertise: Is the basic level in the eye of the beholder? *Cognitive Psychology*, 457-482.

The Double Diamond. (2023). Opgehaald van Design Council: https://www.designcouncil.org.uk/our-resources/the-double-diamond/

Trautmann, L. (2021). Emotions Evoked by Geometric Patterns. *J*, 376-393.

Varnali, K. (2017). *Customer Experience*. Opgehaald van MediaCat: https://mediacatmagazine.co.uk/

Warell, A. (2001). *Design Syntactics: A Functional Approach to Visual Product Form Theory, Models, and Methods*. Gothenburg: Chalmers University of Technology: Chalmers University of Technology.

Yin, Y., Qin, S., & Holland, R. (2011). Development of a design performance measurement matrix for improving collaborative design during a design process. *International Journal of Productivity and Performance Management*, 152-184.

Zamanov, N. (2023, April 1). *What is a Type 2 Electric Car Charger*. Opgehaald van Cyberswitching: https://cyberswitching.com/what-is-a-type-2-electric-car-charger/

14. Appendices

“During the preparation of this work, the author used ChatGPT in order to suggest rephrased sentence structures. After using this tool/service, the author reviewed and edited the content as needed and take(s) full responsibility for the content of the work.”

“During the preparation of this work the author used Grammarly in order to check spelling and construction of sentences. After using this tool/service, the author reviewed and edited the content as needed and take(s) full responsibility for the content of the work.”

Appendix 1 Observation Form

<table>
<tr><th colspan="3">Observation Notes</th><th colspan="2">Participant No.</th></tr>
<tr><td colspan="2">Time:</td><td colspan="2">Date:</td><td>Location:</td></tr>
<tr><td colspan="5">Situation: Start Charging / Stop Charging</td></tr>
<tr><td>1</td><td>Total interaction time</td><td>2</td><td colspan="2">Facial expression and reaction during first interaction (first act is..)</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td>3</td><td>Amount of actions during interaction</td><td>4</td><td colspan="2">Localising Charging Station</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td>5</td><td>Coupling of EV to Charging Station</td><td>6</td><td colspan="2">Start Charging Payment</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td>7</td><td>Stop Charging Payment</td><td>8</td><td colspan="2">Decoupling of EV to Charging Station</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
</table>

Appendix 2 Personas

BERT KRAMER

New User

Age	65
Gender	Male
Occupation	Retired, former science teacher
Location	Utrecht
Years of EV driving	0,5
Average km per day	30

"I want to join in on innovations of todays infrastructure"

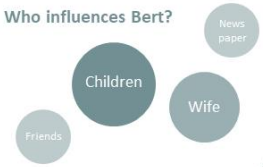
Bert is learning how to realize an optimal charging routine.

Obstacles Bert faces:
- Not experienced with digital, interfaces
- Cable handling

How will Bert interact with a charging station?

Questions Bert will ask:
- Is my car charging?
- Is my car fully charged?
- What are the costs?
- How can I easily handle the cable?

Who influences Bert?



Bert's situation

Goals, motivations:
- Going from home to his wife,
- Wanting to be modern,
- Being mobile and independent

Key words
- Traditional,
- Eager to learn

Bert's story

"I only use my car to visit my wife in a nursery home about 15 km west of our home. I go there each and every day by car. Therefore, I try to use the same charging station across the street.

My children recommended to use an electric car, but I still have to get used to it. Passing by the gas station used to be in my system, but I don't have this routine in using charging stations yet.

I always double check the station, since I have doubts about whether I did it right. I hope these things will not innovate into complex technology in the coming years. Oh, and I find handling the cable a challenge by the way, they are heavy and dirty."

ANGELA JOHNSON

Experienced User

Age	29
Gender	Female
Occupation	Marketeer
Location	Utrecht
Years of EV driving	5
Average km per day	165

"I just want to unplug an be able to leave again"

Angela uses charging stations every day, at her varying work locations.

Obstacles Angela faces:
- Waiting for 'charging' signal light,
- Unconsitent sequence of actions

How will Angela interact with a charging station?

Questions Angela will ask:
- What will this session cost me?
- Is the car charging?
- Will the car be full if I return?
- Am I occupying the charger, and in the way of another EV driver?
- Does my MSP support this charger?

Who influences Angela?

Angela's situation

Goals, motivations:
- Be sustainable,
- Be mobile,
- Be independent

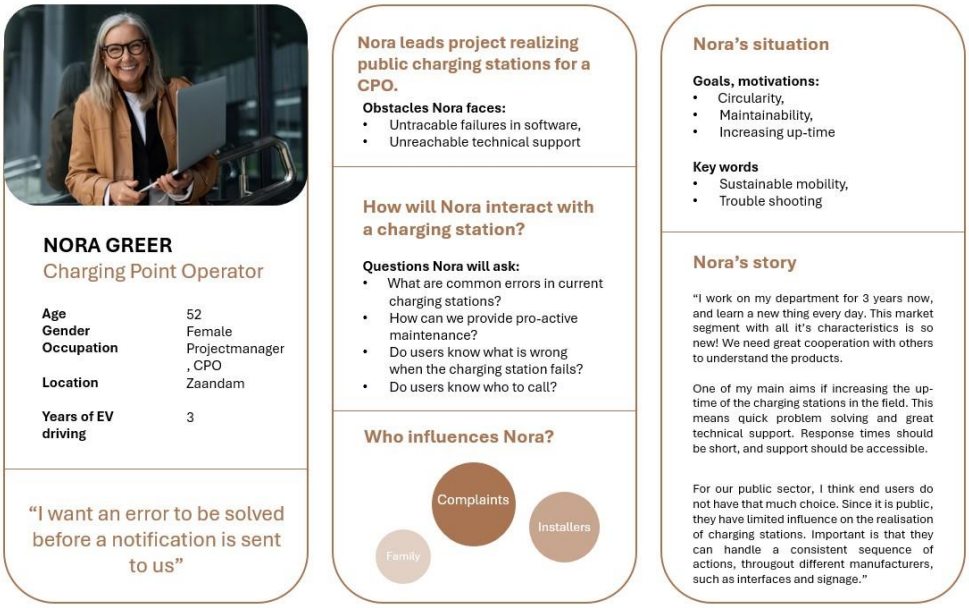
Key words
- Assertive,
- Flexible

Angela's story

"I bought an electric car as my first car. Sustainability is something I value very much. After using solely public transport during my time at uni, a gasoline car was no option for me.

For my job I visit customers thoughout the Netherlands. My days never look the same, so I actively search for charging facilities using an application. Preferrably, I use stations which allow me to pay through this application as well. Most of the time apps give you better insights in what the costs are.

Most of the time I am in a hurry, so I like fast interactions with chargers. No Extraneous information, it just has to work properly."



Appendix 3 Focus Group 1

This focus group included 2 parts. The first part was conducted using a list of brand elements. The participants rated these elements or both the current situation and the desired situation of Vigor. The elements rated were *innovation, reliability, brand awareness, marketing, distinctiveness, value for money, design (aesthetic), quality, product portfolio, in-house knowledge*. Per element of the brand, ratings are allocated from 1 up to 10. With 1 representing the element of the brand as insufficient, and 10 representing the element of the brand as highly sufficient. By comparing the current situation with the desired situation, focus points can be determined to build upon during development.

The elements rated with the largest difference are brand awareness (6,67), product portfolio (4,33), and marketing (3,33). The numbers in the table under rating difference are acquired by subtracting the rating of the current situation from the rating of the desired situation per element. These results underline the relevance of this design study researching Vigor's brand identity and implementing these into a portfolio of products.

The second part of this focus group aimed at agreement and discussion about parts of the brand that can be described. To guide this discussion, the brand identity prism of Kapferer (2009) is used as a format. The three participants were asked to describe the multiple facets of the prism in accordance with the brand's current situation and desired situation. The concept of the brand identity prism was explained by using a familiar brand as an example.

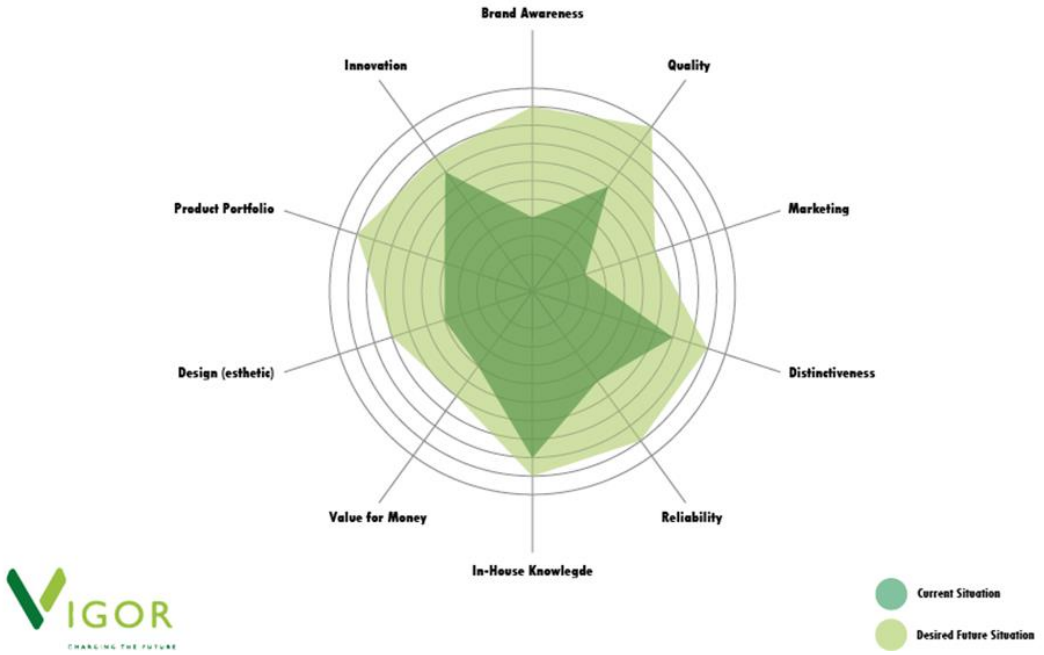
Current aspects of the brand, namely the reflection and self-image of the brand could not be formulated by the participants due to the level of development in which the brand was at that point in time. Therefore, the input given for the current situation is disregarded to avoid biases in the retrieved data.

