

Safety Semiotics

Designing visual and tactile cues for trust and responsibility in mobility



Master Thesis | Integrated Product Design

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Preface

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This master thesis is the outcome of a 100 day graduation project for the master *Integrated Product Design*. The project was completed under the supervision of Skoda Auto and TU Delft and for the whole duration of the project I would work at Skoda's design centre in its home base Mlada Boleslav, Czech Republic. This was my first time working for a big OEM like Skoda and is something I have wanted to try since starting my study at IDE. During my exchange semester in California I was introduced to the topic of CMF design which I found to be very interesting. I am therefore very grateful that I was given this opportunity to come and work on a CMF project at Skoda. Moving to Mlada is an experience on its own and being able to work in the design studio is something I will not forget. Being able to walk around big clay models, deep diving in material samples and working in a team with designers from various backgrounds. During the project I gained a lot of

knowledge in the field of CMF design, working with physical material samples, learning to design my own custom materials in Substance Designer, learning about corporate politics and communicating with fellow designers, be it CMF or interior design. This was only my second CMF driven project that I performed and it proved to be quite challenging to create my own custom materials, as it is another level on top of just selecting existing materials. But creating custom materials with Substance ultimately gave me the freedom to have final materials that fit the perceptible safety assignment without being bound by what is already out there.

Overall I am happy that I got to do this project at Skoda Colour&Trim. It was a valuable experience that I will take with me into the future on my CMF design journey.

Master Thesis

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Executive summary

This report investigates how Colour, Material and Finish (CMF) design can enhance both actual and perceived safety within automotive interiors, with a specific focus on the European market and the brand context of Škoda Auto within the Volkswagen Group. It begins by establishing the theoretical foundation of perceptual safety, exploring how colour, materiality, texture, pattern, form language, and cultural context influence how safety is interpreted. Particular attention is given to CMF as a semantic design tool that translates abstract values such as protection, trust, and reassurance into tangible sensory cues. Exploratory visual research, including material boarding, image analysis, and AI-generated form studies, further examines how safety is constructed and perceived before isolating tactile influence.

The core of the first half of the report presents an empirical tactile material study in which participants evaluated material samples without visual input. Through quantitative and qualitative analysis, the research identifies key distinctions between emotional safety (often associated with softness and warmth) and functional protection (linked to hardness, density, and structural expression). These findings lead to the development of a Perceptual Safety Framework consisting of four themes: Protection, Control, Awareness, and Peace of Mind. Positioned within a functional–emotional and active–passive axis model, this framework provides a structured design tool for applying CMF strategies to future automotive interiors aligned with Škoda’s Modern Solid design language.

AI statement

In this project AI was used to help improve formulation of some text. Next to this it has been used to create visualisations for research purposes, and to add some people into renderings. No AI was used for generation of patterns, materials or shape in the final design.

The second half of the report shifts from research to design application. Based on the four safety themes identified in the Perceptual Safety Framework, a series of custom materials are developed that embody the defined material cues for Protection, Control, Awareness, and Peace of Mind. These materials are then applied to a purpose-designed safety sculpture, created as a three-dimensional exploration tool to test how the themes interact spatially and materially within an interior context. The sculpture serves as a tangible translation of the framework, allowing the themes to coexist and be compared within one coherent object. Finally, the digitally developed materials are physically produced, enabling real-world evaluation of colour, texture, depth, and tactility. This transition from theoretical framework to material realisation ensures that the proposed safety strategies are not only conceptual but experientially validated.

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1. Introduction

This chapter introduces the assignment, explains the basic principles of CMF design, as well as the structure of the report.

- 1.1 Assignment
- 1.2 CMF Design
- 1.4 Report set-up

1.1 Assignment

Research has shown that safety and the perception of safety in consumer vehicles are one of the most important factors when making a purchasing decision. Koppel et al. (2007) finds that consumers often equate vehicle safety with the presence of specific vehicle safety features or technologies rather than the vehicle's crash test results.

While perception plays a role in how vehicles are chosen, the greater design challenge lies in strengthening the actual safety experience for occupants during use.

Currently many safety features are deliberately hidden to preserve design appeal and maintain a 'peace of mind' narrative that avoids reminding passengers of potential danger. However, with the rise of semi- and fully autonomous driving modes, this approach introduces new complexities. Safety today is not only about protection but also about clarity of responsibility and trust.

The project investigates how to make safety related components visible, tangible and meaningful, to reassure users and improve trust in autonomous vehicles. The aim is to enhance both actual safety and perceived safety using CMF design as a means between the two.

All of this within the interior of a car, no exterior safety relevant components will be explored (e.g. radar placement, mirror shaping)

What role do colour, material, and finish choices play in shaping user awareness and behavior in safety?

How can CMF design be leveraged to enhance both perceived and actual safety in automotive human-machine interaction?

1.2 CMF Design

Colour Material and Finish design is a professional discipline that focusses on designing and specifying materials, colours and finishes to support both functional and emotional attributes of products. It is an integral process that runs in parallel with the physical and technical design of products. In some industries it is considered an integral part of industrial design itself (Becerra, 2016).

Unlike purely aesthetic styling, CMF design creates value when it is able to connect sensory perception, material technology, manufacturing constraints and user experience. Research shows us that CMF design decisions influence how products are perceived in terms of quality, usability, emotional resonance, and brand identity (Liu, 2020). As such, CMF design encompasses a wider scope than just surface appearance, including not only visual but also tactile, auditory and thermal cues derived from material and finish choices (Hwang, 2016).

CMF design is closely linked to material semantics, in other words, the meaning users associate with colours, materials, and finishes. Research shows that CMF choices significantly affect how users interpret a product's function, value, and cultural positioning (Hwang, 2016).

Although CMF design has always been around, it is gaining recognition as its own specialized discipline rather than a secondary styling activity. This relatively new positioning of CMF follows the overall design trend of moving towards a more holistic and experience-oriented/system based approach. Design fields where CMF is emphasized include consumer electronics, automotive, furniture and footwear.



Figure 1. Top. CMF Material board | Bottom. Pantone colours

2. Analysis

This chapter presents the analysis of different factors that go into creating perceptual safety. The analysis is performed by doing desk research, materialboard exploration, collage making, sketching, AI research and talking with professional CMF and interior designers. The outcome of this analysis combined with the texture research of chapter 3 will lead to the perceptual safety framework discussed in chapter 4.

- 2.1 What feels safe?
- 2.2 Colour
- 2.3 Patterns
- 2.4 Context & Safety Interpretation
- 2.5 Culture
- 2.6 Skoda Design
- 2.7 Car Safety Components

2.1 What feels safe?

Material boarding

In order to get a better feeling for perceptual safety and materiality, the analysis phase was started through intuitively making 'safe' materialboards. Material boarding is a common practice in CMF design where physical materials are used to make a 'collage' that shows different colours and tones, and how multiple materials interact with each other. This gives a quick and easy to understand overview of the CMF language and feeling the designer is trying convey.

Two material boards were made and analysed on why these specific materials feel safe, which can be seen in figures 2 and 3

Material board 1

he first material board employs an overall warm colour palette, incorporating soft-touch materials and natural grain and speckled textures to evoke a sense of warmth and naturalness, thereby creating a feeling of comfort and safety.

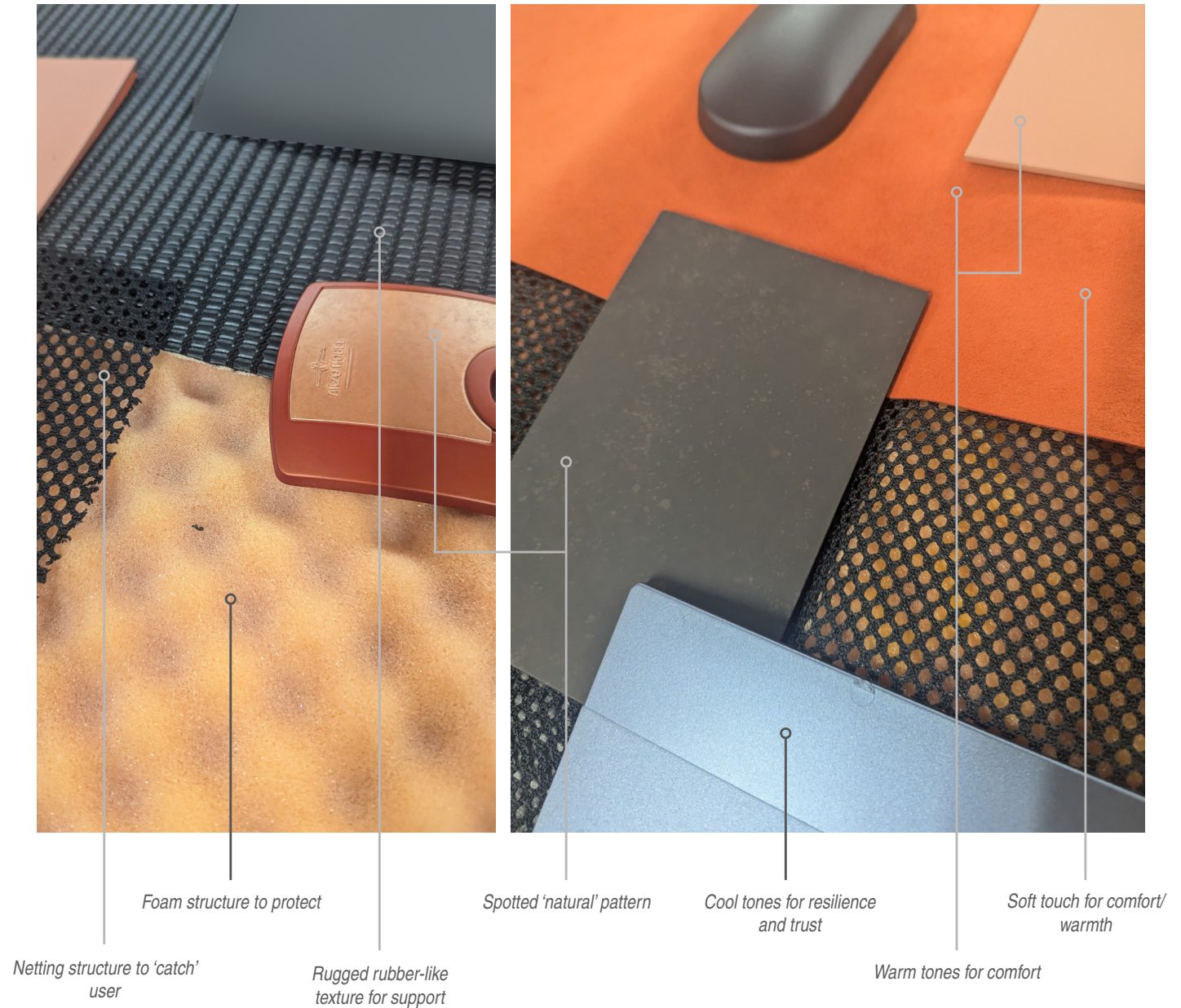
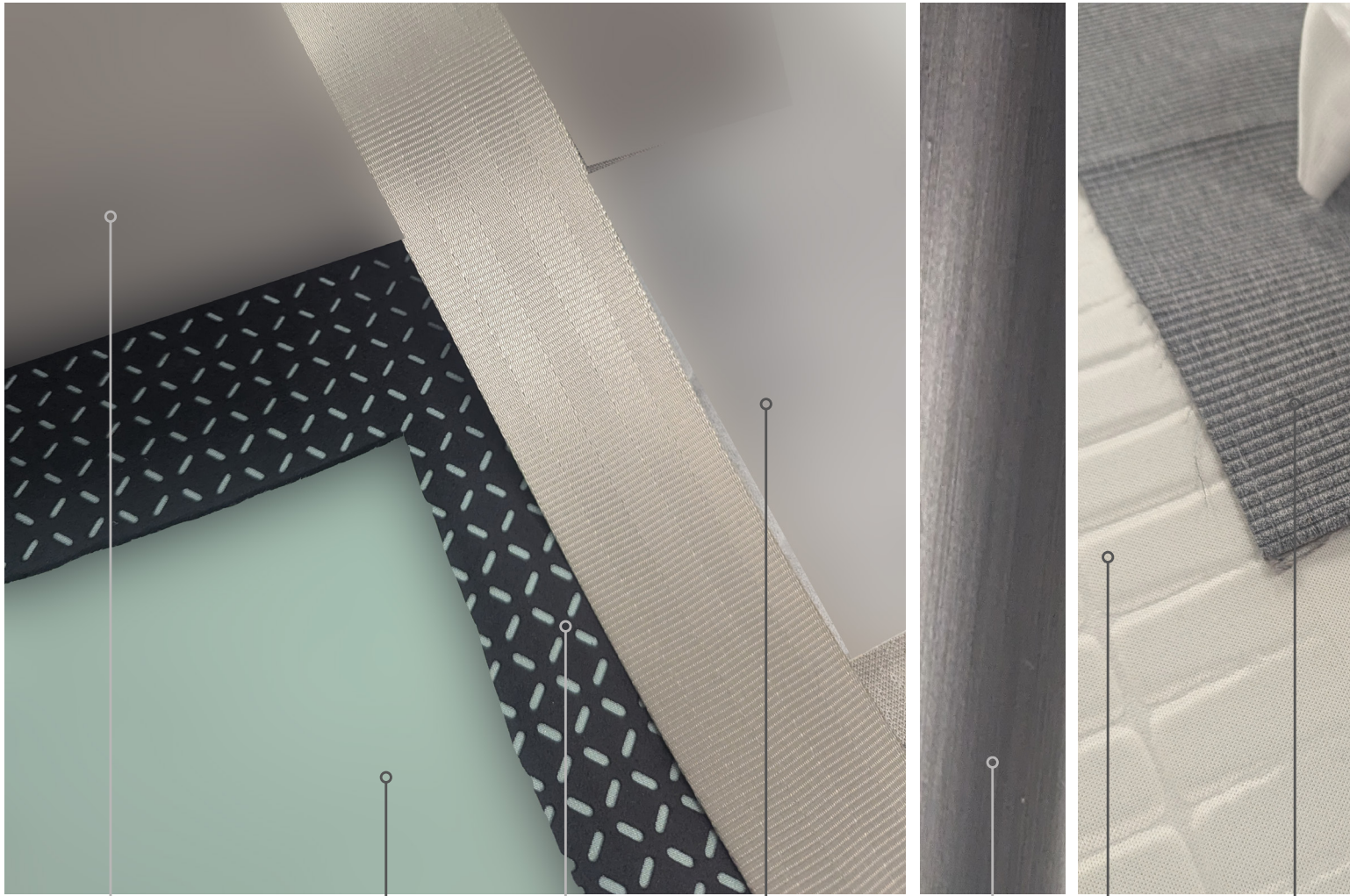


Figure 2. Material board 1



Open knit provides cooling

Pill or ice cube structure

Plus sign has medical associations

Airpocket structure against impact

Metallic accents provide structure

Ice pack-like structure for 'relief'

ribbed textile provides tactile feedback

Material board 2

A second material board was developed with a more sterile, or "clean," approach, in which cooler tones are combined with pluses and pill-shaped forms to create a controlled and hygienic aesthetic.

Figure 3. Material board 2

2.2 Colour

CMF design and Semiotics

As one of the three pillars of CMF design, colour plays an important role in brand recognition as well as having the ability to shape perceptual and emotional responses to products. In CMF design colour is a strategic design element that contributes to atmosphere, value, and user behaviour (Zhou, 2019). Colour can influence attention, interpretation, and action by communicating information or cultural associations.

Semiotic wise, colour is interesting because it can be seen as a symbol or a sign depending on its context (ou et al., 2012). When colour is seen as a symbol it represents a physical item or experience (e.g. red is a symbol of 'good luck' in China). When it is seen as a sign, colour provides specific information through visual communication (e.g. red means 'stop' at a traffic light).