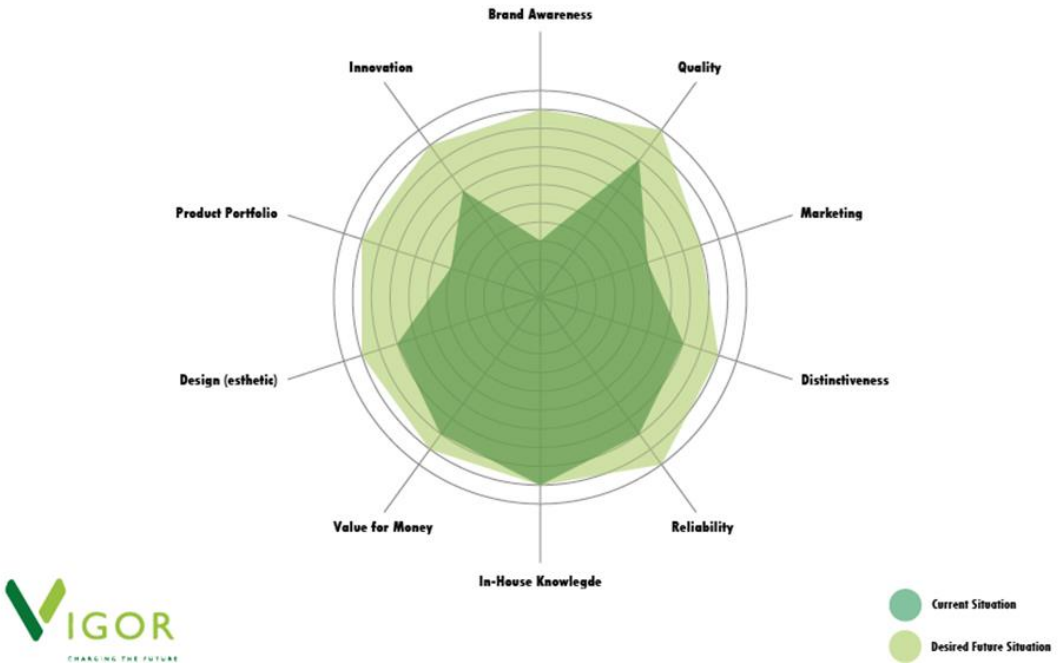
Desired *physique* aspects were formulated as modern, sustainable, unobtrusive, blending in environment, clean and innovative. Desired *personality* aspects were described as experienced, agile, trustworthy, strong and energetic. Relationship aspects were depicted as trustworthy, flexible, thinking along and 'behind the scenes'. Desired culture aspects were stated as circularity, future proof, quality, development and trust. Reflection aspects in the desired situation are envisioned as smart cities, SME, CPO's, governments, car dealers, and indirectly EV-drivers. Self-image aspects were described as modern, successful, innovative, sustainable and high-tech. The complete desired situation prisms are presented in Appendix 6 Brand Identity Prism.

Deducted from this session and communication with business developers, a set of brand values is developed. These values summarise ideas and visions representing the aim of the current brand. These set values will be used to conduct further research and conversations. The brand values of Vigor are set to be Innovativeness, Trustworthiness, High quality, Circularity and Expertise.

A modification of this set is made due to the design scope of this thesis. Circularity and expertise are radiated through customer contact, internal knowledge, and experiences over time. To be able to design with and validate desired values, the set used in this design research (with the aim of radiating the brand through design) is adapted. The set of values addressed in this study includes **Innovativeness**, **Sustainability**, **High-quality** and **Trustworthiness**.

Appendix 4 Spider Charts Brand Element Rating

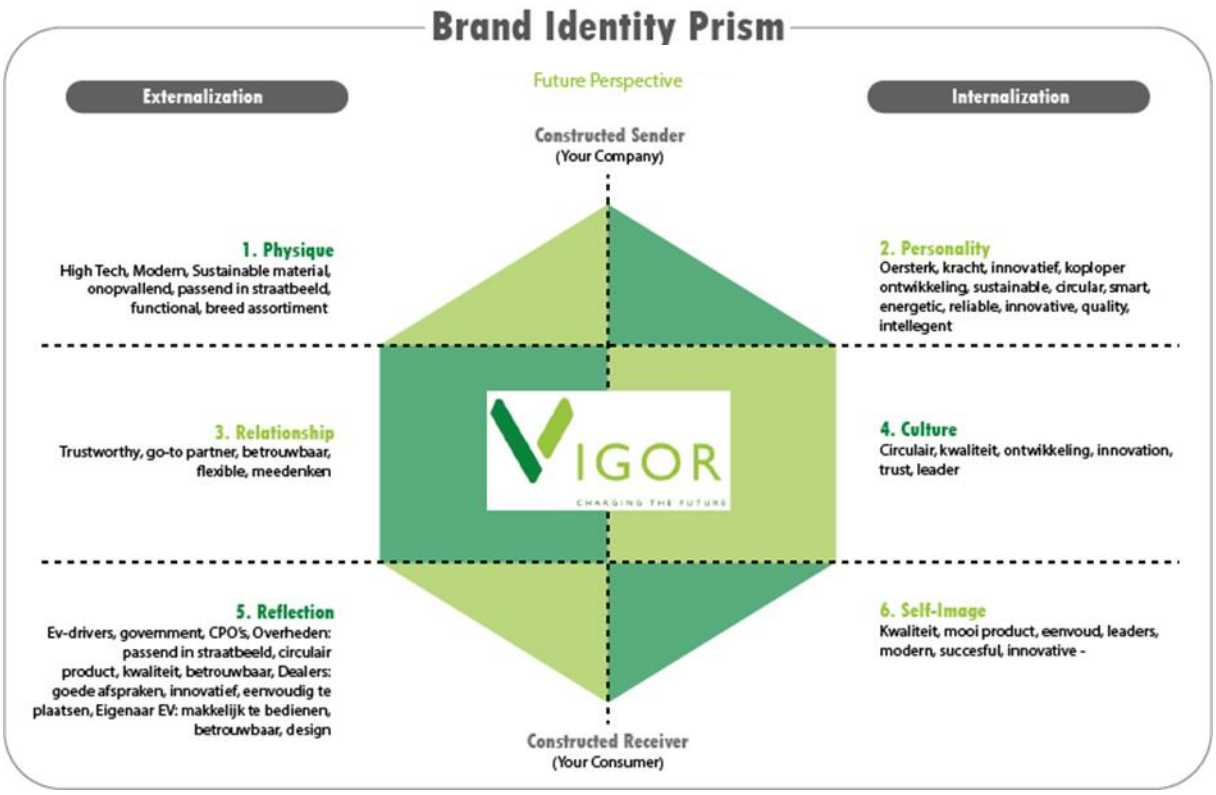


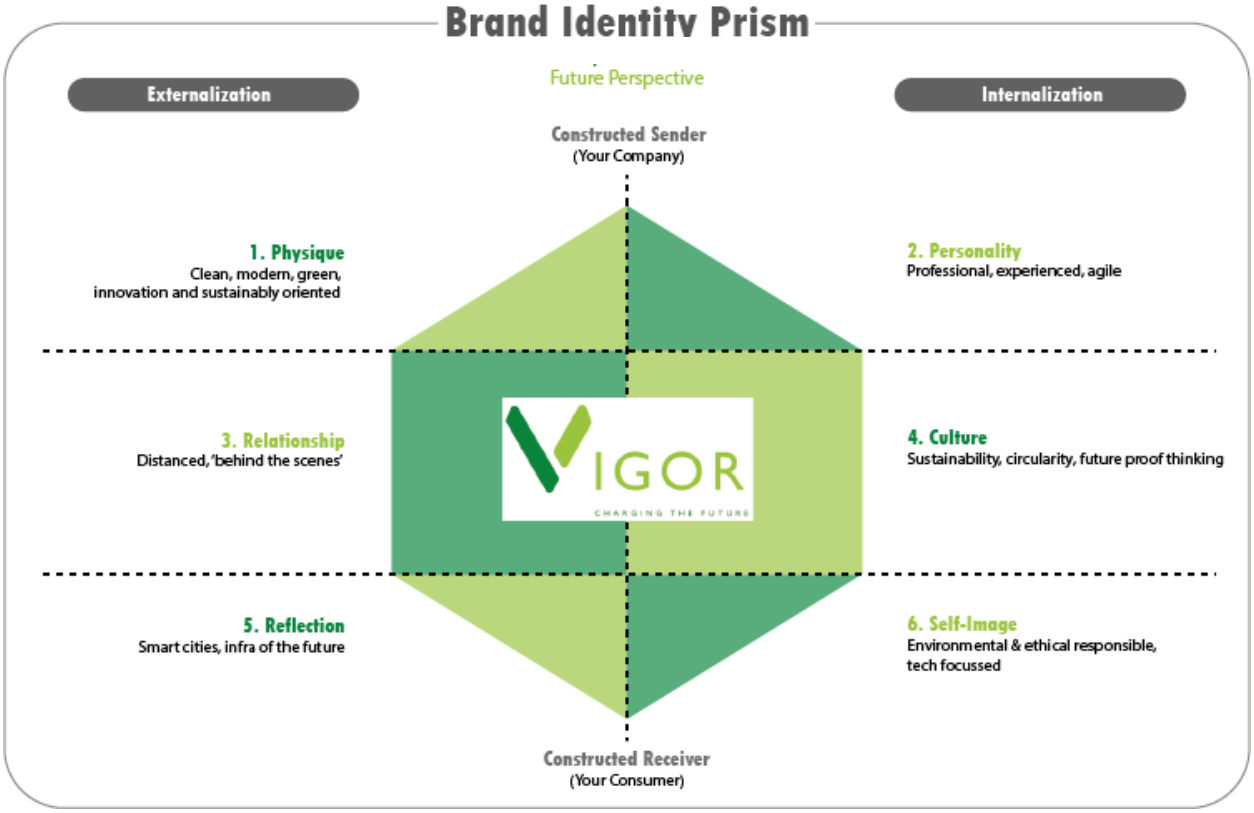


Appendix 5 Overview Brand Element Rating

Aspect	Rating difference			Total	Average
	Participant 1	Participant 2	Participant 3		
Innovation	1	2	3	6	2
Reliability	4	3	2	9	3
Brand Awareness	6	7	7	20	6,67
Marketing	3	4	3	10	3,33
Distinctiveness	2	2	2	6	2
Value for money	2	2	1	5	1,67
Design (estetic)	3	2	2	7	2,33
Quality	4	2	2	8	2,67
Product portfolio	5	3	5	13	4,33
In-House knowlegde	1	3	0	4	1,33

Appendix 6 Brand Identity Prism

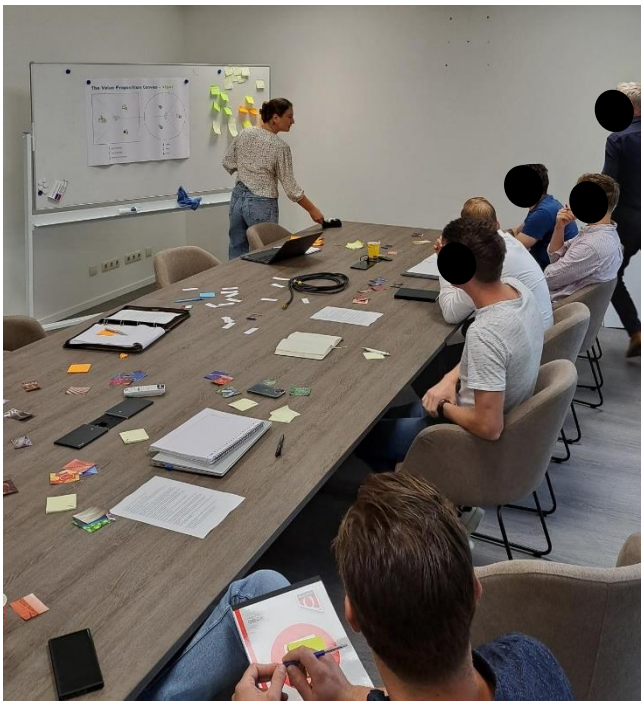




Appendix 7 Focus Group 2

This focus group session was done to unify experiences and knowledge of multiple professions. The first reason for including multiple professions is to collect and understand a more complete overview of existing knowledge. The second reason is that by complying with varying professions contributing to this project an open environment and shared interest can be created. In total nine employees participated with seven different professions. The represented professions are mechanical engineer, electrical engineer, marketing strategist, business developer, technical writer, production planner, and department leader of charging solutions. The value proposition canvas is utilised as a framework to generate insights into customer profile (pain, gains, tasks) and the value map (gain creators, pain relievers, product, and services).

The canvas was explained to participants and warming up exercise was done. Firstly, the customer profile was filled in. Every participant had the chance to stick a sticky note on the designated field on the board. Tasks for the product were for example bidirectional charging, payment method, and sustainable design. Pains were, for example, unclear cause of errors and unaccepted cards. Examples of gains were to be recognizable as a charger and easy to control. Pain relievers that resulted from the session were for example cable support and simplified interaction. Gain creators were for example mentioned to be a visible kWh meter. Lastly, participants described a product and service as integrated in existing infra, a developed ticket system handling errors and external UI for extra information.



The outcomes of the proposition canvas were analysed using coding. By coding the multiple fields, insight can be provided into urgent problems and solutions regarding the task. Codes are ‘V2G/bidirectioneel’ (bidirectional), ‘straatbeeld’ (street scene), ‘betaal’ (pay), ‘zicht’ (sight), ‘gemak’ (ease), “transparant’ (transparent).

Bidirectional was appointed 5 times, street scene was appointed in 6 instances, pay was appointed 7 times, sight was appointed 12 times, ease was appointed in 4 instances and transparent was appointed 3 times.

Summarising the results of this session, different aspects of the product are aimed to create value according to participants' experience. The bidirectional charging functionality should be working and easy to understand and use. The product should be recognizable as an implication of Vigor but blend into the environmental scene. Payment should be enabled to perform contactless and transparently. The interface and design of the product should be insightful, and information should be presented at the right time. Using the innovative technology of bidirectional charging should be comprehensive and the product should be intuitive. Lastly, the product should present clear information about the costs, payment method, support, and errors.

It is important to mention that input given in this session is mainly based on the experiences of employees with their current products and personal experiences. No additional research is done regarding their insights into customers. Insights of this session are partly included in requirement formulation and as inspiration for concept creation.

Appendix 8 Value Proposition Raw data

VIGOR CHARGING THE FUTURE	**Associaties algemeen**
Innovatie, goed werkgever, eenvoudig te bedienen, sterk (merknaam), makkelijk klinken (merknaam), Sterk, Ervaren (meer dan alleen producent), naast hardware ook kennis software tussen auto-laden-Bo (EMS), specialist op V2G/bi directioneel en ervaring WDS, one-stop-shop, expertise (inhoudelijk & technisch), circulair, functioneel, innovatief, simplicity, positief, markt conform, focus: ervaring eindklant/gebruiker, opinie makend, fossielvrije (groene) toekomst, betrouwbaarheid, prijs/kwaliteit verhouding, herkenbaar design, natuurlijke vormgeving, duurzaamheid, toonaangevende leveranciers van AC-DC laders (ervaring), gedreven, stoer uiterlijk, betrouwbaarheid, krachtige uitstraling, one-stop-shop, groen, internationaal, efficiënt, betrouwbaar/robuust, tijdloos, opgaan in/of toevoeging van de omgeving, laadoplossing elektrificatie, energie probleem oplossen (netgongestie), gebruiksvriendelijk, betrouwbaar, gaat op in het straatbeeld, 100% uptime (betrouwbaar), degelijk/robuust, compact	
6	**Tasks**
Support, laden, betaalmethode, innovatief (meedenken met klanten), toekomstbestendig, bi directioneel laden, circulaire materiaalkeuze, reparabel	
5	**Pains**
Kosten om te laden, hoe en met wie contact bij storing, laadprijs inzichtelijk, storing maar waarom, support bij projecten, EMS + systeem koppelingen, ontwikkeling hard- en software, niet intuïtief, 1e lijn kan niet helpen, buiten gebruik, mensen in flat kunnen niet bij laadpaal, zwaar product, lastig te installeren, niet transparant over het product (kosten, hoeveelheid), storingen (kwaliteit laden), gebruikersgemak, hoe te zien welke pas voor welke laadpaal gebruikt kan worden, locatie laadpaal, straatbeeld aangetast, storing, onduidelijke manier van bedienen, lange laadduur, voor de lader staan en niet weten wat te doen, niet weten hoeveel kWh ik heb gebruikt, niet duidelijk hoe het werkt, laadpalen buiten werking, niet duidelijk hoe het werkt, functioneert niet, kan niet laden, laadstress, laadsnelheid niet zichtbaar, onlogische/onduidelijke bediening/interface, bediening is zwaar, bereikbaarheid, slechte support, onhandige kabel (te kort, te lang, ligt in de weg), 'laadpaalplakkers', afzichtelijke paal in het straatbeeld, duurt lang voordat deze geïnstalleerd is, niet altijd duidelijk of een laadpaal vrij is, vaak een app nodig voor gebruik en meerdere voor verschillende laadpalen, niet plug & play..	
4	**Gains**
Transparantie (tarief, laadpas, betaalwijze, support), betaalwijze, duidelijke processen rondom storing (helpdesk, tickets), gebruiker: eenvoud, technische werking, duidelijke instructies, verbruik, betrouwbaar, CPO: S&O groep, ondersteuning installateurs, S&O proces, samenwerking, betrouwbaar (uptime), inzichtelijke UI (kWh), Universeel, Uiterlijk (bloembak?), Oprolbare kabel in paal, bericht op telefoon bij vol of storing, gedimd nacht licht, robuust/kwaliteit, goede service/snelle oplossing bij storing, passend in straatbeeld, kosten inzichtelijk (via app), simpele bediening, snelle laadtijd, één app die alles kan (locaties laadprijs, snelheid, storingen, uitleg, etc.), mooi product, straatbeeld niet verstoren, goed bereikbaar, weten waar de stroom van de laadpaal vandaan komt (duurzaam), makkelijk te installeren lader, mooi en praktisch uiterlijk van de lader, duidelijk/intuïtief laadproces, herkenbaar (zoals tankstation of opladen van telefoon), intuïtieve kabel oplossing, betaling met bankpas ook mogelijk, modulaire opbouw snel te installeren, transparantie voor de gebruiker, eenvoudige bediening, competitieve prijs voor product, is voorbereid op toekomstige zaken (betalen,laadplein,V2G)	

	**Pains & Gains prioritized**
Pains: Het uitzien van de lader, werkt niet, storing, storing, storingen, storing paal, onoverzichtelijk, onduidelijke laadpaal, gebruikservaring Gains: makkelijk te bedienen, toekomstbestendig (voorbereid op toekomstige functies), inzichtelijk, centrale interface met (laadprijs, locatie, stroombron, uitleg, snelheid, service/support), gebruiksgemak, bi directioneel laden	
	**Pain Relievers**
Geen hangende en zware kabels, toepassen van een groot scherm, betalen met pinpas, storingsnummer duidelijk vermelden, korte instructie film voor de gebruiker, design mooier voor het straatbeeld (bv. paal van Johnno), intuïtief gebruik, snelle en probleemloze afhandeling laadtransactie, snelle service bij support vragen, foolproof (Dyson verkoopt direct aan particulieren, overtuigd van product kwaliteit), eindtest in proces product verbeteren/automatiseren, re design laders versie 2.0, S&O inrichten, soortgelijke dot matrix Vanmoof, illustraties voor instellen (bv. Robot stofzuiger), zo min mogelijk schermen en knoppen, robuuste techniek, goede support, laadpaal met sterke onderdelen die niet kapot gaan, service organisatie voor storingen opzetten, geen concessies doen aan kwaliteit basis producten in laadpaal, hoge kwaliteit assemblage, innovatie toepassen zoals dimbaar nachtlicht en betaalsysteem	
	**Gain Creators**
Scherm met icoontjes, zichtbare kWh meter, ontwikkelde software tool om alle info te delen, betrouwbaarheid, door ontwikkelen software en hardware, gebruikersdata analyse, afhandeling van begin tot eind via ticket systeem, simpele interface zonder allerlei schermpjes/teksten etc., gebruik maken van icoontjes i.p.v. teksten, dot-matrix scherm met intuïtieve animaties, verschillende stappen tijdens het proces een voor een duidelijk weergeven/op laten lichten, groot scherm met alle informatie, gebruiksvriendelijk, overzichtelijk (in een oog opslag alle informatie voor handen, wat te doen bi storing, prijs), inzicht krijgen hoe huidige product wordt ervaren in gebruiksgemak, deze verbeterpunten doorvoeren in ontwikkeling product, eenvoudig, inzichtelijke, betrouwbare betaalmethode, eigen controller, ontwikkel V2G (WDS samenwerking, praktische informatie uit projecten), touchscreen implementeren, app voor connectie en betalen, kennis van het product hebben, marktkennis, samenwerken met klanten (CPO), juiste product ontwikkel tools, PM kennis geode productie processen	
	**Products & Services**
“Vigor levert als producent duurzame hoge kwaliteit laadpalen die circulair zijn geproduceerd. De producten zijn eenvoudig te bedienen en snel en gemakkelijk te plaatsen.” “service, ontwikkeling innovatie en produceren, advies en begeleiding bij laadinfra projecten, kennis delen met de markt.” “verbetering WDS V1.1 in gebruiksgemak en betaalsystemen (inzichtelijkheid). Assortiment uitbreiden met producten voor MKB (staande paal en wandlader als één familie), DC-lader.” “Vigor staat voor groen. Dit moet je weer terg vinden in de laadpaal. Denk aan planten, de laadpaal moet opgaan in de omgeving.” “Real-time info dashboard. ‘scan me’ sticker op de laadpaal.” “groot hidden/lit of ‘dead’-pront display van plastic of glas (voordeel; white label). Enkel stap laten zien die ertoe doet op dat moment. Geen afleiding door overige UI-elementen.” “Auto is laadpas – plug&charge. Geen laadpas nodig, auto communiceert met BO.” “Belangrijke ontwikkeling op korte termijn – inzicht krijgen in betaalgegeven en gebruik.” “App + Helpdesk”	