Contrast

Next to personal and cultural associations, colour perception is rooted in human genetics. Increased contrast between objects and their background in the colour vision of human ancestors helped them better identify social signals, potential threats or food (Neitz & Neitz, 2017). Colours with higher chromatic contrast (for humans mainly red and yellow) are associated with increased perceptual salience, which has been shown to improve risk perception and detection (Elliot & Maier, 2014). These perceptual principles can still be found in contemporary design and safety communication. Think of a yellow ambulance that must move through traffic quickly and needs to be seen. Or red fire-related equipment of which the location needs to be easily identifiable.

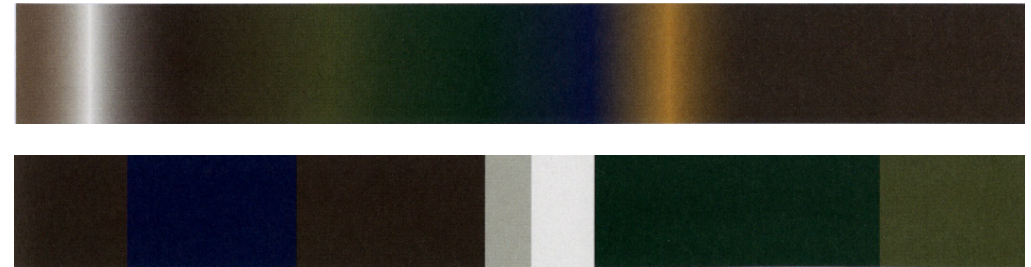


Figure 4. Natural Colour palletes

Natural colours

Colours commonly found in nature (such as greens, blues, and earth tones) are widely accepted as having calming psychological effects and overall positive human perception. These kind of colour palletes can reduce stress by aligning with pshycological needs to connect with nature (Ulrich, 1984). For example, green hues are linked to relaxation and associated with replenishment in various cultures (Kapland & Kaplan, 1989). Similarly blue colours are often associated with feelings of tranquility and trust, due to their common appearance in stable natural features such as the sky and bodies of water (Elliot & Maier, 2014). Environments dominated by natural colour palletes can lower stress, including lowering heart rate or blood pressure and are also consistantly rated as aesthetically pleasing (Küller et al., 2009).

Overall These natural colours have a calming effect and are positively perceived because they resonate with human needs to connect with nature.

Magazine Research

Research was conducted using a selection of magazine imagery (from the CMF and fashion design field) in order to explore how visual composition, particular colour, contributes to the perception of safety. Images were reviewed and selected according to if they subjectively conveyed a sense of safety, comfort or reassurance. This magazine research was performed together with another intern and there was discussion between each other as to why some images felt safer than others. The images were then categorised to get a broad overview of 'safe feeling' objects, all categories can be found in appendix A.

Colour analysis

A colour analysis was performed on the different categories to identify what influence colour has on perceptual safety. Pastel tones are commonly associated with emotional safety. Their reduced saturation and softened contrast are linked to calmness and decreased visual tension. Warm tones, like desaturated yellows, peaches and soft oranges, were found in images suggesting relational warmth and comfort, this can be supported by research that states that warm hues can create feelings of friendliness and reassurance if not overly saturated (Pegler & Kong, 2018). Natural colours were found in imagery perceived as environmentally safe. Transparency and opacity also played a meaningful role. Semi-transparent materials often conveyed openness and honesty, reinforcing perceptions of clarity and trust (Adams, 2021). High visibility colours, such as bright yellows and reds or neon colours, often appeared in with either playful or functional safety. When associated with functional safety these high-vis colours have

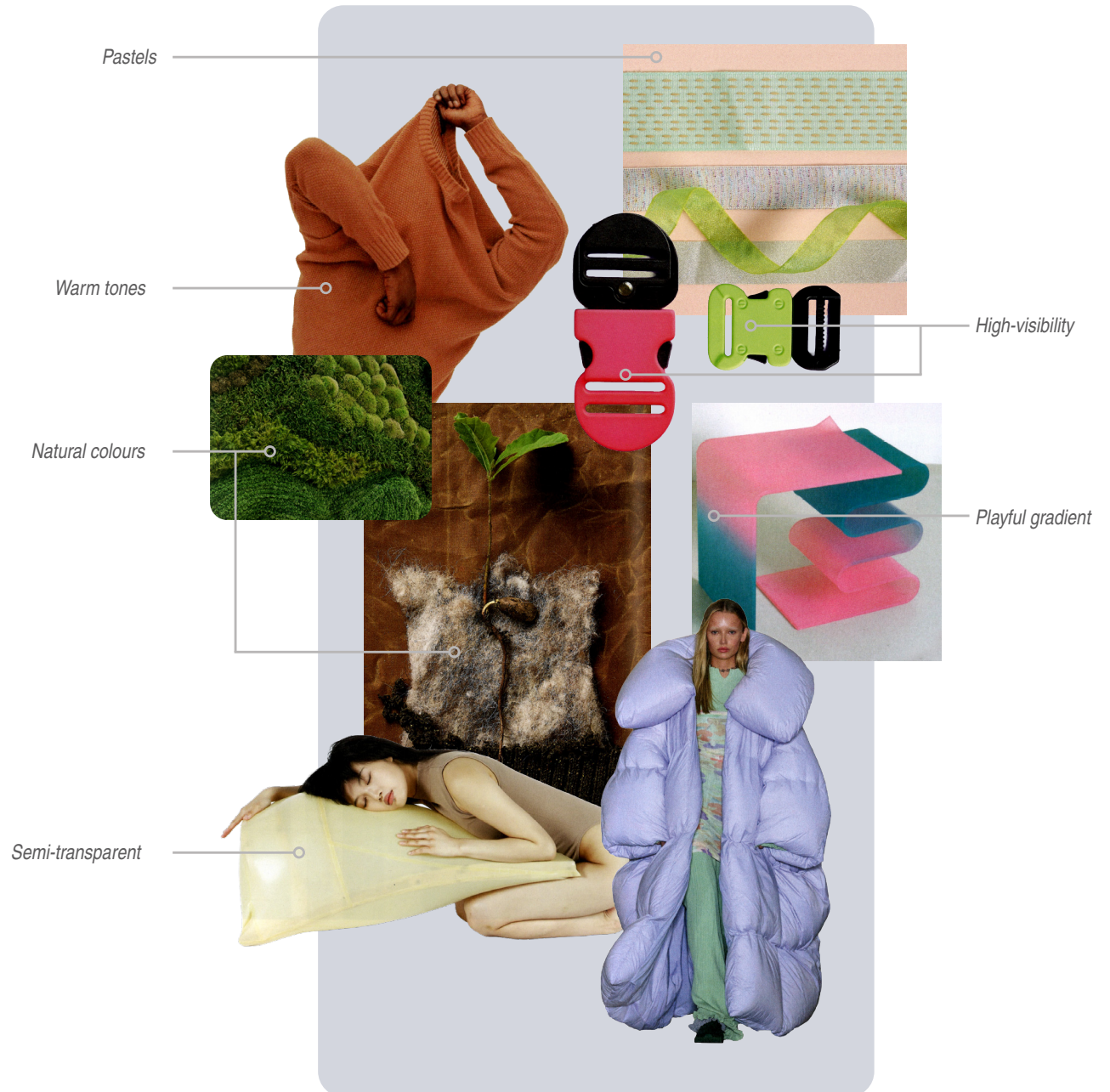


Figure 5. Safe feeling CMF elements



some communicative function, highlight specific areas or use cues. When associated with playful safety, colours can be high in contrast and bright in saturation as to suggest informal or child-oriented safety contexts. Gradients reduce visual rigidity and create a feeling of approachability (Opera & Cantwell, 2014).

Colour & interpretation of form

To further examine the role of colour in shaping perceptions of safety, all previously selected images were converted to black and white, removing hue and saturation information while retaining contrast and form. by isolating colour from form the aim is to determine whether the perceived safety of an image comes from its form or if colour served as a critical interpretative component. This second review revealed notable shifts in perception. Several images that previously were perceived as safe lost this quality when colour was removed. This is consistent with research suggesting that colour

significantly influences appraisal and meaning attribution, even before the interpretation of shape (Elliot & Maier, 2014). Without chromatic cues, viewers may rely more heavily on contrast or recognisable forms to interpret. For example pastels or warm, when viewed in black and white, become very neutral as they lack contrast. Removing the colour, in this case diminishes the emotional softness or warmth that formed the original sense of safety. In figure 6 some examples are shown of different interpretations of the same image depending if colour is present.

Rather than just decorating form, colour actively shapes how form is understood and how it can change the perception of the viewer.

2.3 Patterns

Visual patterns significantly influence how safe or hazardous a material is perceived, often independent of its actual physical properties. High-contrast, angular, or irregular patterns increase arousal and vigilance (Bar & Neta, 2006). For instance, diagonal hazard stripes, chevrons and sharp geometric repeats are widely used in safety signage because they visually signal caution and potential danger (figure 7.). These patterns use perceptual biases towards sharpness and contrast associated with threat detection.

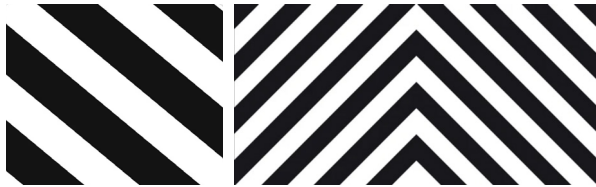


Figure 7. Warning stripes and chevrons

Conversely, softer and low contrast patterns tend to reduce visual tension and are often interpreted as stable or non-threatening (Reber et al., 2004). From a product semantics perspective, patterns function as communicative cues that can frame expectations before any tactile interaction (Crilly et al., 2004).

Visual patterns also influence perceived material reliability. Regular, symmetrical, and grid-based patterns often communicate order and control, which are qualities associated with stability and dependability (Hekkert, 2006). For example, knurled grips or repeated hexagonal textures on

tools visually imply friction and grip, see figure 8. On the opposite, chaotic graphics may undermine trust in the material by suggesting instability or fragility. This does not mean that patterns can not have some random element in it, as randomness is very common in the natural environment,

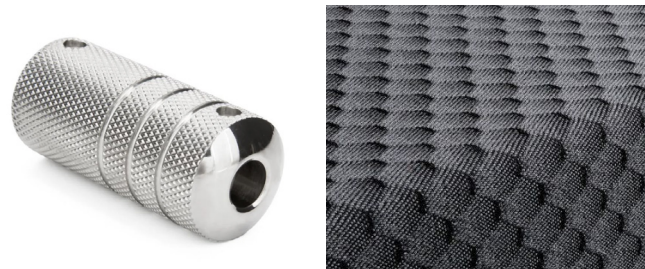


Figure 8. Gripping textures

it just means that the randomness should be understandable, not leading to confusion by the user. In figure 9 can be seen how the texture on the back of a playstation controller may look random at first, but on closer look the 'random' pattern is made up out of stacked playstation symbols. Both providing functional grip and visual interest that fits the brand while still being coherent. Through contrast, repetition, and geometry, pattern design plays an important role in how a material is perceived and therefore plays a large part in CMF design.

In chapter 3 the relation between patterns, their tactile qualities and their perceived sense of safety is studied.



Figure 9. intentional randomness

2.4 Context & Safety interpretation

Another important factor when considering perceptual safety is context. Perceptions of safety are created from the interaction between form language and contextual expectations. People generally associate curved, organic forms with pleasantness and reduced threat, whereas sharp or angular forms tend to trigger feelings of potential danger (Bar & Neta, 2006). This bias is often explained through evolutionary principles that suggest that sharp signals danger. However, product semantics research shows us that meaning attribution depends on the object's intended function and situational context (Crilly et al., 2004). This means that the perception of safety is not inherent in form itself but is affected by how well an object's form aligns with learned user expectations about what a given object should communicate.

Scissors & carabiners

In figure 10 two examples can be seen. Although scissors are inherently cutting tools, models with softened edges or an overall organic form language are frequently perceived as safer, particularly in domestic or child-oriented contexts. Such designs reduce perceived threat by visually altering cues associated with sharpness, even if the cutting blade remains unchanged. In this case

the organic form language supports the contextual expectation that scissors should feel manageable and controlled in order to be perceived as 'safe'.

On the other hand, in high-risk contexts, the same organic form language may undermine perception of reliability. A carabiner, functions as a safety-critical device, where users expect structural strength and mechanical integrity. Research on risk perception demonstrates that in situations involving potential life-threatening danger, people prefer cues associated with stability and technical competence (Fenko et al., 2010). Geometric clarity may therefore communicate durability more effectively than fluid, organic forms. How well a form matches its intended function is generally central to positive evaluation (Hekkert, 2006). Thus, while organic scissors may appear safer due to reduced visual threat, an organic carabiner may appear less dependable because it conflicts with contextual expectations of strength.

These contrasting examples demonstrate that safety perception is context dependent, identical form qualities can signal reassurance in one setting and unreliability in another.

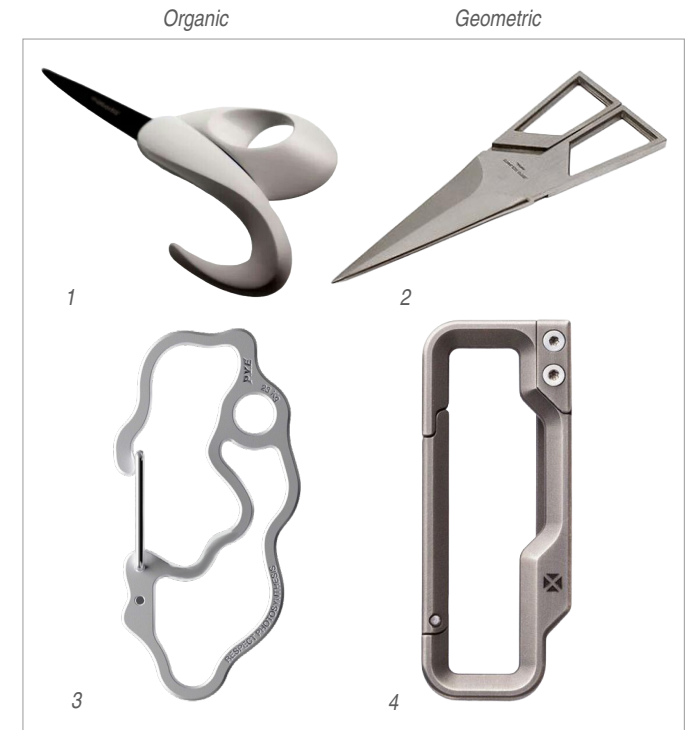
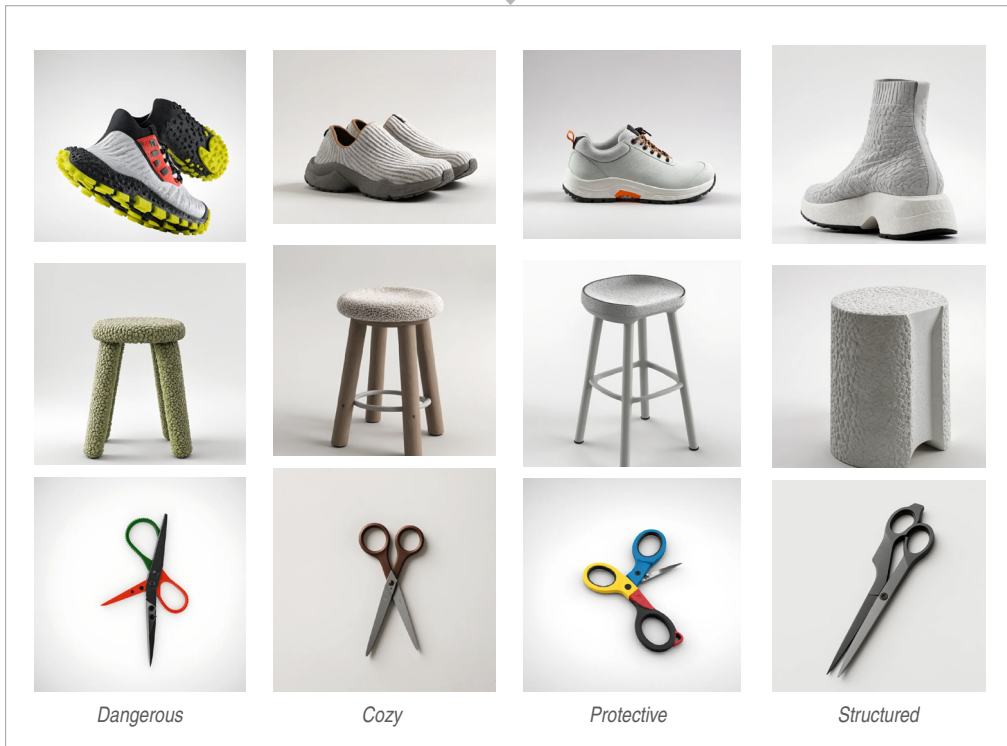


Figure 10. context dependent items



AI & contextual interpretation of safety

To further investigate how context can affect form interpretation, artificial intelligence image-generation tools (Vizcom) were used to produce visual iterations of three product categories: shoes, stools and scissors. For each object, a series of prompts was constructed using emotionally loaded descriptors. For example: ‘*Dangerous shoe, with dangerous colours and dangerous texture.*’ see also figure 11. These prompts were then executed with difference influences of reference images of typical products in their respective categories. By adjusting the weight of a reference image, the study shows how the AI can interpret emotional descriptors within a product design context. See appendix B for all generated images and respective prompts.