Appendix 9 Average Shape Congruence Ratings with Brand Values

SYMMETRIC	2	3	5	6	8	Average	X-2,5	ASYMMETRIC	1	4	7	9	10	Average	X-2,5	Winner
Innovative	3,45	1,82	3,55	3,45	4,45	3,344	0,844	Innovative	1,91	4,18	4	3	2,55	3,128	0,628	Symmetric
Sustainable	2,73	2,73	2,73	4	2,82	3,002	0,502	Sustainable	2,45	3	4,18	3,36	3,27	3,252	0,752	Asymmetric
High-quality	3,36	2,82	2,36	4,09	3,64	3,254	0,754	High-quality	2,55	3,91	3,45	2,64	2,45	3	0,5	Symmetric
Trustworthy	3,27	4,09	2,36	4,18	2,91	3,362	0,862	Trustworthy	3,55	3,09	3,27	2,82	2,64	3,074	0,5074	Symmetric

ORGANIC	6	7	8	9	10			GEOMETRIC	1	2	3	4	5			
Innovative	3,45	4	4,45	3	2,55	3,49	0,99	Innovative	1,91	3,45	1,82	4,18	3,55	2,982	0,482	Organic
Sustainable	4	4,18	2,82	3,36	3,27	3,526	1,026	Sustainable	2,45	2,73	2,73	3	2,73	2,728	0,228	Organic
High-quality	4,09	3,45	3,64	2,64	2,45	3,254	0,754	High-quality	2,55	3,36	2,82	3,91	2,36	3	0,5	Organic
Trustworthy	4,18	3,27	2,91	2,82	2,64	3,164	0,664	Trustworthy	3,55	3,27	4,09	3,09	2,36	3,272	0,772	Geometric

DYNAMIC	2	4	7	8	9			STATIC	1	3	5	6	10			
Innovative	3,45	4,18	4	4,45	3	3,816	1,316	Innovative	1,91	1,82	3,55	3,45	2,55	2,656	0,156	Dynamic
Sustainable	2,73	3	4,18	2,82	3,36	3,218	0,718	Sustainable	2,45	2,73	2,73	4	3,27	3,036	0,5036	Dynamic
High-quality	3,36	3,91	3,45	3,64	2,64	3,4	0,9	High-quality	2,55	2,82	2,36	4,09	2,45	2,854	0,354	Dynamic
Trustworthy	3,27	3,09	3,27	2,91	2,82	3,072	0,572	Trustworthy	3,55	4,09	2,36	4,18	2,64	3,364	0,864	Static

SLIM	2	4	5	8	9			ROBUST	1	3	6	7	10			
Innovative	3,45	4,18	3,55	4,45	3	3,726	1,226	Innovative	1,91	1,82	3,45	4	2,55	2,746	0,246	Slim
Sustainable	2,73	3	2,73	2,82	3,36	2,928	0,428	Sustainable	2,45	2,73	4	4,18	3,27	3,326	0,826	Robust
High-quality	3,36	3,91	2,36	3,64	2,64	3,182	0,682	High-quality	2,55	2,82	4,09	3,45	2,45	3,072	0,572	Slim
Trustworthy	3,27	3,09	2,36	2,91	2,82	2,89	0,39	Trustworthy	3,55	4,09	4,18	3,27	2,64	3,546	1,046	Robust

POINTY	1	2	4	5	7			ROUNDED	3	6	8	9	10			
Innovative	1,91	3,45	4,18	3,55	4	3,418	0,918	Innovative	1,82	3,45	4,45	3	2,55	3,054	0,554	Pointy
Sustainable	2,45	2,73	3	2,73	4,18	3,018	0,518	Sustainable	2,73	4	2,82	3,36	3,27	3,236	0,736	Rounded
High-quality	2,55	3,36	3,91	2,36	3,45	3,126	0,626	High-quality	2,82	4,09	3,64	2,64	2,45	3,128	0,628	-
Trustworthy	3,55	3,27	3,09	2,36	3,27	3,108	0,608	Trustworthy	4,09	4,18	2,91	2,82	2,64	3,328	0,828	Rounded

Appendix 10 Average of Brand Values Congruence with Shape Ratings

Brand Value	Shape 1	Shape 2	Shape 3	Shape 4	Shape 5	Shape 6	Shape 7	Shape 8	Shape 9	Shape 10
Innovative	2,23	2,82	2,68	4,14	2,32	3,18	4,27	4,09	2,91	2,09
Sustainable	1,68	2,27	3,27	2,68	2,32	2,91	3,82	2,59	3,77	3
High-quality	3,05	2,82	3,77	3,5	2,18	4,05	3,36	3,91	2,68	2,55
Trustworthy	3,68	3	3,86	2,73	1,91	3,77	2,77	2,86	2,95	2,82
Average score	2,66	2,73	3,40	3,26	2,18	3,48	3,56	3,36	3,08	2,62

Appendix 11 Average Geometry Congruence Ratings with Brand Values

SYMMETRIC	2	3	5	6	8	Average	X-2,5	ASYMMETRIC	1	4	7	9	10	Average	X-2,5	Winner
Innovative	2,82	2,68	2,32	3,18	4,09	3,018	0,518	Innovative	2,23	4,14	4,27	2,91	2,09	3,128	0,628	Asymmetric
Sustainable	2,27	3,27	2,32	2,91	2,59	2,672	0,172	Sustainable	1,68	2,68	3,82	3,77	3	2,99	0,49	Asymmetric
High-quality	2,82	3,77	2,18	4,05	3,91	3,346	0,846	High-quality	3,05	3,5	3,36	2,68	2,55	3,028	0,528	Symmetric
Trustworthy	3	3,86	1,91	3,77	2,86	3,08	0,58	Trustworthy	3,68	2,73	2,77	2,95	2,82	2,99	0,49	Symmetric

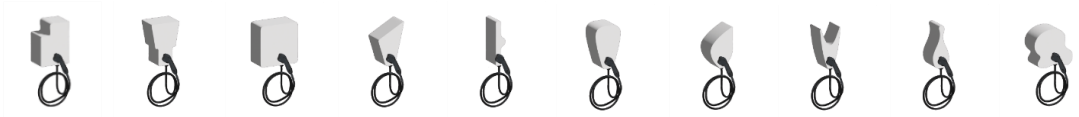
ORGANIC	6	7	8	9	10			GEOMETRIC	1	2	3	4	5			
Innovative	3,18	4,27	4,09	2,91	2,09	3,308	0,808	Innovative	2,23	2,82	2,68	4,14	2,32	2,838	0,338	Organic
Sustainable	2,91	3,82	2,59	3,77	3	3,218	0,718	Sustainable	1,68	2,27	3,27	2,68	2,32	2,444	-0,056	Organic
High-quality	4,05	3,36	3,91	2,68	2,55	3,31	0,81	High-quality	3,05	2,82	3,77	3,5	2,18	3,064	0,564	Organic
Trustworthy	3,77	2,77	2,86	2,95	2,82	3,034	0,534	Trustworthy	3,68	3	3,86	2,73	1,91	3,036	0,536	-

DYNAMIC	2	4	7	8	9			STATIC	1	3	5	6	10			
Innovative	2,82	4,14	4,27	4,09	2,91	3,646	1,146	Innovative	2,23	2,68	2,32	3,18	2,09	2,5	0	Dynamic
Sustainable	2,27	2,68	3,82	2,59	3,77	3,026	0,526	Sustainable	1,68	3,27	2,32	2,91	3	2,636	0,136	Dynamic
High-quality	2,82	3,5	3,36	3,91	2,68	3,254	0,754	High-quality	3,05	3,77	2,18	4,05	2,55	3,12	0,620	Dynamic
Trustworthy	3	2,73	2,77	2,86	2,95	2,862	0,362	Trustworthy	3,68	3,86	1,91	3,77	2,82	3,208	0,708	Static

SLIM	2	4	5	8	9			ROBUST	1	3	6	7	10			
Innovative	2,82	4,14	2,32	4,09	2,91	3,256	0,756	Innovative	2,23	2,68	3,18	4,27	2,09	2,89	0,390	Slim
Sustainable	2,27	2,68	2,32	2,59	3,77	2,726	0,226	Sustainable	1,68	3,27	2,91	3,82	3	2,936	0,436	Robust
High-quality	2,82	3,5	2,18	3,91	2,68	3,018	0,518	High-quality	3,05	3,77	4,05	3,36	2,55	3,356	0,856	Robust
Trustworthy	3	2,73	1,91	2,86	2,95	2,69	0,190	Trustworthy	3,68	3,86	3,77	2,77	2,82	3,38	0,880	Robust

POINTY	1	2	4	5	7			ROUNDED	3	6	8	9	10			
Innovative	2,23	2,82	4,14	2,32	4,27	3,156	0,656	Innovative	2,68	3,18	4,09	2,91	2,09	2,99	0,490	Pointy
Sustainable	1,68	2,27	2,68	2,32	3,82	2,554	0,054	Sustainable	3,27	2,91	2,59	3,77	3	3,108	0,608	Rounded
High-quality	3,05	2,82	3,5	2,18	3,36	2,982	0,482	High-quality	3,77	4,05	3,91	2,68	2,55	3,392	0,892	Rounded
Trustworthy	3,68	3	2,73	1,91	2,77	2,818	0,318	Trustworthy	3,86	3,77	2,86	2,95	2,82	3,252	0,752	Rounded

Appendix 12 Average of Brand Values Congruence with Geometry Ratings



Brand Value	Geo 1	Geo 2	Geo 3	Geo 4	Geo 5	Geo 6	Geo 7	Geo 8	Geo 9	Geo 10
Innovative	1,91	3,45	1,82	4,18	3,55	3,45	4	4,45	3	2,55
Sustainable	2,45	2,73	2,73	3	2,73	4	4,18	2,82	3,36	3,27
High-quality	2,55	3,36	2,82	3,91	2,36	4,09	3,45	3,64	2,64	2,45
Trustworthy	3,55	3,27	4,09	3,09	2,36	4,18	3,27	2,91	2,82	2,64
Average score	2,615	3,20	2,87	3,55	2,75	3,93	3,725	3,46	2,96	2,7275

Appendix 13 Difference in Average Rating Shape Congruence versus Geometry Congruence

AVERAGE RATING	1	2	3	4	5	6	7	8	9	10
A Shape	2,66	2,73	3,4	3,26	2,18	3,48	3,56	3,36	3,08	2,62
B Geometry	2,62	3,2	2,87	3,55	2,75	3,93	3,73	3,46	2,96	2,72
Difference (B-A)	-0,04	0,47	-0,53	0,29	0,57	0,45	0,17	0,1	-0,12	0,1

Appendix 14 Differences in Rating Shape versus Geometry per Brand Value

INNOVATIVE	1	2	3	4	5	6	7	8	9	10
Shape	2,23	2,82	2,68	4,14	2,32	3,18	4,27	4,09	2,91	2,09
Geometry	1,91	3,45	1,82	4,18	3,55	3,45	4	4,45	3	2,55
Delta	0,32	-0,63	0,86	-0,04	-1,23	-0,27	0,27	-0,36	-0,1	-0,46

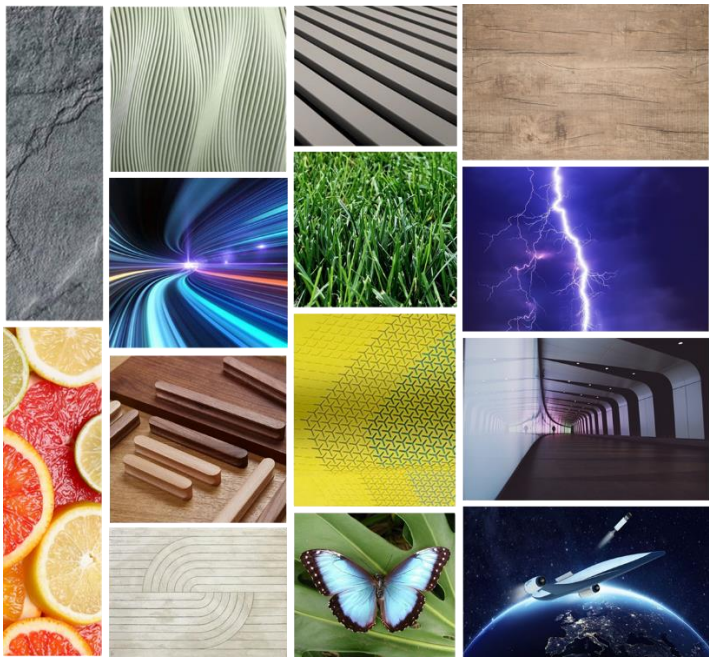
SUSTAINABLE	1	2	3	4	5	6	7	8	9	10
Shape	1,68	2,27	3,27	2,68	2,32	2,91	3,82	2,59	3,77	3
Geometry	2,45	2,73	2,73	3	2,73	4	4,18	2,82	3,36	3,27
Delta	-0,77	-0,46	0,54	-0,32	-0,41	-1,09	-0,36	-0,23	0,41	-0,27

HIGH QUALITY	1	2	3	4	5	6	7	8	9	10
Shape	3,05	2,82	3,77	3,5	2,18	4,05	3,36	3,91	2,68	2,55
Geometry	2,55	3,36	2,82	3,91	2,36	4,09	3,45	3,64	2,64	2,45
Delta	0,5	-0,54	0,95	-0,41	-0,18	-0,04	-0,09	0,27	0,04	0,1

TRUSTWORTHY	1	2	3	4	5	6	7	8	9	10
Shape	3,68	3	3,86	2,73	1,91	3,77	2,77	2,86	2,95	2,82
Geometry	3,55	3,27	4,09	3,09	2,36	4,18	3,27	2,91	2,82	2,64
Delta	0,13	-0,27	-0,23	-0,36	-0,45	-0,41	-0,5	-0,05	0,13	0,18

Appendix 15 Focus Group 3 Report

The aim of the third focus group session was to gain insights into existing brand and product associations amongst employees about the brand Vigor. Additionally, cooperative ideas and techniques are generated to stimulate an inclusive way of working. Firstly, 3 images and 3 words (Ashby, 2004) were selected by each of the 5 participants. Subsequently, the participants were invited to elaborate and argument their choices. The overview below shows the combination of selected images and words.



Basic

Nature

Honest

Powerful

Modern

Compact

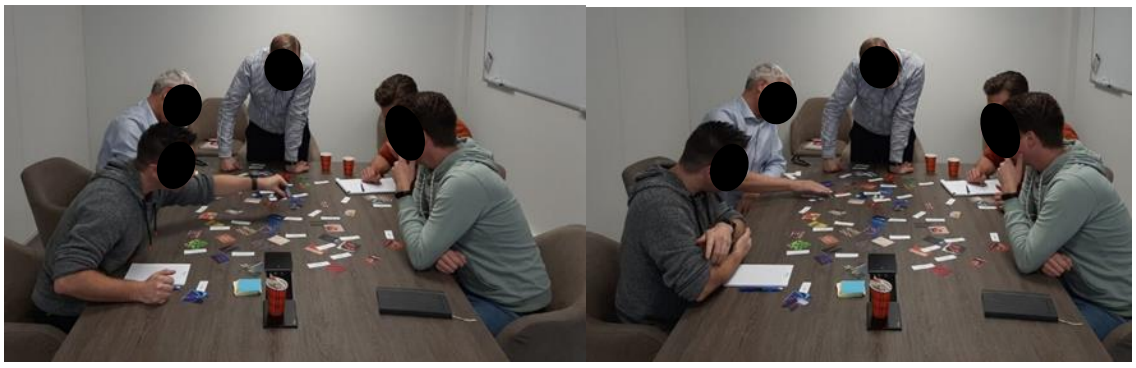
Elegance

Urban

Simple

Affordable

Functional



Lotus Blossom

The second activity of the session was lotus blossom (Shen et al., 2016) to generate partial solutions and ideas, by using a 9x9 matrix. The center 3x3 matrix formulates in the center a design problem with 8 partial solutions. All 8 partial solutions are than centered. These are the center of the other 8 3x3 matrices, which leave room for 8 ideas to achieve a partial solution in the center.

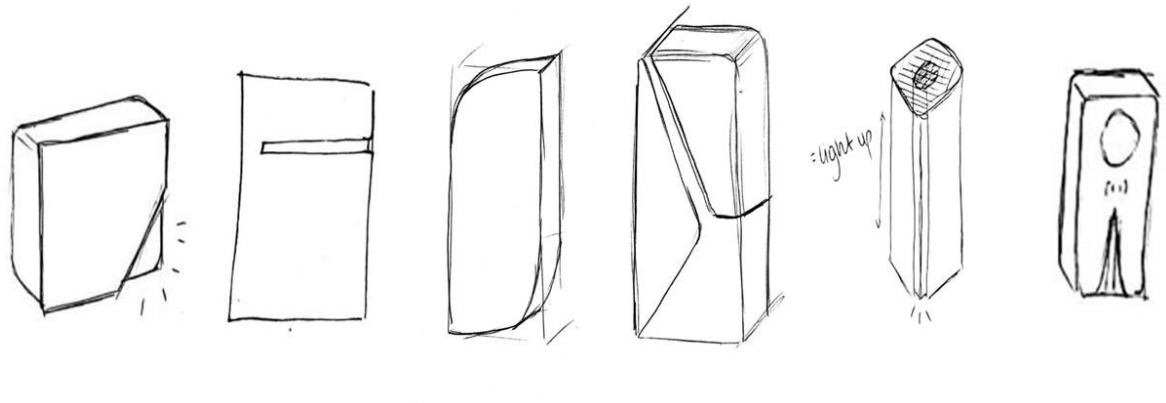
Interesting partial solutions resulting from this activity are for example a transformable casing, facilitating an application, dynamic lights to indicate charging directions, interchangeable elements to blend in environment, recognition of license plate to eliminate scanning debit card, confirmation sound and light, and recyclable panels for casing.

*Brainwriting (6*3*2*)*

During this activity a broad collection of ideas was generated through performing the 6*3*2* method (Method 635, 2024). This means that the original method with 6 participants, 3 ideas per participant, and 5 pass-on actions is adapted to a version with 6 participants, 3 ideas per participant, and 2 pass-on actions. The three ideas are guided by three given topics based on desired unique selling points. This resulted in 6 sheets with at least 9 ideas for selected topics.

Ideas and techniques resulting from the brainwriting activity were based on three topics per sheet. These topics all together were usability, cable management, unobtrusive versus recognizable, recyclability, intuitive design, and easy to install. The topic usability led to ideas like handing out cable, pulsing light for charging direction, colours indicate charging status, and projection on the floor. The topic cable management led to ideas like implementing a reel, internal cable, garden hose principle, cable in floor/wall, implement cable into design/shape, cable around charger, and lighten the eight. The topic unobtrusive versus recognizable led to usage of organic materials, flexible appearance of casing, interchangeable front panel, and usage of dimmable light with proximity sensor. The topic recyclability led to the idea of modularity in construction of the product to enable partial maintenance. The topic intuitive design led to the idea of lighting up the relevant part of the charger in the action sequence. The last topic of easy to install led to the ideas of using universal parts and clicking mechanisms.

Appendix 15 Selected Ideation Materials



Appendix 17 Focus Group 4 Report

This focus group meeting is aimed at defining and appointing prototypical and brand typical attributes. Prototypical attributes include aspects that define a certain product group. In this research, the product group is single socket wall chargers, specified to participants in this session in advance. Brand typical attributes are aspects referring to the brand identity.

A collection of comparable chargers was presented. Additionally, a list of design aspects was presented to allow detailed discussion about the attributes. Deducted from this discussion and knowledge about in house chargers, prototypical attributes are described. These attributes are a socket, user interface, internal components, RFID scanner, and a cable for private usage.

Brand typical attributes are formulated in a discussion. This discussion was initiated using abstract hand drawn sketches and Ai-generated images. Figure 27 presents examples of sheets used in the session. By evaluating perceived congruence with the brand identity and perceived difference with the brand identity a common direction can be concluded. The visuals are used to have conversations about what participants see instead of describing fictive and conceptual ideas.

As a first step, sketches of silhouettes and basic geometric shapes were made. These implemented multiple sources of inspiration, to diverge as much as possible and explore beyond existing familiarities. Figure X presents an example of an ideation sheet sketches during this phase.