Research in computational generative design suggest that AI models do not understand emotion conceptually but reproduce culturally learned visual correlations embedded in the training data (Elgammal et al., 2017). For example, when prompted to generate a dangerous shoe, the outputs frequently exhibited sharp geometries, high-contrast and saturated colours and aggressive textures. On the opposite, when asked to create a cozy shoe it tended to produce rounded contours, soft materials and muted colour pallets.

Importantly, the amount of reference image influence affected the expressiveness of emotional translation. When no reference image was used, the AI relied more heavily on stereotypical visual signals associated with the emotional cues, producing exaggerated forms and colour schemes. With a stronger influence of the reference image the emotional cues were more subtly integrated. The images generated with no reference therefore are best to show what the form and materials should look like for each specific emotional cues, as it is more obvious. But the images with more influence show how these same emotional cues can be used in more conventional forms.

Figure 11. AI workflow

2.5 Culture

Culture in CMF

While some CMF design principles are broadly shared, such as higher contrast improving legibility or matte finishing reducing glare, others are different per culture. As stated earlier the symbolism of colour varies widely across cultures. In Western cultures white might suggest cleanliness in hospitals whilst in many Asian cultures it is associated with mourning and death. Next to colour, material preferences also differ across cultures (Nakao et al.). Natural materials or materials that age gracefully over time are associated with authenticity and more valued in western and Japanese culture, while in rapidly growing economies (e.g. China, Brasil) high-gloss finishing and contemporary plastics are more valued as they signal modernity and progress (Becerra, 2016).

Acknowledging this cultural aspect is important for CMF designers who want to design inclusive and culturally sensitive products. If overlooked designers risk alienating the user or causing emotional discomfort, even if the design functionally works. Culturally informed CMF design can enhance user satisfaction and perceived safety (Helliwell, 2006).

Culture and Safety

Cultural differences do not only affect aesthetics or emotion, they can also affect design making in safety critical scenarios. Case studies from aviation and nuclear power plants, where safety is critical, shows us that different forms of communication or hierarchy can suppress important feedback. Analyses of the Fukushima Daiichi nuclear disaster suggest that social cultural norms can discourage open criticism and limit learning from known errors observed previously. (Perrow, 1999).

Next to the social-cultural norms, simple cultural design differences, such as turning a knob or faucet clockwise versus counterclockwise, can influence actual safety as the users expectation might be different from reality and

users are therefore more likely to experience errors in use, particularly in a stressful situation (murata, 2017).

Target Market

As cultural factors have a lot of influence on how CMF design is perceived, it is better to choose a target market to design for. This way designers can take into account cultural value of materials into their designs.

Skoda operates in multiple markets (Europe, India, South America) but since Europe is currently their largest market, this thesis will focus its research and design on the European user.

2.6 Skoda Design

Volkswagen Group Volume Brands

Skoda is part of the Volkswagen group and is considered one of the 'volume brands'. Other brands in this category are Volkswagen and Cupra. Previously these brands were very much differentiated by price, with Skoda and Cupra in a more affordable segment than Volkswagen, but the current Volkswagen Group strategy is differentiation by design. So each of these brands should be perceived equal in value but should have their own identity and design language, that differentiates them from the others. Figures 12,13,14 show the latest concept car interiors from each brand.

Skoda

Skoda's current *Modern Solid* design language, most visible in the Skoda Vision O concept, emphasizes strong horizontal lines, simplified surfacing, and a more upright, architectural stance (Skoda Auto, 2023). Compared to the previous design language *Bohemian Crystal* which employed a sharper crystalline language, this new direction introduces smoother volumes while retaining geometric discipline. The overall message is durability, usability and rational confidence. Less ornamental and more structural, practical, rugged. Skoda's approach in 2025-2026 feels more mature

than before, positioning the brand as robust and future-oriented while remaining accessible. The Skoda customer is someone who is moving upmarket and wants something that feels premium but must be sensible.

Volkswagen

Volkswagen's updated design language is called Pure Positive. Compared to Skoda, Volkswagen's surfaces are more fluid and rounded, but avoiding heavy sculptural tension, going for a 'friendly' and 'accessible' approach. Volkswagen occupies a centered position in the portfolio, in between the rugged and practical Skoda and the emotional and aggressive Cupra.

Cupra

Positioned as the most emotional or radical brand among the volume brands, the Cupra design language is centered around dynamic surfaces, aggressive shape changes and triangular details. Cupra strategically separates itself from the more rational mainstream brands, its design language prioritizes distinctiveness over universality or accessibility.



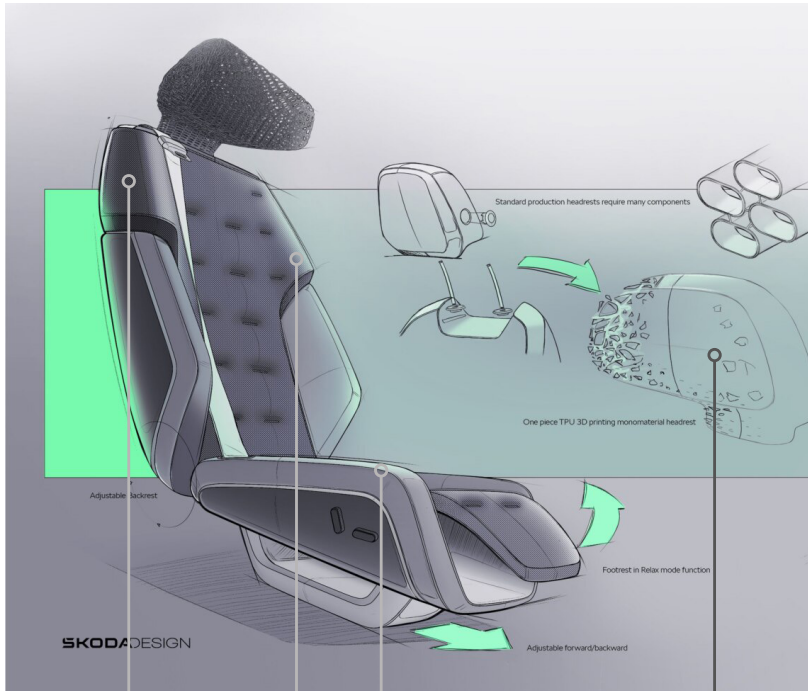
Figure 12. Skoda Vision O Concept



Figure 13. Volkswagen ID CROSS Concept



Figure 14. Cupra Tindaya Concept



Understandable solid surfaces

Simplifying components

Large fillets combined with hard edges

Figure 15. Modern Solid



Pill shaped details

Rounded edges and horizontal lines

Practicality and functional components

Simple geometric cutouts with sharp hard edges

Modern Solid

Skoda's *Modern Solid* design language represents a deliberate shift towards clarity and robustness. The approach emphasises understandable, solid surfaces with reduced visual noise, where volumes read as structurally coherent rather than overly sculpted. A defining characteristic is the combination of large fillets with sharply defined edges. Details often use pill-shaped silhouettes. Modern solid tries to communicate durability and future oriented functionality through simplification, creating an honest expression of structure rather than decorative complexity.

2.7 Car Safety Components

Safety features can be found in various parts of a car's interior, including the seats, doors, roof, and the vehicle's structural body itself. Some are obvious at first glance, while many are hidden elsewhere. These safety features are designed to protect passengers before, during, and after an accident. The overall vehicle safety system combines active safety, which focuses on preventing accidents, and passive safety, whose main purpose is to reduce injuries if an accident does occur.

Seatbelt

The most important safety feature in a car is the seatbelt. Every seat in a vehicle must have its own seatbelt, which consists of a lap section and a shoulder section. These are anchored to the vehicle's body, usually at the pillar beside the seat and near its lower base. In the event of a collision, special pretensioners instantly tighten the belt, while load limiters help reduce chest injuries. Seatbelts not only act during a crash but also passively help by keeping passengers in the correct position, so other systems, such as airbags, can function properly and effectively.

Airbags

Another very important part of a vehicle's safety system is the airbags. They are hidden in various locations throughout the cabin and, in the event of a collision, inflate almost instantly. In the front of the vehicle, one airbag is located in the driver's steering wheel and another in the dashboard on the passenger side. Side airbags are usually

positioned in the outer sides of the seatbacks or directly in the doors; their main purpose is to protect the chest and torso. Curtain airbags are stored in the roof lining above the doors and are designed to protect the occupants' heads during a side impact or a rollover. When activated, they deploy downward. The center airbag is located on the inner side of the driver's seat, sometimes on the passenger's seat, or occasionally in the center console. This airbag helps during a collision by inflating between the driver and the passenger to prevent them from hitting and injuring each other. Additional airbags are hidden along the pillars: the A-pillar is at the front, near the windshield (on the sides of the front window); the B-pillar is in the middle of the car, between the front and rear doors; and the C-pillar is at the rear, behind the rear doors, near the rear window. A car may also contain knee airbags, although they are not present in every vehicle; these airbags are located under the dashboard.



Figure 16. automotive airbags

Grabbing Handle

The grabbing handle is not considered one of the main protective features like the seatbelt or the airbag, but it is still important from a safety perspective. In certain situations, such as sudden braking, acceleration, or sharp turns, it provides passengers with a psychological sense of safety by enhancing stability and control. It can be found above the side window

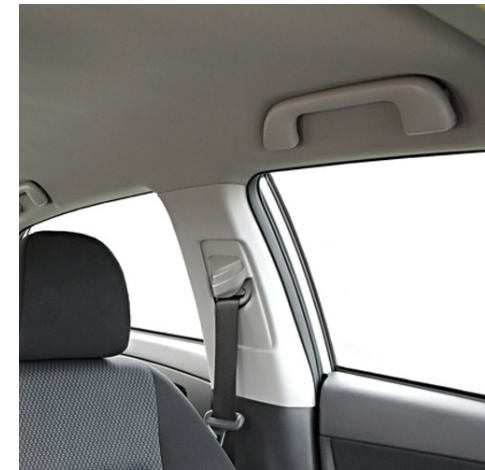


Figure 17. Grabbing handle

Mirrors

Mirrors are an important safety feature because they help the driver clearly see the surrounding traffic, including vehicles behind the car, and reduce blind spots when changing lanes or parking, thereby helping to prevent accidents. The rear-view mirror is mounted on the windshield in front of the driver, while the side mirrors are positioned on the exterior of the doors.

Headrest

At the top of each seat there is a headrest, whose purpose in a rear-end collision is to prevent neck injuries by limiting backward movement. In many cars, an active Whiplash system can also be found that moves the headrest forward during an impact.



Figure 18. headrest

Doorlocks & hammer

Another safety feature is the door lock system, which is especially important when travelling with small children, as it prevents the doors from opening unexpectedly while driving. However, in the event of an accident, a possible problem may be that the doors cannot be opened. For this reason, a vehicle may also be equipped with a window-smashing tool, although this is not part of the mandatory equipment.



Figure 19. window breaking hammer

3. Touch & Perceptual Safety Testing

In this chapter user testing will be performed in order to get a better understanding of how touch and texture influence the feeling of safety. A research plan, results, and conclusions will be discussed.

3.1 Research Plan

3.2 Results

3.3 Conclusions

3.1 Research Plan - Touch & Perceptual Safety

Objective

The objective of this test is to investigate how the tactile qualities of materials contribute to the perceived feeling of safety and to identify if the application location of the materials influences this perception of safety. By separating tactility from visual influence, the study aims to clarify the role of material feel in shaping emotional responses related to safety.

Research questions

- How does the tactile experience of different materials influence the perceived feeling of safety?
- Which material cues are most strongly associated with a sense of safety?
- How do different application locations of the materials influence the perceived feeling of safety?

Methodology

Participants

The study will involve 17 participants. As the study was not allowed to be conducted outside of Skoda Design, all the participants have a design background (Interior, Exterior, CMF, HMI). Informed consent will be obtained in accordance with ethical research standards.

Material Samples

A curated set of 15 materials samples will be used in the study. The samples will vary in tactile

properties such as softness, surface texture, temperature perception, compliance, depth and grip (see appendix C for full range).

Setup

Participants will interact with the material samples through touch only inside a blind box, the participants will not be able to see the materials. Each participant will be asked to handle all 15 samples individually. Before touching the samples the participant will be told 1 of the 3 application locations (Seatbelt, Grabbing points, Airbag covers) and will be shown an image with the application location highlighted, for the duration of the test see figure 20.

Data Collection

Quantitative

During interaction with each material sample, participants will rate their perceived feeling of safety using a Likert-scale questionnaire (1 = safe, 5 = unsafe). Additional scales will assess the presence of specific materials cues such as softness, grip or warmth.

Qualitative

After ranking the sample on the Likert-scales, the participant is also asked to describe what is pleasant, disturbing and unique about the sample and finally why the material feels safe/unsafe to them. The responses will be transcribed for analysis, allowing deeper insight into subjective interpretations of the materials.