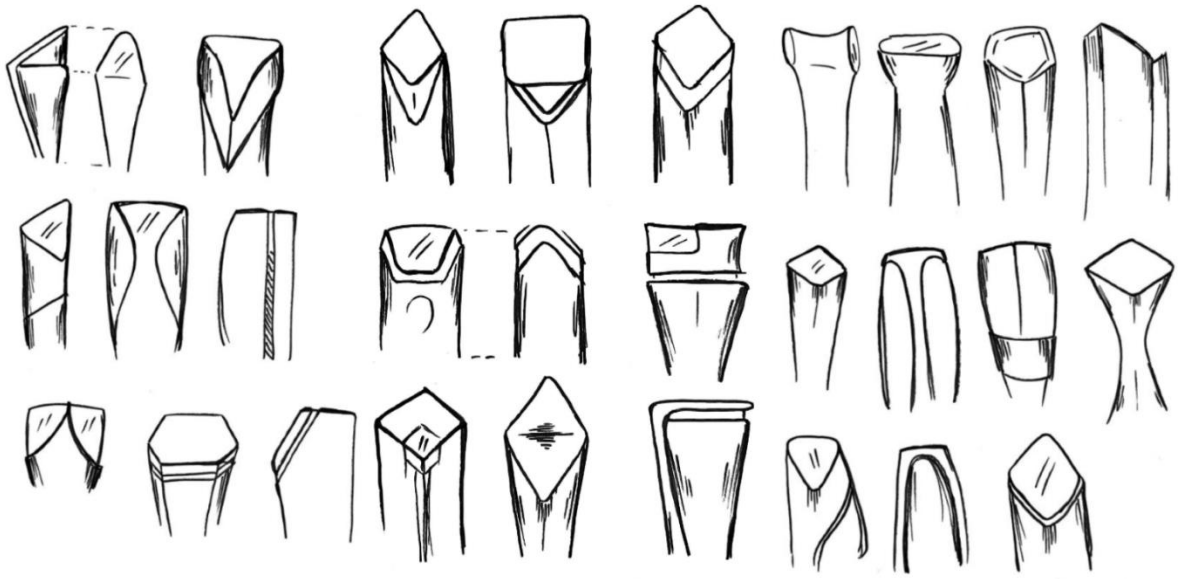


Figure 27 Example Ideation Sketches

Figure 28 Example Clay Exploration

Additionally, to handmade sketches, the AI tool Bing Create was used to generate images. The input for this application was deducted from the defined core values of Vigor and desirable product features. Examples are unobtrusive, blending in environment, LED screen, sustainable design, Volkswagen styling, Ferrari styling, and simplistic. The aim of generating these images was to concretise certain elements and associations in the context of an EV charger. These images can inspire and motivate critical thinking during initial brainstorming sessions.

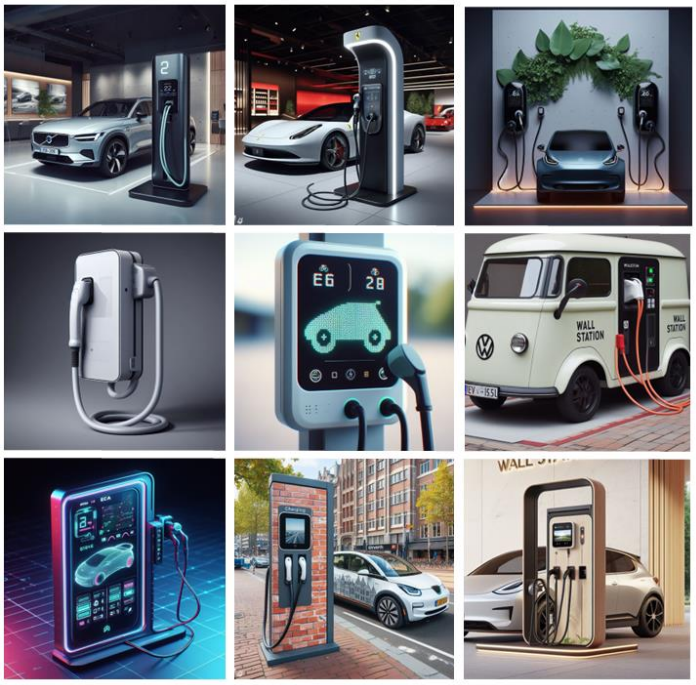


Figure 29 Example Artificial Intelligence Image Sheet

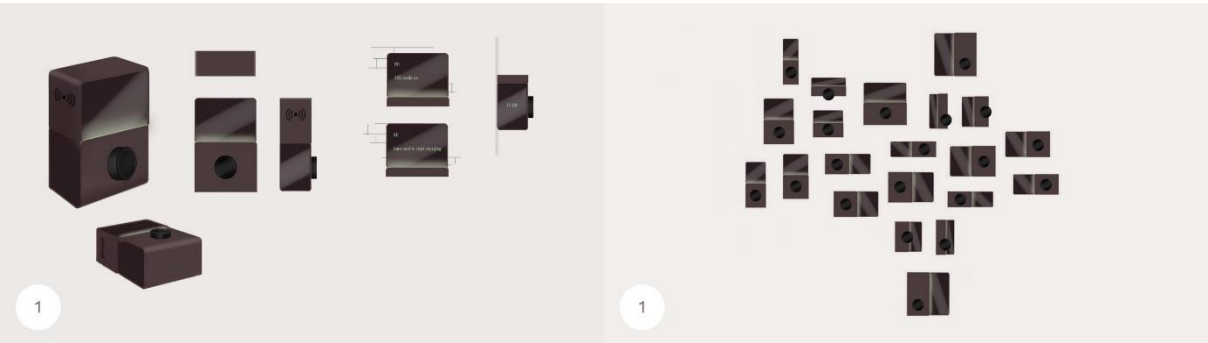
Perceived congruent aspects with the brand identity of drawings and images were appointed as dark base, matte finish, simple, rounded, elegant and dynamic. Differences perceived with the brand identity were described as too much light, a lot of information, too detailed, too organic, not functional, and too decorative.

As a summary of this session figure X was made as an overview. The left side presents prototypical attributes, and the right-side presents resulting brand typical attributes.

Appendix 18 Concept Description

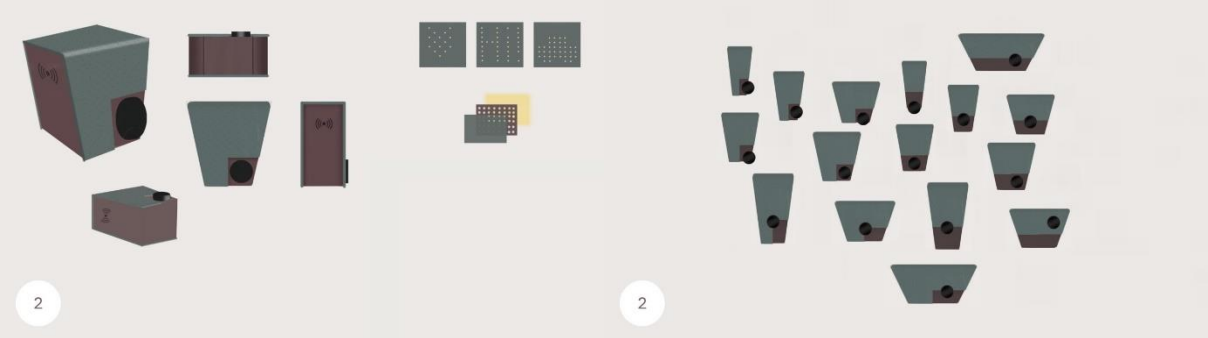
This phase diverged into five concepts with varying interfaces and geometries. A focused and critical evaluation could take place by developing different working principles in specific concepts with a certain geometry. It is important to address that all working principles can be integrated into all the different geometries. This section elaborates on the different concepts and evaluates them by explaining the advantages and disadvantages per concept.

Concept 1 E-Fold



Concept E-Fold implements the indicators of trustworthiness of a symmetric, rounded and robust appearance. This concept consists of two matte panels and four glossy panels. The matte panels cover the top and bottom and embed the RFID reader on the side and socket on the front bottom. The screens present detailed information about charging. Indirect light radiates from below the bottom front panel to indicate the charging status.

Concept 2 Connecting Dots

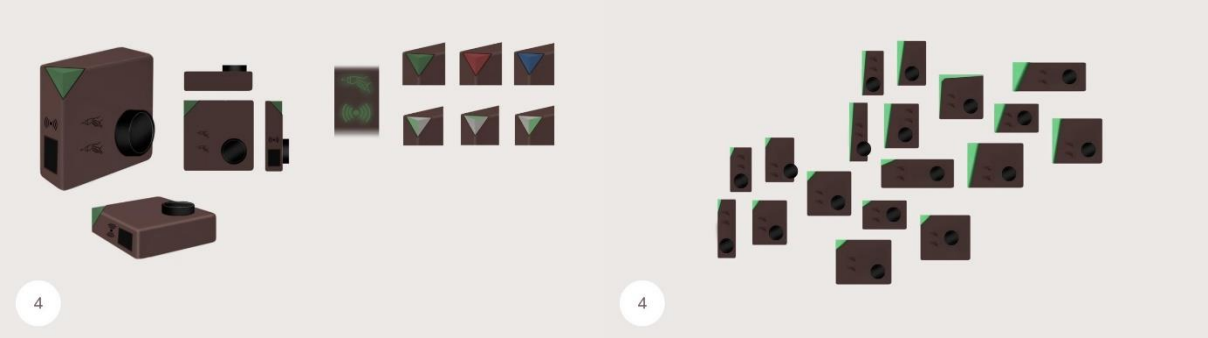


Concept Connecting Dots implements that top-heavy shapes are an indicator of innovativeness, in combination with symmetry and robustness to evoke trustworthy associations. This concept presents information through a dot matrix, a collection of lights together forming an icon or text. This allows for a simplified and clear representation of information. The front, top and back panels are made of glossy materials, able to implement dot matrices. The bottom, left and right panels are matte material, with on the left side the RFID reader. The socket is placed on the bottom right, falling inside an indent of the front panel.