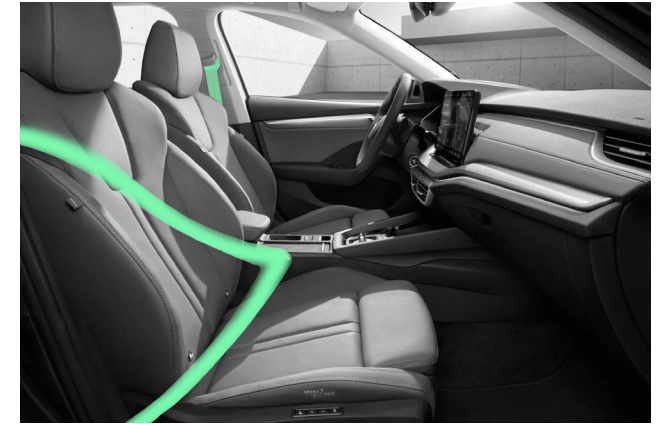


Figure 20. Material sample application locations

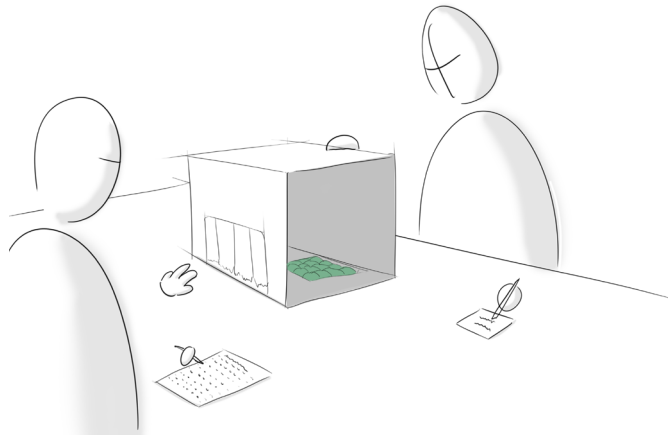


Figure 21. test setup

Data analysis

Quantitative data will be analysed using descriptive statistics to identify overall trends between material cues and perceived safety ratings, and the relation between their application location. Qualitative data be analysed through thematic analysis to identify recurring descriptors related to perceptual safety, most common descriptors will be visualised in wordclouds for each material, giving a quick overview of the samples main material cues.

Hypotheses

It is expected that the study will reveal a clear relationship between specific tactile material cues and the perception of safety. It is expected that samples with soft surface texture or foam-like structure will consistently be rated as safer than others.

Findings will help to get a better understanding of how tactility in materials supports emotional safety and may contribute to creating CMF design strategies that enhance perceived safety in products.

Limitations

The relatively small participant pool (n=17) consisting of only designers may not fully reflect real-world customers as that would be a more diverse range. Next to that, cultural associations with materials may influence perceptions of safety and cannot be entirely controlled.

		How does the material feel?						
		1	2	3	4	5		
Smooth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Rough	
Comfortable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Uncomfortable	
Hard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Soft	
Cold	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Warm	
Happy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Sad	
Bumpy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Flat	
Ordered	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Chaotic	
Light	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Heavy	
Dry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Moist	
Protective	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Vulnerable	
Secure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Restrictive	
Dainty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Robust	
Clean	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Dirty	
Reliable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unreliable	
Honest	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Secretive	
Safe	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Unsafe	

What is the most pleasant quality of the material?

What is the most disturbing quality of the material?

What is the most unique quality of the material?

Why does this material feel safe or unsafe to you?

Figure 22. Answer sheet

3.2 Results

Quantitative Results

The quantitative results showed overall trends in how tactile material cues create the perceived feeling of safety. Materials with the properties softness and warmth consistently received higher safety ratings. In contrast hard and robust materials were less frequently associated with feelings of safety but were strongly linked to the perception of protection. This indicates that there is a distinction between emotional safety and functional protection. Next to this, comfortability seems to be not inherently linked to perceptual safety. Materials that were rated as comfortable to touch did not consistently rate as more safe, therefore indicating that comfort and safety represent two different perceptual criteria.

To visualise the results of the Likert scales, graphs were made showing the overall average ratings across all participants (n=17) as well as average ratings per application group (see figure 23). While the application-group graph shows some distinctions in how materials were perceived depending on their application location, the limited number of participants per group (n=6) does not allow for statistically significant results. See appendix D for all quantitative results.

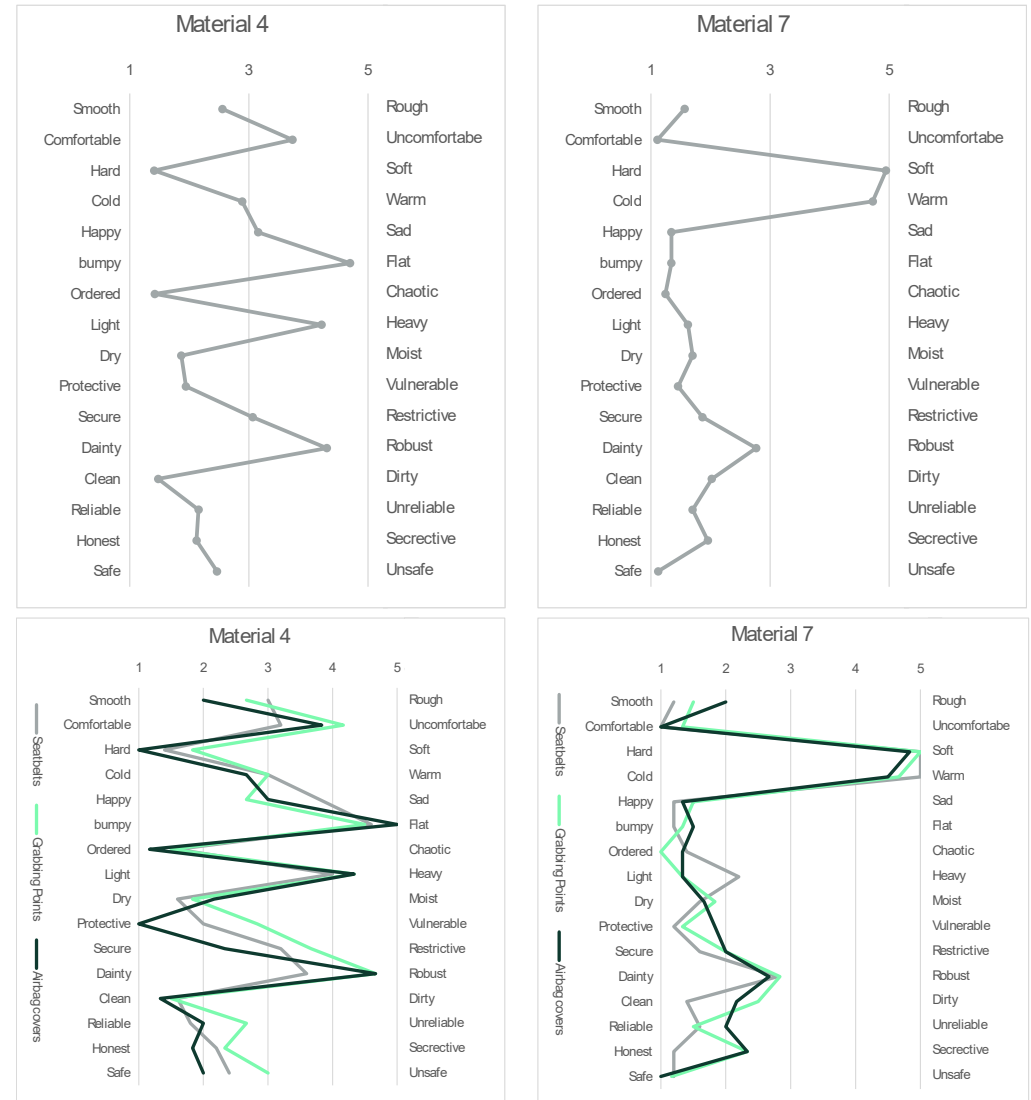


Figure 23. Rating average (top) Ratings per group (bottom)

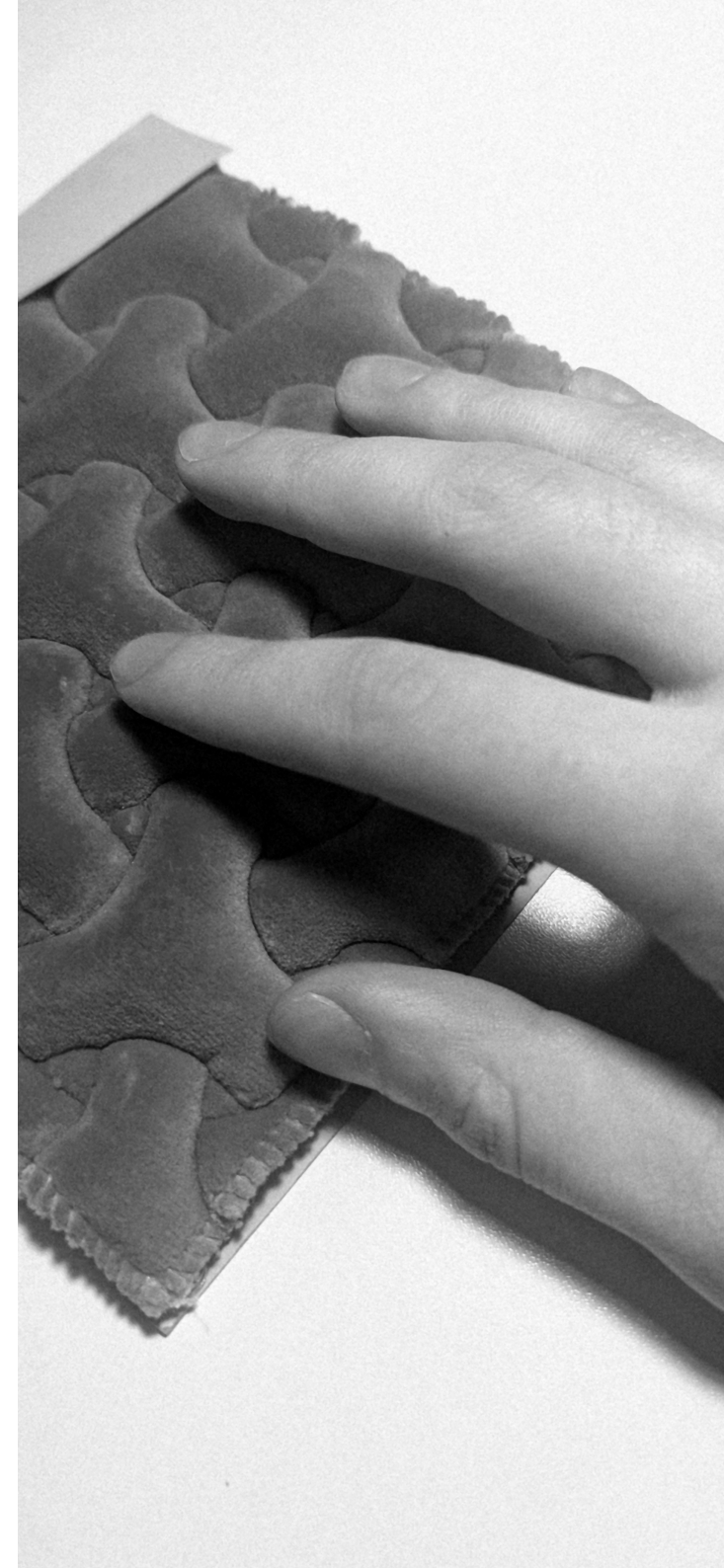
3.3 Conclusions

This material test investigated how tactile material qualities influence the perceived feeling of safety when touched blindly. The results indicate that certain tactile cues, particularly softness and warmth, are more frequently associated with higher perceived safety ratings. Next to that, materials that were described as hard or robust, were associated more with protection instead of safety on its own. This distinction suggests that emotional safety and functional protection are perceived as two separate factors. Additionally, the results show that comfort alone does not directly translate to perceived safety, as materials rated as comfortable were not consistently evaluated as safer.

The application location has an important influence on perceived safety, this could be observed in the quantitative results, however the limited number of participants per application group does not allow for statistically significant conclusions. From the qualitative data it can be concluded that perception of safety is highly personal. Participants often gave opposing meanings to the same tactile cues based on personal experiences and associations. For example, hard and cold materials were described as potentially dangerous and as safe, by having material qualities that can both hurt

as protect. Similarly, softer materials were commonly associated with emotional safety, but in some cases were also perceived as fragile or lacking strength.

These findings suggest that the tactile perception of safety of materials are not only determined by material properties, but instead as a combination of tactile cues, application context, and individual interpretation. The test provides insight into how texture and touch can support perceived safety in material-driven design. This understanding may help CMF designers when creating CMF languages that aim to give users a perceptually safe feeling.



4. Safety Themes

In this chapter user the perceptual safety framework will be introduced, consisting out of four safety themes. Next to this, desired material cues per safety theme will be proposed.

- 4.1 Perceptual Safety Framework
- 4.2 Safety Themes Explained
- 4.3 Protection
- 4.4 Control
- 4.5 Awareness
- 4.6 Peace of Mind
- 4.7 Material Cues

4.1 Perceptual Safety Framework

Safety themes

Rather than treating safety as a singular objective, the analysis shows that, perceptual safety can be achieved through a multitude of approaches. The combination of emotional, functional and cultural interpretation of material cues must be considered when designing for perceptual safety. In order to help designers design for perceptual safety a perceptual safety framework has been created consisting out of four safety themes. Each of these safety themes is an approach to perceptual safety with their own form language, materiality, colours and application context. The safety themes identified are: Protection, Control, Awareness, and Peace of Mind. Each of the safety themes works on its own as a guide for creating perceptually safe designs, but including more elements of different safety themes will make the overall feeling of perceived safety stronger and/or more relatable to a larger user group. As all people interpret material cues differently and therefore have a different expectation of what safe design should look like, each of the safety themes is meant to appeal to all users, however some safety themes may resonate stronger with a user than others.

Framework explained

The four safety themes live in a framework consisting out of two axis, and each quadrant is filled by a safety theme.

The **functional-emotional** axis points to how safety is experienced.

Functionally: safety is interpreted cognitively, based on performance, strength or grip. Emotionally: Safety is experienced affectively, supported by comfort, reassurance or reduced stress.

The **passive-active** axis references to the user's influence on their own feeling of safety. Here, active means the user actively recognises use cues through materiality. On the opposite, passive refers to the user subconsciously registering the function of materials and assigning a feeling of safety.

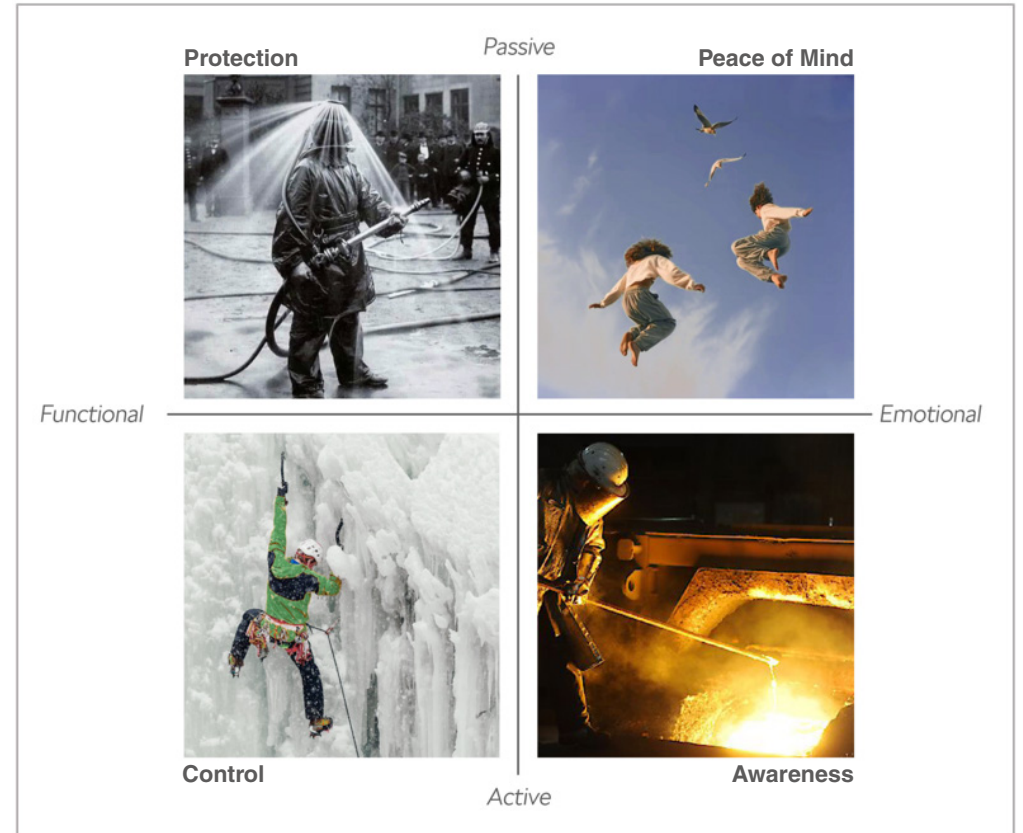


Figure 24. Perceptual Safety Framework

4.2 Safety Themes Explained



Protection

A crucial component of perceived safety is protection, which is the user's perception of being physically or mentally protected.

In material terms, this feeling is often represented through solidity, bulk, and resistance, such as thick sections, tough materials, or surfaces that imply durability and impact absorption. High structural integrity materials or materials with obvious protective qualities (eg. rubberized coatings, dense polymers, layered constructions) communicate protection and shelter, enabling users to automatically connect the object with a sense of safety.



Control

The feeling of safety is directly influenced by control, which is the user's experience of being able to manipulate interactions with an object or environment.

Materials play an important role by producing tactile feedback, such as textured grips, reactive surfaces, or materials that prevent unwanted movement. CMF design can, through these material cues, minimise ambiguity and therefore creating sense of control over the situation. Which in turn creates a sense of perceived safety when it clearly indicates how an object should be held or handled.

4.2 Safety Themes



Awareness

Awareness refers to the user's ability to perceive relevant information and/or changes in their environment, which helps to create a feeling of preparedness which, in term, contributes to a sense of safety. Through CMF design, awareness can be enhanced by contrast, visibility, transparency, and sensory cues. For example reflective finishes, colour differentiation or texture differentiation. These kind of CMF choices enhance awareness by making boundaries or critical areas perceptible, thus contributing to a sense of safety.



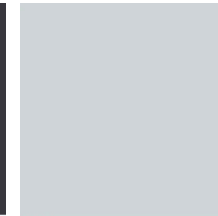
Peace of Mind

Peace of mind is created when all of the other safety themes are in place and the users does not have to actively think about safety, manifesting as calmness, trust and reduced cognitive load. Material wise this can be expressed through softness, warmth, and visual coherence, such as matte finishes, mute colours, and materials associated with comfort. By minimising visual noise and harsh sensory stimuli, materiality can create emotional reassurance, allowing users to subconsciously feel safe.

4.3.1 Moodboard - Protection



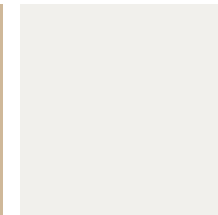
PANTONE®
19-3916 TCX
Charcoal Art



PANTONE®
12-4102 TSX
Grout



PANTONE®
15-1218 TCX
Semolina



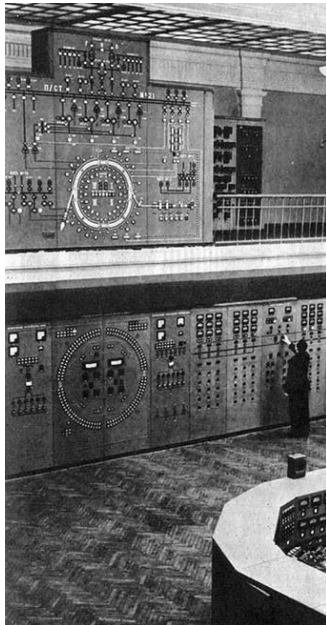
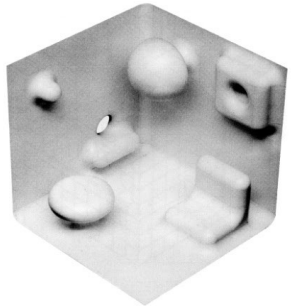
PANTONE®
11-0602 TCX
Snow White



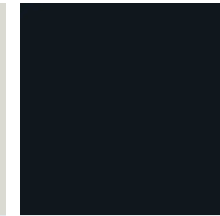
PANTONE®
19-4029 TCX
Navy Peony

Protection
care/shielding

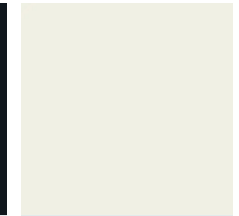
4.4.1 Moodboard - Control



PANTONE®
Cool Gray 1 CP



PANTONE®
Black 6 C



PANTONE®
11-4302 TCX
Cannoli Cream



PANTONE®
13-0651 TCX
Evening Primrose



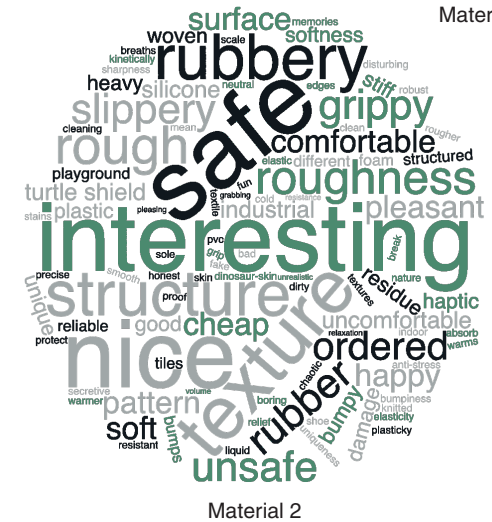
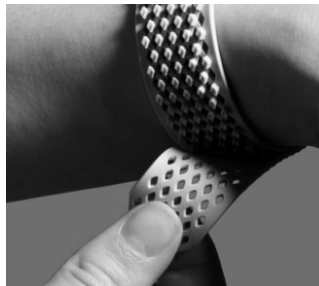
PANTONE®
17-1562 TCX
Mandarin Red



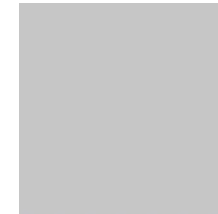
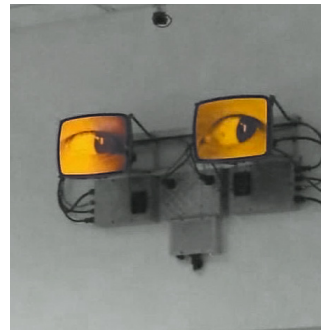
PANTONE®
P 138-5 C

Control
clarity/adjustability

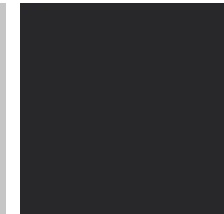
4.4.2 Product inspiration board - Control



4.5.1 Moodboard - Awareness



PANTONE®
14-4102 TCX
Glacier Gray



PANTONE®
19-3911 TCX
Black Beauty



PANTONE®
16-4803 TCX
Debonair Gray



PANTONE®
14-0957 TCX
Spectra Yellow



PANTONE®
15-1157 TCX
Flame Orange

Awareness
visibility/empowering

4.6.1 Moodboard - Peace of Mind



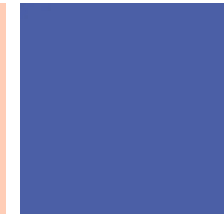
PANTONE®
12-0705 TCX
Sea Pearl



PANTONE®
14-4103 TCX
Gray Violet



PANTONE®
12-1121 TCX
Peach Mousse



PANTONE®
18-3945 TCX
Amparo Blue



PANTONE®
17-1424 TCX
Brick Dust

Peace of Mind
comfort/worry-free

4.7 Material Cues

In CMF design material cues are crucial because they translate abstract intentions (eg. safety, trust, or comfort) into perceptible qualities through colour, material and finish. Users form rapid judgments about a product's character based on sensory cues, often before any functional interaction (Norman, 2004). CMF elements therefore act as a semantic language that shapes user expectations by signaling durability, usability or reassurance through material expression.

By Defining and applying material cues, designers reduce ambiguity, enabling users to intuitively recognise a product as 'safe' while reinforcing coherence across a product family or complex product like an automotive interior.

Five desired material cues were derived from material texture testing and literature review for each safety theme and will be used from here on out to create custom materials or form.

Protection

Material cues for protection safety theme.

- **Reinforced**
- **Structured**
- **Hard**
- **Smooth**
- **Dense**

These material cues visually and tactilely communicate resistance and stability. In product perception users often associate hardness and density with strength and durability, suggesting an ability to withstand impact or external threats. However they can also be interpreted as as something that would cause harm depending on application. A

structured and reinforced material language implies intentional engineering and reliability, while smoothness reduces signs of fragility or wear. Together, these qualities support an intuitive understanding of the product as a protective barrier, supporting a sense of physical safety.

Control

Material cues for control safety theme.

- **Grippy**
- **Ordered**
- **Fine grain**
- **Tactile**
- **Clarity**

Grippy and tactile materials enhance

physical feedback and reduce the risk of user error by supporting secure handling, which strengthens the users sense of being in control. Ordered structures and fine grain textures communicate precision and intentionality. Consistent textures and material distinctions provide clarity, allowing users to quickly understand points of contact and interaction.

Awareness

Material cues for awareness safety theme.

- **Depth**
- **Patterned**
- **Contrast**
- **Transparency**
- **Large-grain**

Users can identify layers and functional zones through the use of depth and contrast, making potential points of interaction easier to understand. Transparency lowers ambiguity and promotes comprehension of what is going on behind the scenes by enabling the user to see into internal structures. Patterned and large-grain materials can draw attention and guide the eye. Together these material cues enhance situational awareness by

making relevant information more legible.

Peace of mind

Material cues for peace of mind safety theme.

- **Softness**
- **Plush**
- **Padded**
- **Bumpy**
- **Warm**

Softness and padded surfaces visually and tactually communicate impact absorption and gentleness. Plush fabrics produce feelings of comfort and warmth. While warm material qualities contribute to a sense of human-centeredness. Subtle bumpy texture can provide calming tactile feedback that can reduce stress. These material cues create emotional reassurance for the user and allows them to get into a relaxed state of mind.

5. Design

In this chapter user the perceptual safety framework will be introduced, consisting out of four safety themes. Next to this, desired material cues per safety theme will be proposed.

5.1 Material Creation

5.2 Safety Sculpture

5.3 Physical Material samples

5.1 Material Creation

In order to translate the four safety themes into tangible design outcomes, one dominant material group was selected for each theme. This decision was made to create clarity and focus within the design process. Rather than combining multiple unrelated material expressions per theme, each safety category has its own material cues (explained previously) that will now be applied on one material category that most clearly communicates its core intention. By doing so, the relationship between abstract safety values and physical material expression becomes more legible, both conceptually and experientially.

Protection - Embossing

For the Protection theme, embossing was chosen as the primary material strategy. Embossed surfaces create physical depth and relief within a material, visually and tactually reinforcing the idea of structural integrity. The raised geometries suggest reinforcement, layering, and engineered robustness—qualities commonly associated with impact resistance and durability. Embossing also allows the base material to remain structurally coherent while visually communicating strength through pattern density and controlled repetition. The shadows created by the relief enhance the perception of thickness and solidity without adding unnecessary bulk. In this way, embossing embodies protection not only as a physical barrier but also as a perceptible signal of engineered resilience.

Control - Hard plastics & rubbers

For Control, hard plastics and rubbers were selected as the dominant material group. Control is closely linked to grip, feedback, and precision, all of which are effectively communicated through firmer materials with defined tactile properties. Hard plastics provide structural clarity and communicate technical reliability, while rubberized surfaces enhance friction and prevent slippage. Together, these materials support secure handling and intentional interaction. Their fine textures and ordered surface treatments reduce ambiguity, clearly indicating where and how an object should be touched or manipulated. The inherent firmness of these materials also reinforces the idea of responsiveness and mechanical competence, strengthening the user's sense of agency and control.

Peace of Mind - Wovens

The Peace of Mind theme is expressed through woven materials. Wovens introduce softness, warmth, and a sense of domestic familiarity that contrasts with more technical interior components. The interlaced structure of textiles visually communicates flexibility and adaptability, while their tactile qualities reduce sensory harshness. Compared to hard polymers or highly structured surfaces, woven materials absorb light, soften edges, and create a calmer visual field. Their association with upholstery, clothing, and home environments supports emotional reassurance

and comfort. By choosing wovens, the design intentionally shifts toward human-centered tactility, emphasizing emotional safety over mechanical performance.

Awareness - Graphics

For Awareness, a graphic material approach was selected. Awareness relies on visibility, contrast, and the communication of information. A graphic style, through printed patterns, contrast lines, transparency effects, or layered visual elements draws attention and guides perception. Unlike the other themes, which rely heavily on tactile qualities, Awareness benefits from visual immediacy. Graphic interventions can highlight functional zones, indicate boundaries, or suggest internal structures. By incorporating contrast and/or scale variation, the graphic language enhances legibility and situational preparedness. This approach ensures that critical areas are perceptible without requiring conscious effort, supporting safety through clarity and visual guidance.

By assigning one material group to each safety theme, the project establishes a clear and structured translation from conceptual framework to physical expression. Embossing communicates reinforced protection, hard plastics and rubbers enable controlled interaction, wovens create emotional reassurance, and graphic treatments enhance perceptual awareness.

Digital Material Creation

To explore and create a lot of material iterations Adobe Substance Designer was used. This is a program that allows the user to digitally build up any material. Explorations for each theme have been made, keeping in mind the respective material cues and material group. Then a selection of preferred materials per theme was made. See Appendix F for all alternatives

By creating digital materials first it is possible to rapidly iterate the material, before going to production. This saves time and raw materials, being more sustainable than creating material proposals physically and then iterating.

In figure 25 can be seen how one single material might be constructed digitally. All large blue boxes represent different qualities of the material. Within the blue boxes, red boxes (nodes) can be found. These are mathematical inputs or conversions and by connecting different nodes with each other and altering the values material qualities can be changed or influenced.