Concept 3 ProjectionPillar

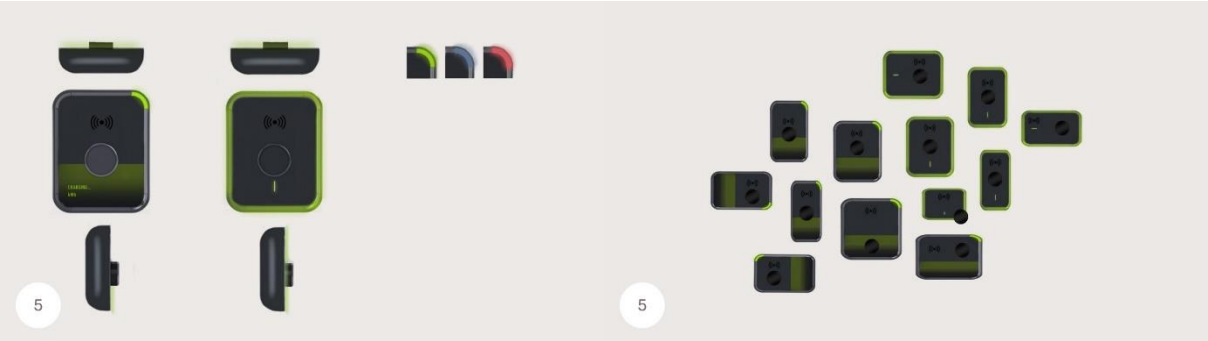
Concept ProjectionPillar implements organic and rounded surfaces to evoke sustainable design and high quality. The robust and symmetrical characteristics aim for perceived high quality and trustworthiness. The concept has two rounded panels on the sides, contrasting with the middle panel. The middle panel on the top includes the RFID reader. On the bottom of the middle panel, the socket is located. Below the socket, an opening allows for projection of information on the ground surface.

Concept 4 Electricube



Concept Electricube implements a pointier appearance to evoke innovative associations. The symmetry, robust and static characteristics aim for high-quality and trustworthy associations. This concept has a cubical base of one piece with one cut-off corner. This corner is lit by diffuse light. Different icons for information provision are located on every surface of the cubical base. The cut-off corner, being a distinctive feature, communicates the charging status of the product. The user is guided through the action sequence by presenting each type of information on a different side of the product.

Concept 5 Hue Charge



Concept Hue Charge implements round and robust characteristics to elicit sustainability, high quality and trustworthiness. Besides that, symmetric characteristics support a high quality and trustworthy appearance. This concept is built up by a shield on the back with a body placed in front. A subtle space is left between the shield and body on the top compartment to shine an indirect light on the inside of the shield. The lights can present the charging status of the product. Information can be projected on the bottom part of the shield, below the socket located in the middle. The surface of the shell is used as an indirect information carrier.

In consultation with the project team, a rating was given, considering every concept's advantages and disadvantages regarding the communication method and outer design.

Appendix 19 Summary of Concept Rating

Evaluation concept 1 E-Fold

Regarding the factor of sustainable design, it is considered that the relatively large screens are costly, but due to the simplistic geometric shapes, it is easy to manufacture in a durable manner (4/5). Regarding the usability factor, it is considered that the screen surface, as proposed, enables flexible and elaborate information provision. Indirect lighting can make the product easier and more pleasant to find but is questionable in visibility with bright sunlight. Using sensors or timers, the light intensity can be set as an alternative (5/5). Discussing the design & styling resulted in how the colour brown can be associated with dirt, but when toned, more anthracite is favourable by the team. The subtle lights are evaluated as beneficial for the design (5/5). Innovativeness with delicate animations and indications around the socket in mind was seen as an advantage. The overall geometry was not seen as specifically innovative (2/5). General remarks were about how waterproof the overlapping surfaces would be and how constant lights attract bats in nature.

Evaluation Concept 2 Connecting Dots

The factor sustainable design was mentioned that this could be manufactured both of metal and plastic. Though, for metal the connection between surfaces is challenging to make waterproof since one wants to avoid welding. It could be interesting to research the possibility of translucent coating (3/5). Regarding the usability factor, the design of elements and composition of dots determines the level of usability. If this is executed well, the simplicity of communication is an advantage. If not, using dots has no advantage compared to screens (5/5). The design & styling resulted in a low perceived safety due to sharp corners. The top-heavy shape was not perceived as matching the brand and preferences (2/5). The factor Innovativeness arose that usage of dots matrices is refreshing. The concept of light dots can benefit the design if executed well. The visibility of the LEDs should be tested with bright sunlight, researching high-power LED performance (4/5). General remarks were to investigate VanMoof electric bikes and Tado thermostats for dot matrix interfaces for inspiration and working principles.

Evaluation Concept 3 Projection Pillar

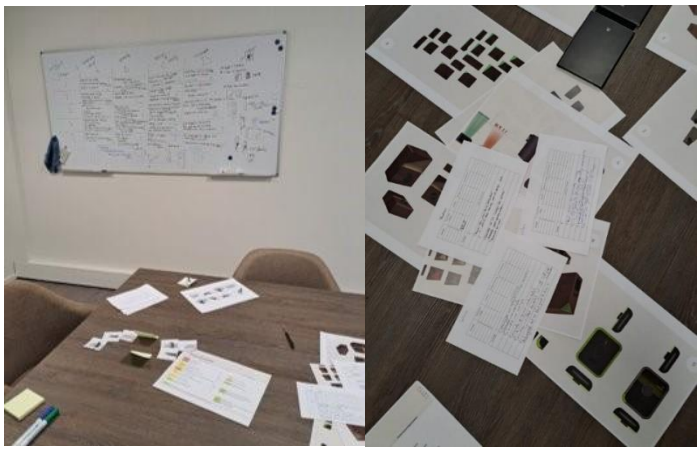
The sustainable design factor led to a comparison with the existing durable design of EV chargers. The concept can be manufactured in a convenient manner due to the limited number of components. This small number of components makes it easy to recycle materials. This concept also avoids the implementation of expensive screens (4/5). This concept's usability depends on the projection surface, so external factors, such as grass for example, would make perceiving the projection difficult. The location of information on the ground instead of the product itself is unexpected and, therefore, could be undesirable. It could be beneficial for perceiving information from a distance (3/5). The design & styling of this concept is compared with one positively and one negatively associated competitor and is therefore known already. It was mentioned that the friendly rounded shape could blend well in the environment (3/5). The innovativeness of this concept is explained to be in the projecting aspect and surely not in the outer design of the product (3/5). General remarks were to simplify projection only to a bundle of light to indicate charging status.

Evaluation Concept 4 Electricube

Sustainable design is dependent on material, it was stated. The concept could be produced with plastics by injection molding for example. This mould should be weighed with the number of products due to high mould costs. The shape is easy to manufacture when applying angled surfaces, and there is low chance for damage when consisting of one piece (5/5). The usability is considered not as intuitive due to the subtle guidance per surface. This could be improved when light elements are enlarged and clearly light up simultaneously with icons. (3/5). The design & styling is explained to be straightforward, but the cutout is very recognizable. This could be an example of a distinguishing part of the brand. There is no strong association with the functionality of a charging station (4/4). The innovativeness of the cutout, either as a surface or point, is seen as innovative. This is due to the guidance it can give per surface per action. The appearance is not perceived as innovative, different but not future oriented (4/4). General remarks about this concept were that e relatively larger 'cut out' would improve the functionality of guiding actions during the interaction with the charging station.

Evaluation Concept 5 Hue Charge

The level of sustainable design depends on the manufacturing since it is possible to make from metal and plastic. Moulding would be convenient due to its rounded shape, whereas injection moulding would be less costly compared to aluminium moulding. The geometry is easy to manufacture. (4/5). The usability is examined as high due to all the information on the front surface. The projection of the product enables flexibility and clarity in communication. Look into bright sunlight in combination with the projection intensity. An alternative could be the same concept with an inlaid screen (5/5). The design & styling is stated to appear modern and neat. The diffuse lighting could function as ambient light instead of irritation for the environment (4/4). Recessed surfaces with projection and diffuse lights are perceived to be innovative and distinctive. The rest of the outer design is not evaluated to be extremely innovative (3/5). A general remark about this concept was to research a recessed screen as an alternative for projection.



Appendix 20 Outcomes Focus Group Session 5 Concept Rating

Concept	Sustainable design	Usability	Design & Styling	Innovativeness	Ideas
1	Screens are expensive. Simple shapes, simplicity, easy to manufacture relatively large screen	You can make a lot clear with a screen, flexible display, indirect light makes you findable, still visible with sunlight? If necessary, adjust based on time or sensor intensity	Brown can be seen as dirty/dirty, subtle light, anthracite is beautiful (as shown on screen)	With a screen you can make innovative expressions, indication around the socket?	Watch out for rain in edges, bats can be attracted to light
Rate	4	5	5	2	4
2	Look into light permitting coating, plastic versus metal, connection waterproof is a challenge, avoid welding	Requires separate UX design, determines design and clarity, icons, etc. determine user-friendliness in this concept	Has many sharp edges and corners that you get stuck on (safety), unappealing shape, top heavy, developing a matrix can make a difference!	Dot matrix is innovative, you have to work it out and test it properly (make it or break it), how does it work with bright sunlight (high intensity LED)	Look at VanMoof and Tado thermometer, High power LED
Rate	3	5	2	4	3,5
3	Similar to EcoTap and Technagon, easy to manufacture, few parts (simplicity), recyclable, not an expensive screen	Depending on the surface, it is not noticeable if you have to find information on the ground, useful from a distance, if necessary project higher, the environment is decisive	Please note that KwH and price must be at a certain level (appropriate), resembles EcoTap (-), resembles Technalgon (+), not innovative, round shape can blend in well with the environment	Looks like existing charging stations, 'yet another land post', project is innovative, the rest of the design is not	Only lamp bundle colour for availability (green, red, blue)
Rate	4	3	3	3	3,25

4	Is material dependent, could be made from plastic, easily manufacturable, not likely to break, with injection molding (limited to production method)	Not intuitive enough that everyone understands, make areas of light larger than clearer divisions and distinctions. Lamp surface and icon at the same time is clear, it can take a lot of searching	Corner lamp is original, otherwise straightforward, not a strong charging station association	Indicating each action flatly is innovative, the entire concept does not feel very innovative, it is slightly different but not futuristic	Cut off instead of protruding, larger edges of the surface to clarify where you need to be
Rate	5	3	4	4	4
5	Easily manufacturable, by casting roundings from plastic or aluminum, possibly injection molding	Clear everything at the front, a lot possible, clear, look at the visibility of projection in sunlight, alternative is a screen that is slightly set back	Modern and neat appearance, diffuse light is an advantage, yellow light as mood light in the dark	Reclining surface/projection and diffuse light innovative and new/distinctive, otherwise the design is not extreme	Screen as an alternative to projection on product
Rate	4	5	4	3	4