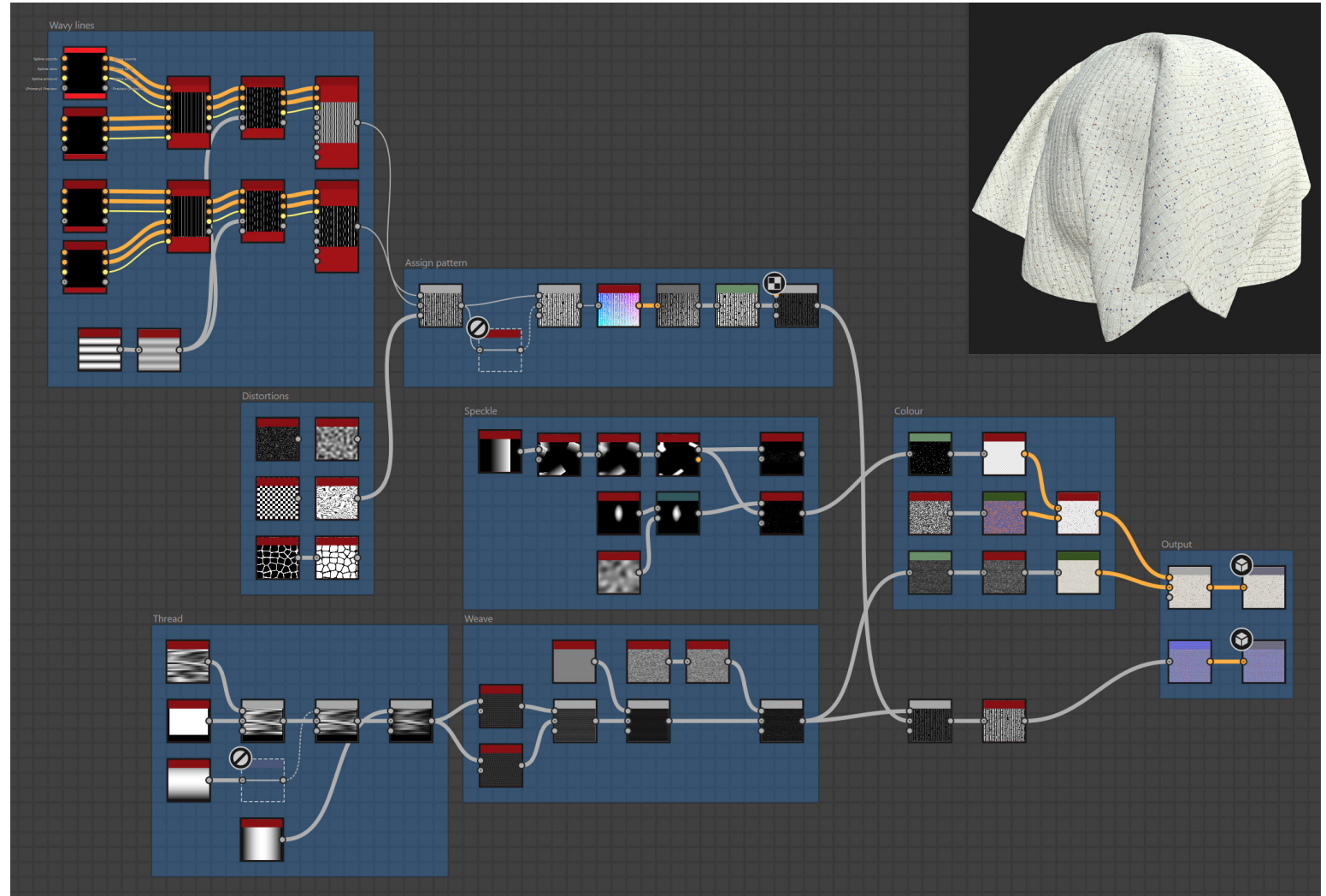
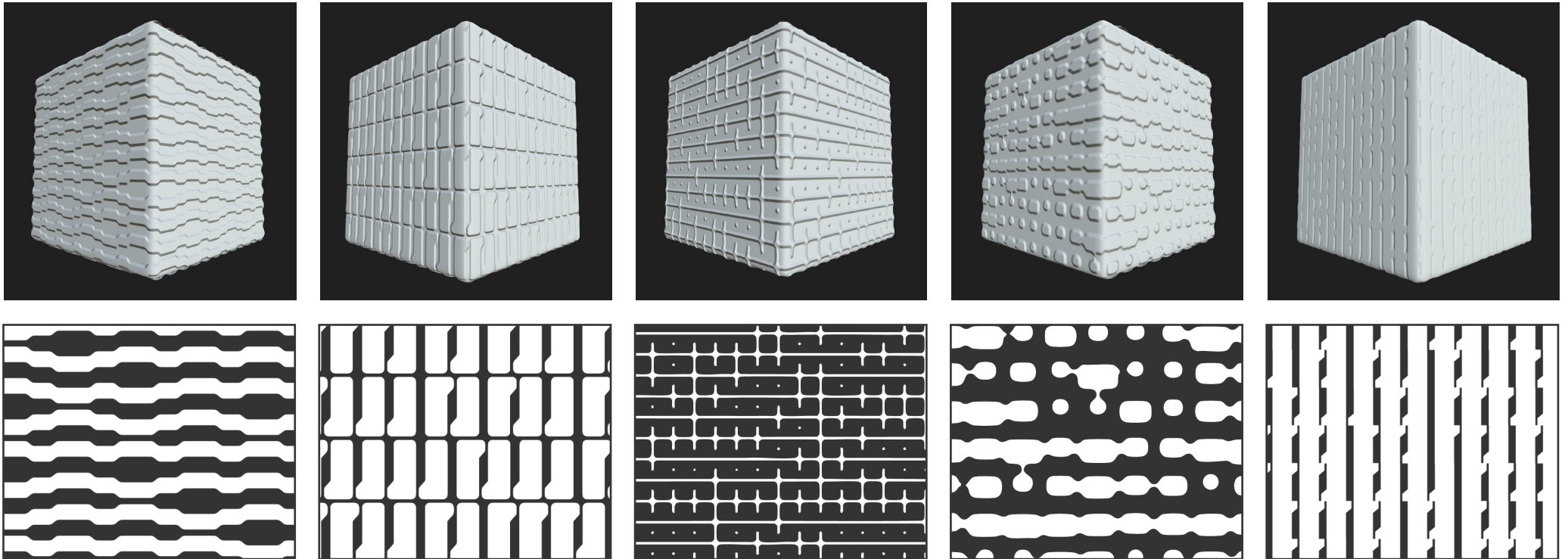


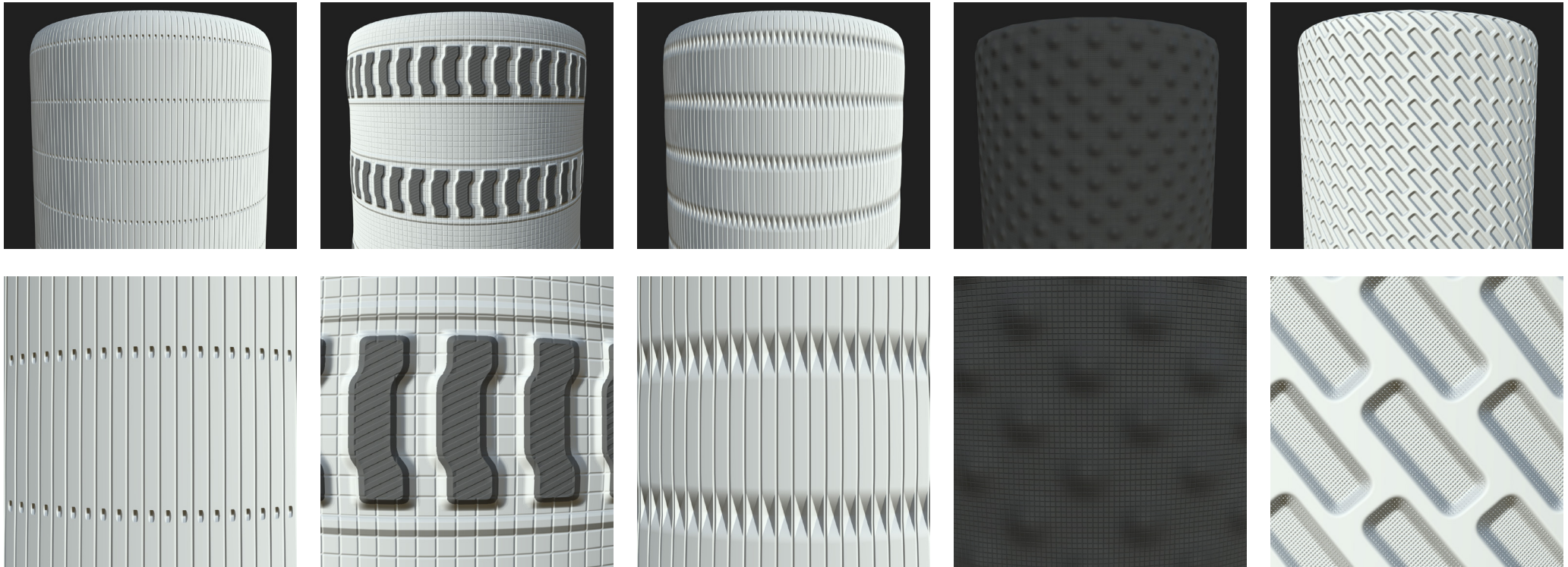
Figure 25. Adobe Substance Designer Sheet

■ Protection - Embossings



All of the embossing patterns should feel reinforced and structured. This feeling is created through the use of larger solid shapes and connecting horizontal or vertical lines. The patterns also have a certain ruggedness to them, this was done in order to keep the inline with the rugged/durable Skoda identity. Embossing can be applied on foam-backed wovens or on sheet metal parts. In the patterns seen above the black sections will be debossed, leaving the white part as a 3D structure.

Control - Hard Plastics & Rubbers



All of the Control materials should feel grippy, ordered and should be understandable. The patterns therefore consist out of relatively simple geometric shapes. Next to that, all the materials have a macro and a micro structure. Meaning that there is grippiness to be found on two different levels. All of the parts in white will be hard plastic, while the grey areas will be a rubber-like material (eg. TPU). This is done to give some of the materials even more grip for specific use cases.

Peace of Mind - Wovens



The wovens in the Peace of Mind theme should feel warm, familiar and appear soft. This has been implemented through some organic waviness and randomness in the patterns. All of the materials incorporated small height differences (bumpiness) that should make it feel pleasant to the touch. Different colour speckles were also implemented to make the materials more joyful, whilst at the same being placed in a warm neutral tone that keeps the overall material calm.

■ Awareness - Graphics



The graphics created for the awareness theme should indicate to the user where specific safety components are located in the car. This can be done through text, icons or patterns. All graphics are based on an icon of a heart. A heart shape was chosen as its shape is often associated with emotional safety and care. It also lets the user know that the material where the graphic is placed has a purpose. The heart shape is slightly abstracted in order to make it feel more technical and less love-related. The heart shape can be used to create various other icons or can be used as an arrow to point to important features. Furthermore, it can be used in a pattern to indicate surfaces with a safety-related function.

5.2 Safety Sculpture

In order to display the created materials in their intended application a 'safety sculpture' is created. In this sculpture all the research about materials, colour and form comes together and serves as a guide to designers on how to create and apply 'safe feeling' design in their CMF or interior work. The sculpture is purposely designed to be a free floating object but incorporates various recognisable automotive elements, such as: seat, A-pillar, dashboard, armrest, HMI/Center console, control dials.

Sketch Exploration

Sketching formed a key part in finding an appropriate form for the Safety sculpture. Keeping in mind the four themes and in collaboration with Skoda CMF and interior designers selections of promising sketches where made. These sketches then serve as a reference and starting point for 3d modelling of the sculpture. Some of the key inspiration sketches can be seen in figure 26

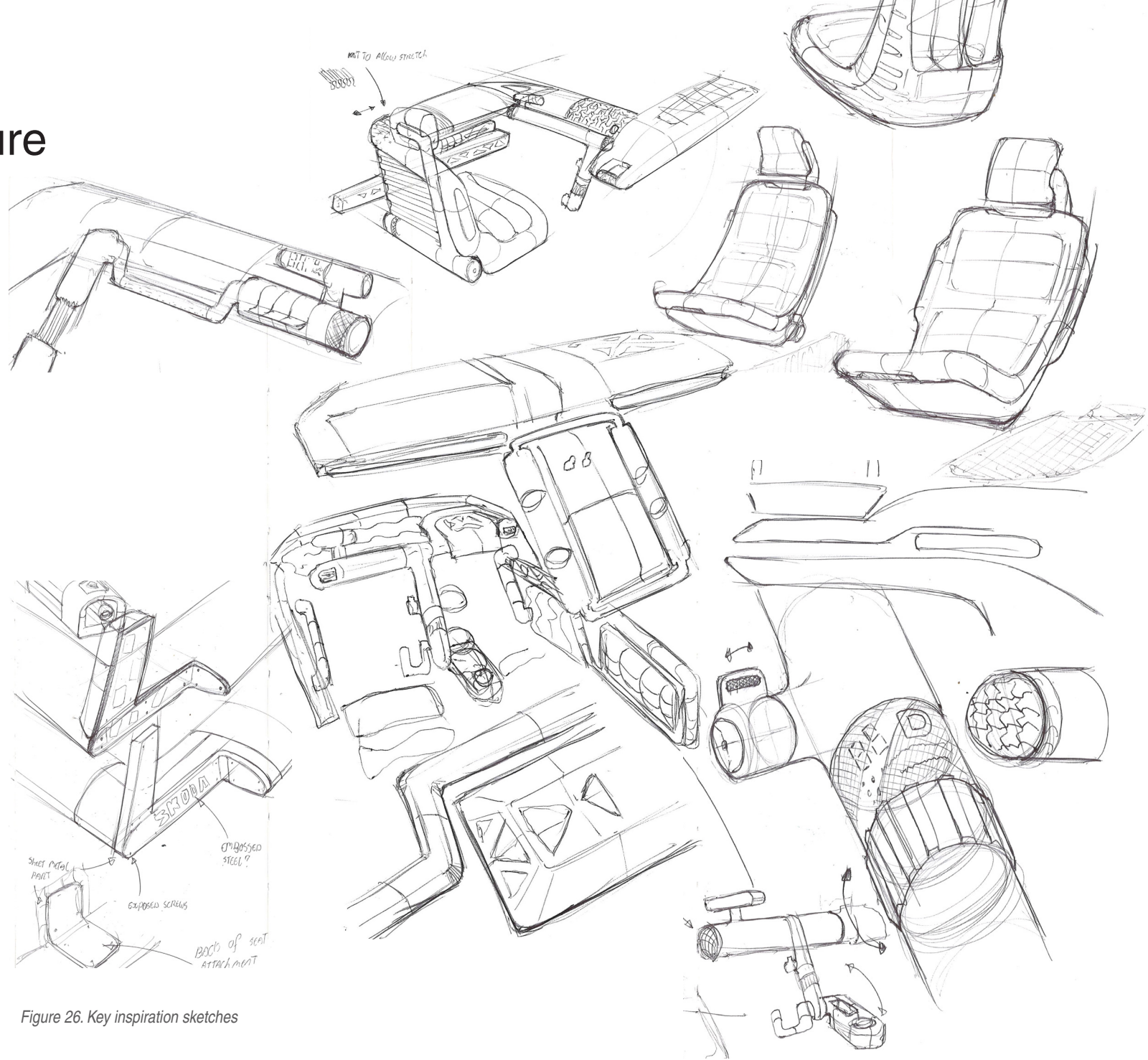


Figure 26. Key inspiration sketches

Digital Modelling

In figure 27 digital iterations of the safety sculpture can be seen. A VR modelling tool (Gravity Sketch) was used to quickly explore how the sketches could translate to a 3d form. The sculpture has undergone multiple iterations, until finally settling on the sculpture shape seen on the bottom right. This sculpture incorporates all the expressive form elements from the 1st element while also aligning with Skoda's current design language Modern Solid.

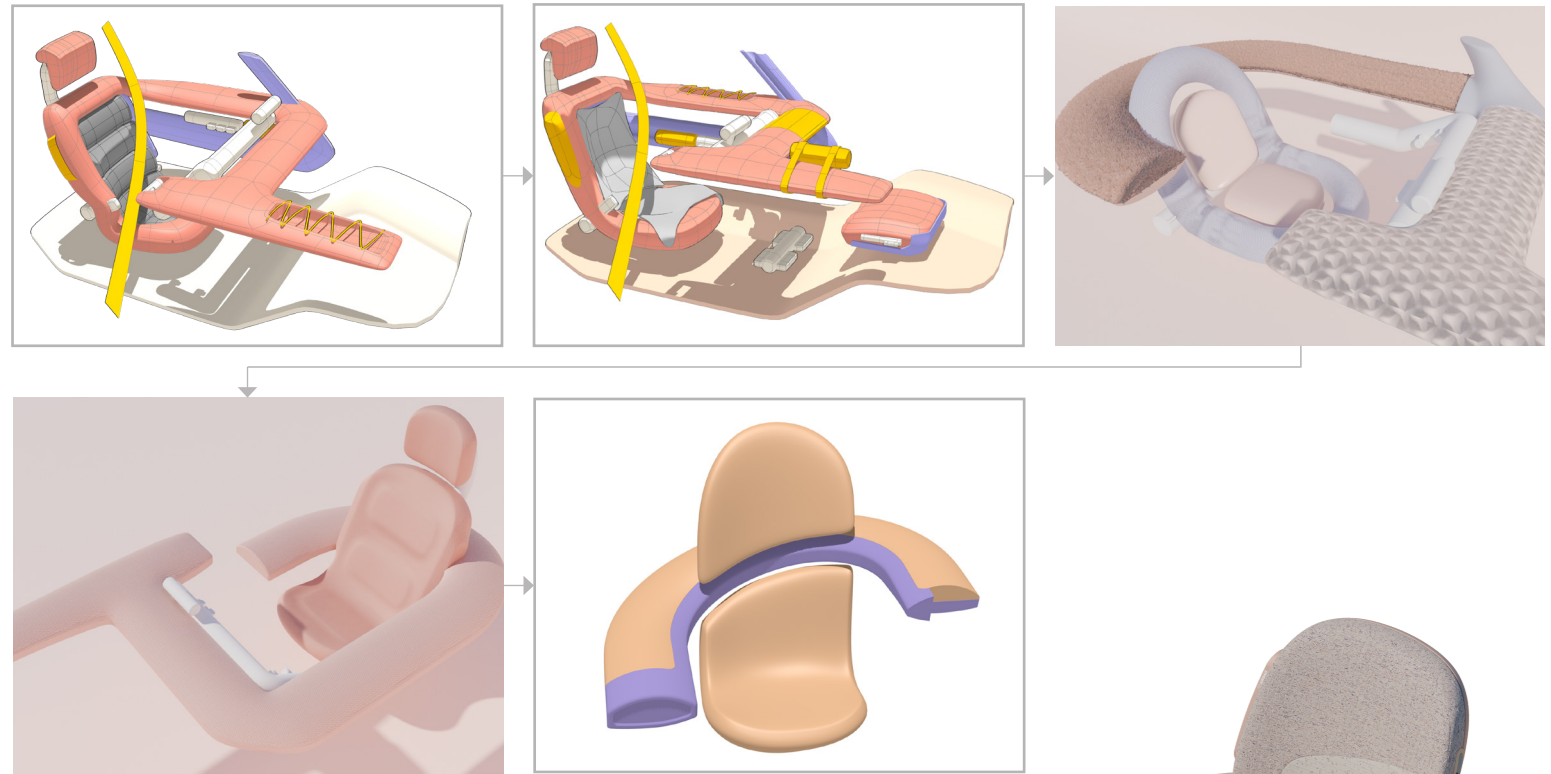


Figure 27. Digital sculpture iterations



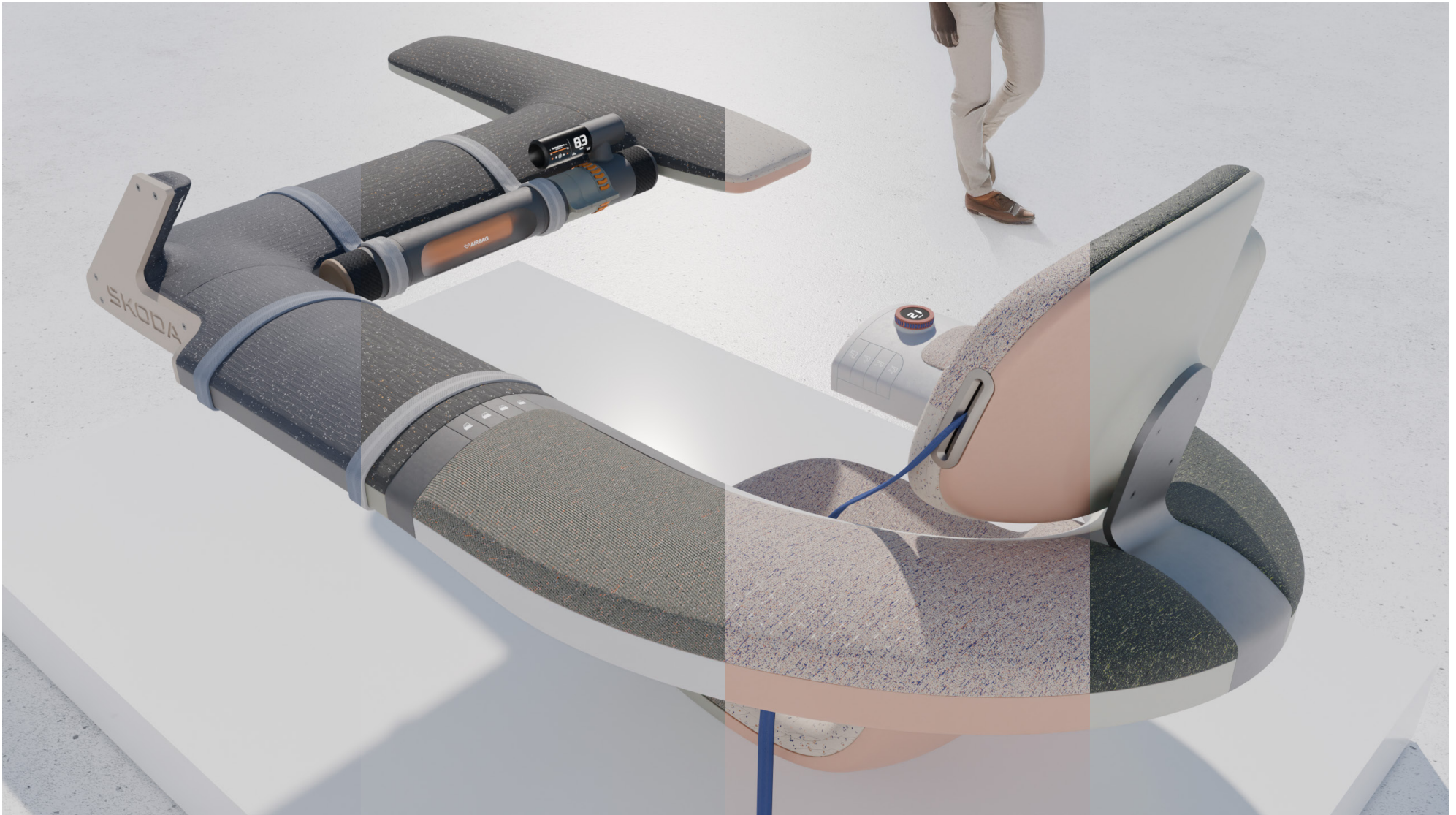


Figure 28. Final safety sculpture with 4 CMF ways

Final Safety Sculpture

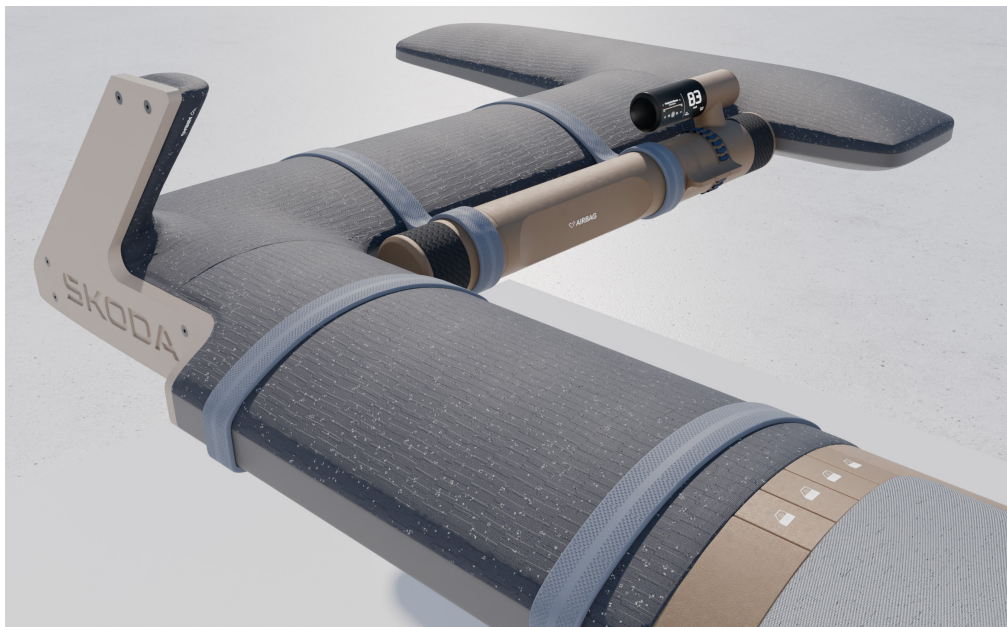
The sculpture is executed in 4 different CMF ways corresponding with the established safety themes.

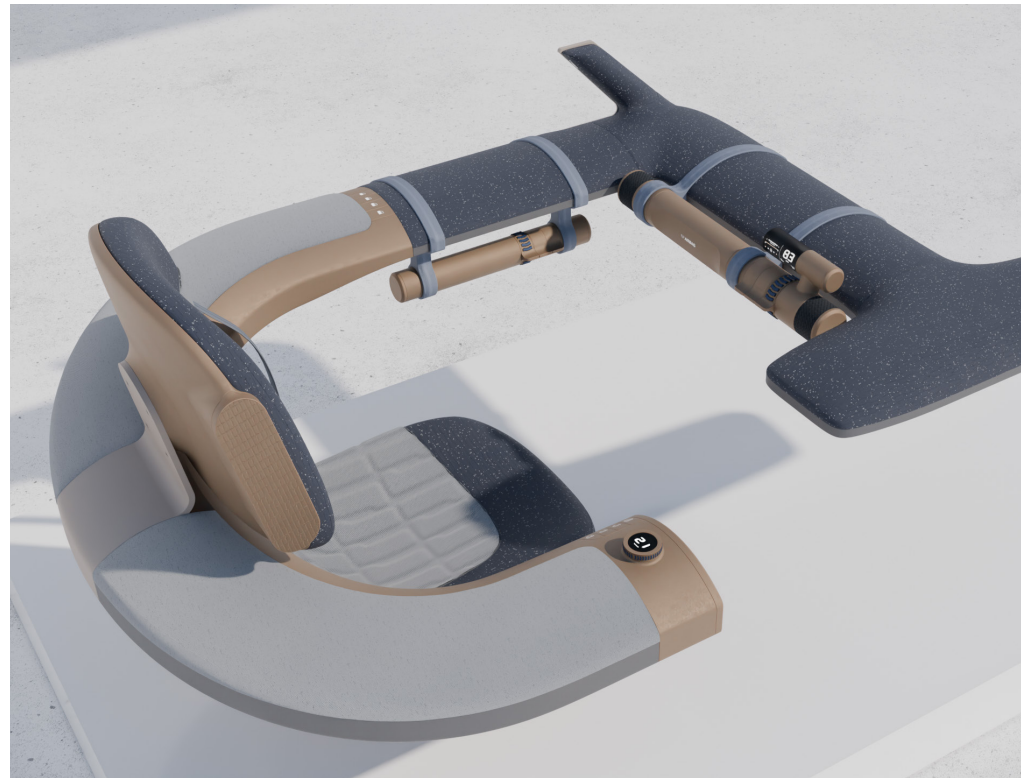
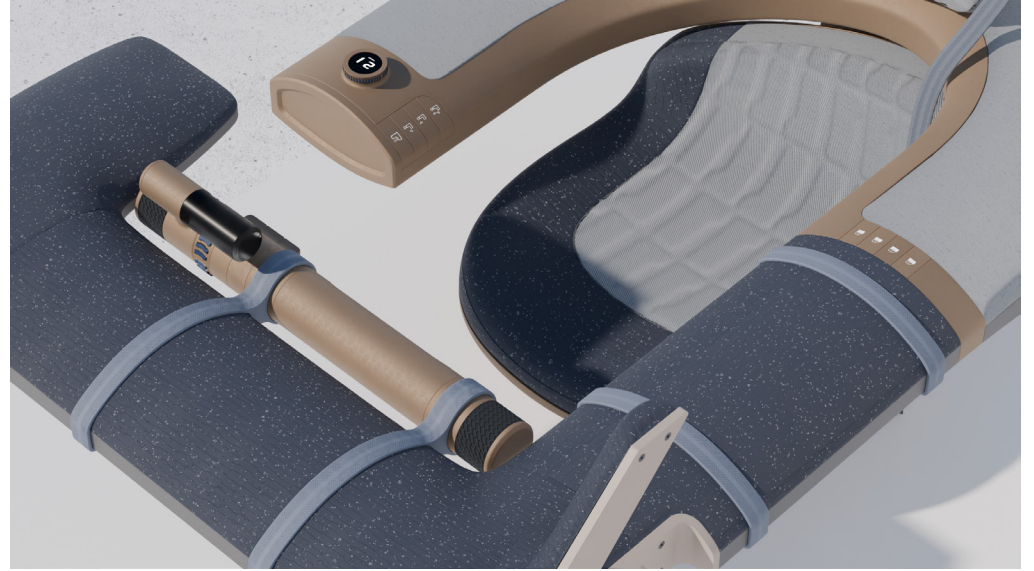
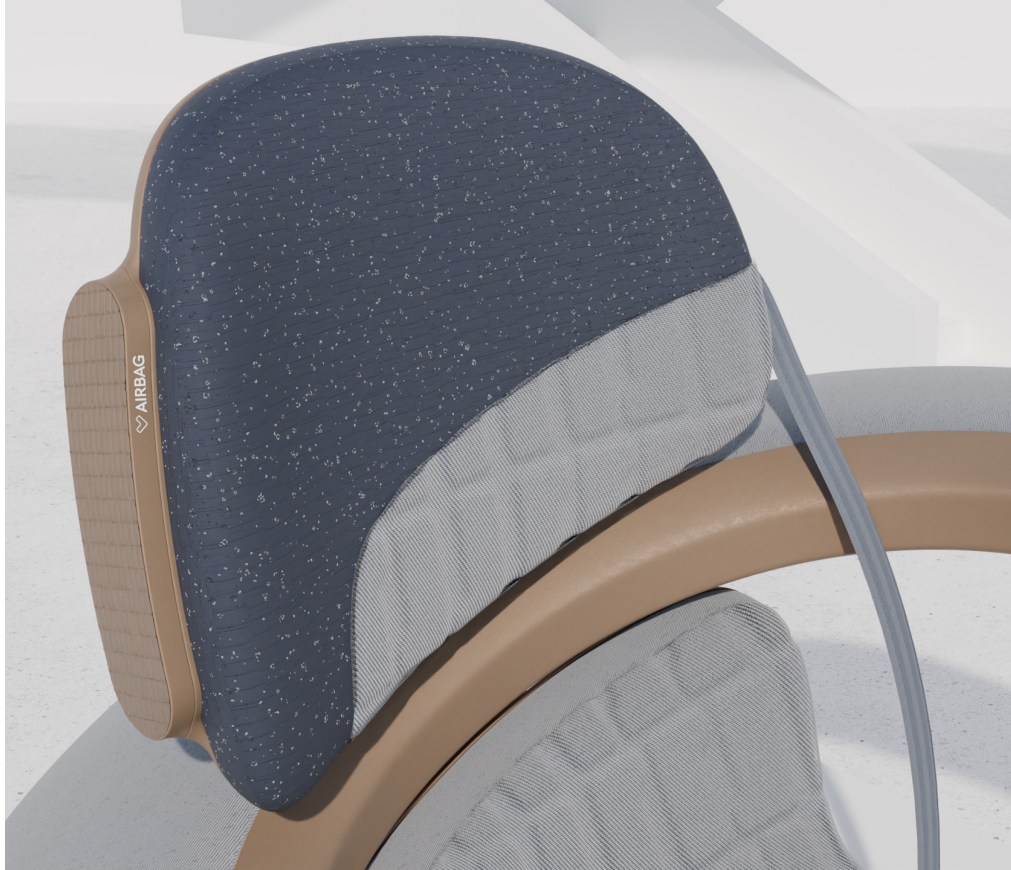
Protection CMF way

This CMF way features a more conventional dark blue and grey colour way, creating a visually strong and protective ring around the occupant. In order to not make this colourway feel to cold, all the functional plastic parts close to the user are executed in a warmer brown tone. The embossing on the seat insert has a pattern with large elements that feel padded and like they could absorb impact. The same pattern is used on the airbag cover on the side of the seat. The light grey fabric closest to the user (which is also used for the embossing) is executed in a denim weave in order to create familiarity with the user.