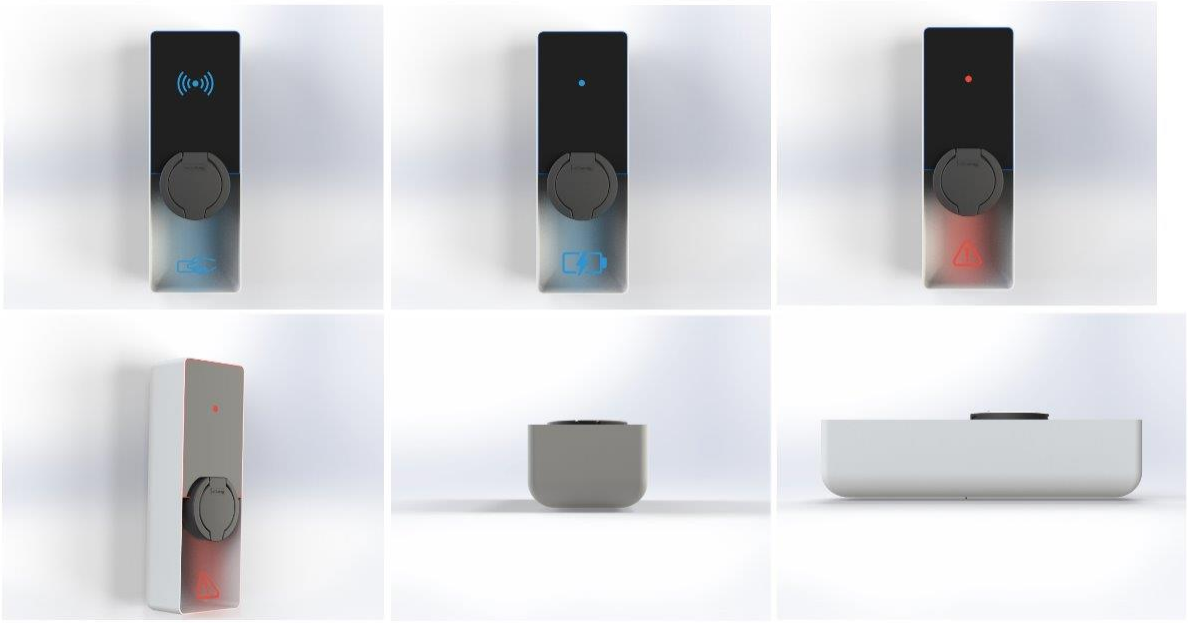
Appendix 21 Outcomes Focus Group Session 5 Concept Rating Remarks

Concept	Ideas and Remarks (participant 1)
1	Schermpjes aan de zijkant misschein verwijderen, Interactie aan voorzijde
2	Interactie aan voorzijde
3	Projectie op grond onduidelijk
4	Misschien niet altijd duidelijk wat welk licht moet aanduiden
5	Belangrijk dat de tekst goed te lezen is

Concept	Ideas and Remarks (participant 2)
1	
2	Risico op uitvoering moeilijk, dot matrix wel heel mooi idee, rest van de paal minder
3	Lastig voor gebruiker als je dichtbij staat, misschien alleen lichtbundel zonder tekst
4	Heeft potentie, mogelijk kunnen we 45 graden draaien (punt naar voren) dan kun je vlakverdeling zien van vooraanzicht
5	Als scherm niet goed zichtbaar is dan moeilijk

Concept	Ideas and Remarks (participant 3)
1	
2	Bouwen lastig, maar daarna betrouwbaar, valt of staat heel erg met UX design LEDs
3	
4	Driehoekje wel in combinatie met icoontjes oplichten, driehoekje groot genoeg maken
5	Let op, veel techniek, modernste qua looks

Appendix 22 Model Description



Model 1A combines the geometry of a rounded cube with communicating information by projecting onto the product itself. The design consists of a vertical shell with a body in front of which the RFID reader is placed. On the bottom of the body, the socket is oriented. The space below the socket on the shell is used to project information about the charging session to the user.

Model 1B combines the geometry of a shield with communicating information by projecting on the product itself. The design consists of a shield-shaped shell with a body in front of which the RFID reader is placed. This body allows icon to show icons and text lighting up from the dark surface. The bottom part, below the socket, can present a coloured glow to indicate the charging status.

Model 1C combines dynamic geometry with communicating information by projecting onto the product itself. The design consists of a case with an indent on the front panel. A panel under an angle can present information presented on it from above. This information consists of status and operational mode for example. The information is presented in the colour representing the charging status of the product.

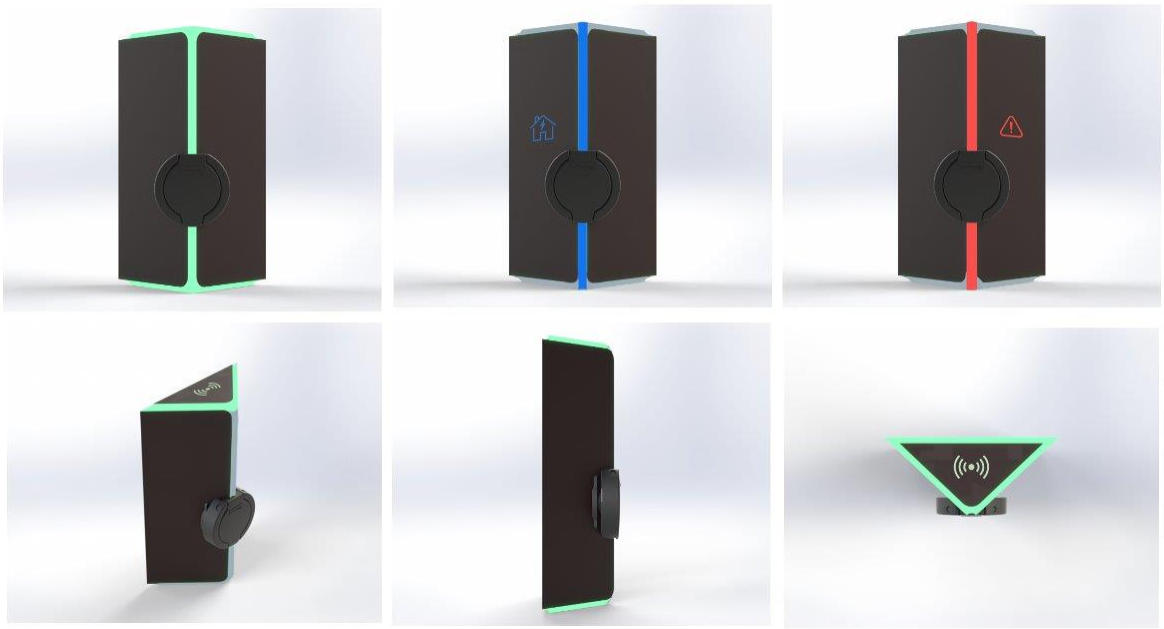
Model 2A combines the geometry of a rounded cube with communicating information through a dot matrix screen. The design consists of a base to be coloured in the desired colour and a front interface. This front interface is a medium gloss panel. Behind this panel the RFID reader and a dot matrix screen are located. The dot matrix can provide relevant information about actions required, charging status and operational mode. Around the medium gloss panel, a strip is located to present the charging status from a larger distance.

Model 2B combines the geometry of a shield with communicating information through a dot matrix screen. The design consists of a rounded base with a medium gloss panel on the front. The front panel is enclosed with comparable strips. Behind this panel the RFID reader is located and a dot matrix. The dot matrix can provide relevant information about actions required, charging status and operational mode. The left and right upper corner are provided with strips indicating the charging status from a distance.

Model 2C combines dynamic geometry with information communication through a dot matrix screen. This design consists of an asymmetric base of medium-gloss material. On the front, a distinctive panel partially covers the base. This top panel presents the RFID reader, whereas information about the required actions, charging status, and operational mode is presented on the front plane by a dot matrix.

Model 3A combines the geometry of a rounded cube with communicating information through guidance per surface in use. This design consists of a rectangular base, enclosed by rounded top and bottom compartments. The top part includes the RFID reader, the middle panel presents required actions, charging status, and operational mode, and the bottom part is around the socket. The middle panel is a dark panel that presents bars on the location of required actions.

Model 3B combines the geometry of a shield with communicating information through guidance per surface in use. This design consists of three panels placed on an extruded base. These panels each have their own type of information to present. The top panel presents and lights up when authorization of the user or payment is required, the left panel presents the charging status, mode of operation, and the right panel presents errors or unknown parameters. The middle strip guides users on the interface by enclosing the relevant panel by diffuse light indication.



Model 3C combines dynamic geometry with communicating information through guidance per surface in use. This design consists of three panels. These panels each have their own type of information to present. The top panel presents and lights up when authorization of the user or payment is required, the left panel presents the charging status, mode of operation, and the right panel presents errors or unknown parameters. The middle strip guides users on the interface by enclosing the relevant panel by light indication.

Appendix 23 Focus Group Session 6 Evaluation

The aim of this focus group session is to converge towards a design direction for the final design proposal of this design research.

All nine models are considered in the focus group session. Firstly, the context and origin of the models were elaborated on. Secondly, the different models were presented and discussed in level congruence with the brand Vigor and feasibility. Thirdly, the geometries with example interfaces were presented and discussed in level congruence with the brand Vigor and feasibility. Feasibility in different fields of expertise could be discussed due to the multidisciplinary group of participants. The group of participants consisted of a mechanical engineer, an electrical engineer, a technical writer, the business unit manager, and two business developers.

The presented models were first rated on their appearance complementary to the brand identity of Vigor. All participants could assign three different types of ratings, a green, yellow and red arrow based on how they perceive the models. The green arrow represents very positive congruence with brand identity (+2), the yellow arrow represents positive congruence with brand identity (+1), and the red arrow represents negative congruence with the brand identity (-2). Table 17 presents an overview of the rates of this rating.

Table 17 Model Rating Outcomes

	1	2	3
A	0	5	-6
B	-4	2	3
C	2	0	-2

This first rating results in the four highest ratings for models 2A, 2B, 2C and 3B.

More extreme geometries of 3A (rounded) and 3C (dynamic) are rated low due to insufficient usage of volume of the product. Projection of product (column 1) models are rated lower due to cavities which could allow dirt to be collected.

A subsequent rating was done with example interfaces on the identical models of the first rating. presents an overview of the rating results of the second rating.

Table 18 Model with Interface Rating Outcomes

	1	2	3
A	1	3	-6
B	1	5	5
C	-1	-1	-6

The second rating results in the highest ratings for models 2A, 2B, and 3B. Projections on the product would be dependent on the environment and are therefore rated low. Concepts using a strip indicating status and movement are rated high due to the functionality of bidirectional charging.

As a result of the discussions, combining the considered concepts will be finalised into one. Due to the efficient use of space, flexibility in casing graphics design and room for varying information types model 2A is used as a foundation. Other features from concept rating are integrated and adapted in the final model. This would include guiding the user's attention subtly integrated in a model with simplistic appearance. This model should allow for flexible information provision over time.