Figure 29. Protection digital materials





Peace of Mind CMF way

This version of the sculpture incorporates a muted but still playful colour way, fitting with the peace of mind theme. The fabrics here are light and soft to the touch with subtle bumpiness and colourful speckles. The light up graphics are unintrusive against the light grey plastic. The terracotta control rings give an extra playful touch of colour and contrasts well with the blue as a pop colour.

This CMF way does not incorporate any of the embossing patterns created for the protection theme on the seat insert, as the form language of these embossings would clash too much with the overall softer feel of this CMF way. Instead one embossing pattern is more subtly integrated into the airbag cover on the seat.

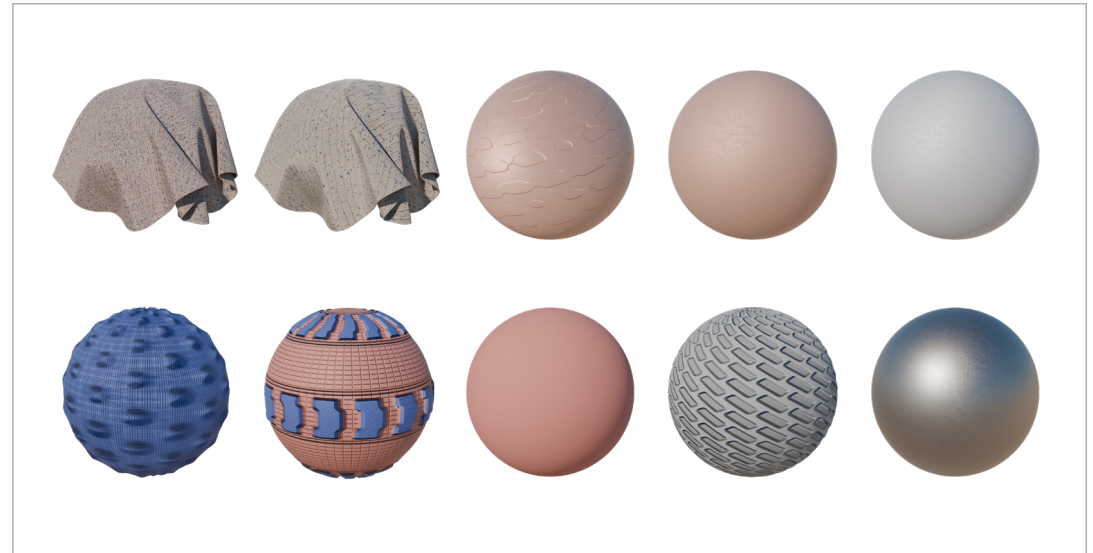
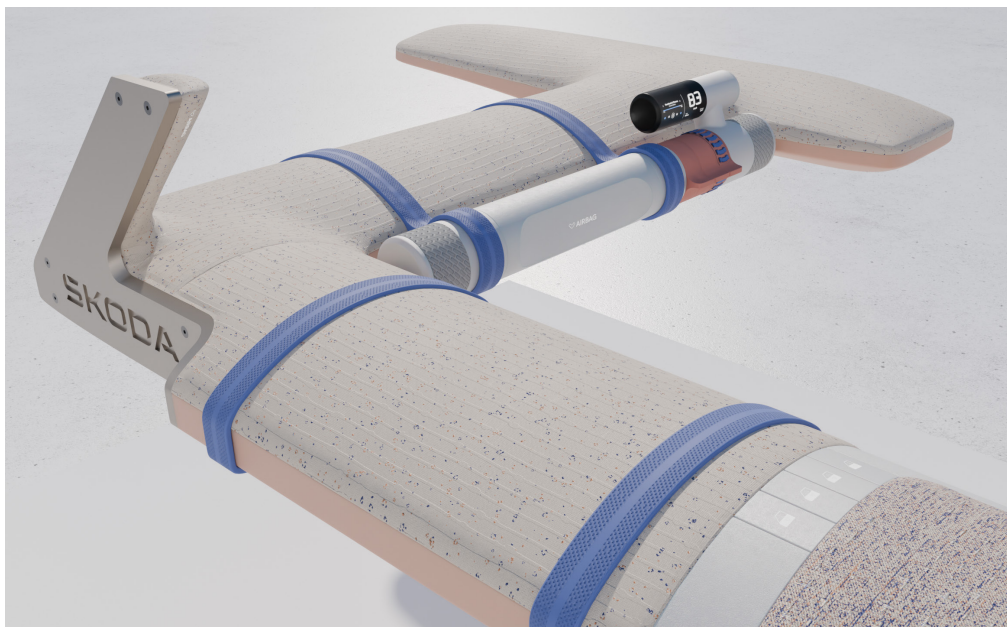
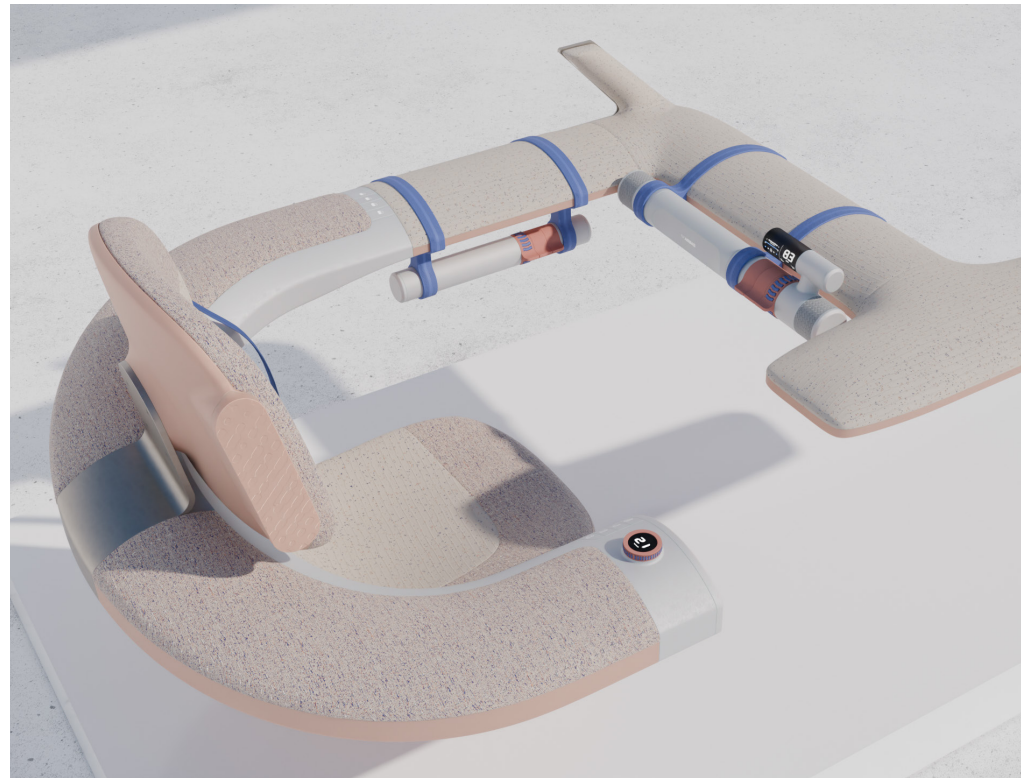
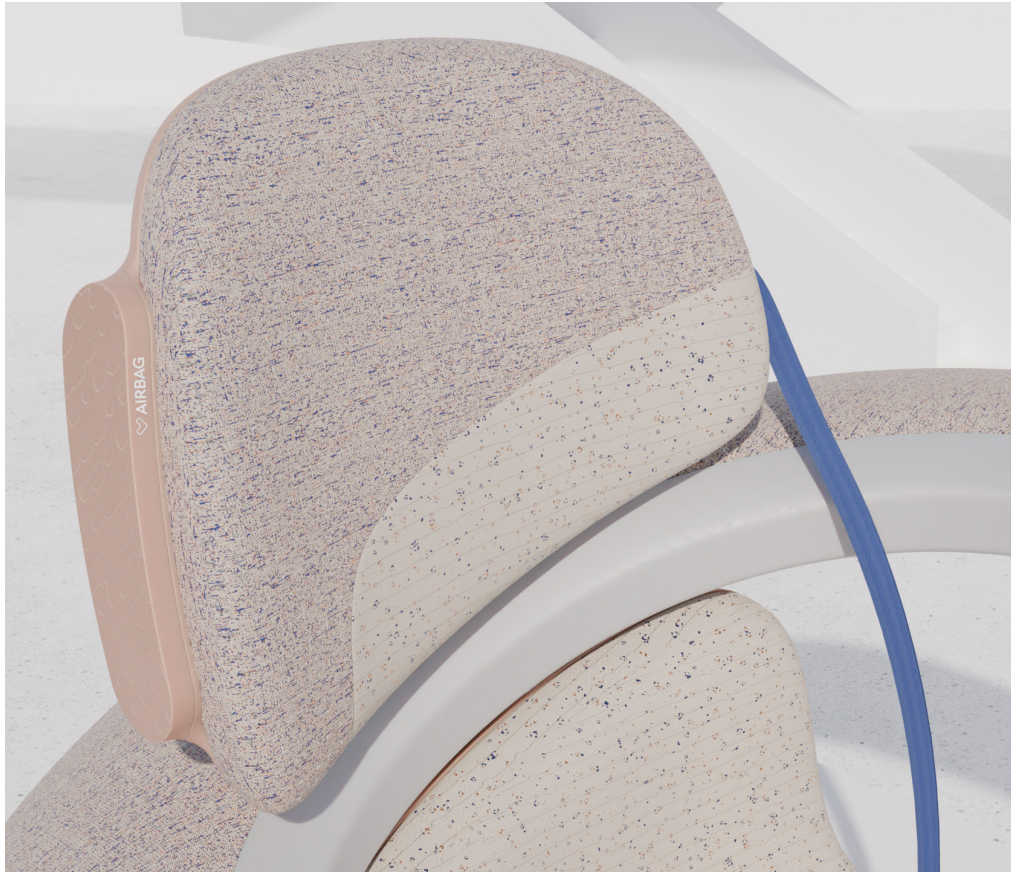


Figure 30. Peace of Mind digital materials





Control CMF way

This CMF way is mostly light coloured, with a dark green ring around the user and highlights on safety or control components. The airbag in the dashboard is executed in a bright yellow and now visible behind a frosted transparent panel. The seatbelt is executed in the same colour. The rubber elements on the control knobs are dark green contrasting against the light base colour. The red rubber straps highlight in wat areas the most important controls are and keep them in place. The fabrics in this CMF way have a rough surface finish, achieved by using a coarser weave. This rougher finish gives more grip and makes the user feel more in control. The embossing pattern chosen for the seat insert is the most delicate out of the 5 patterns, this was chosen to give the fabric a high fidelity feel.

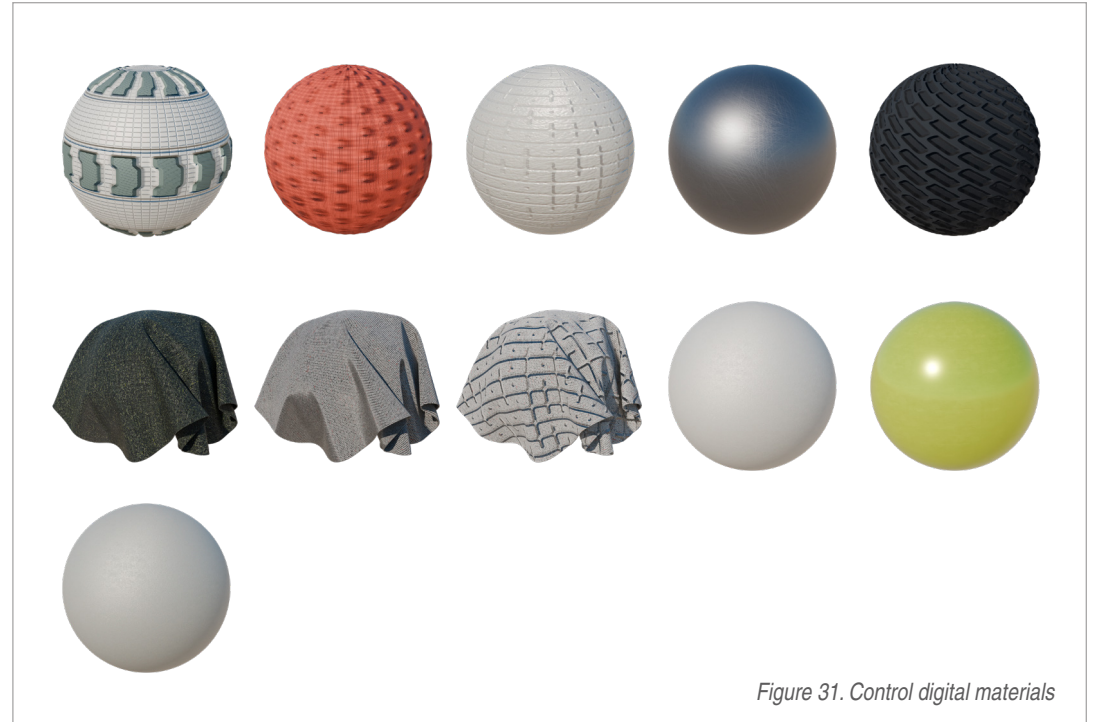
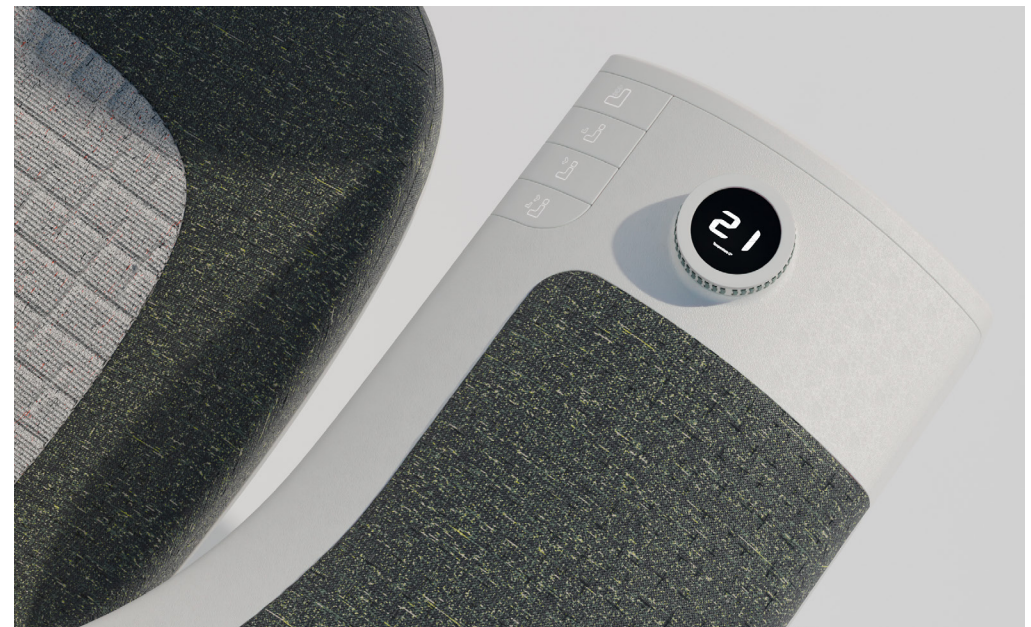
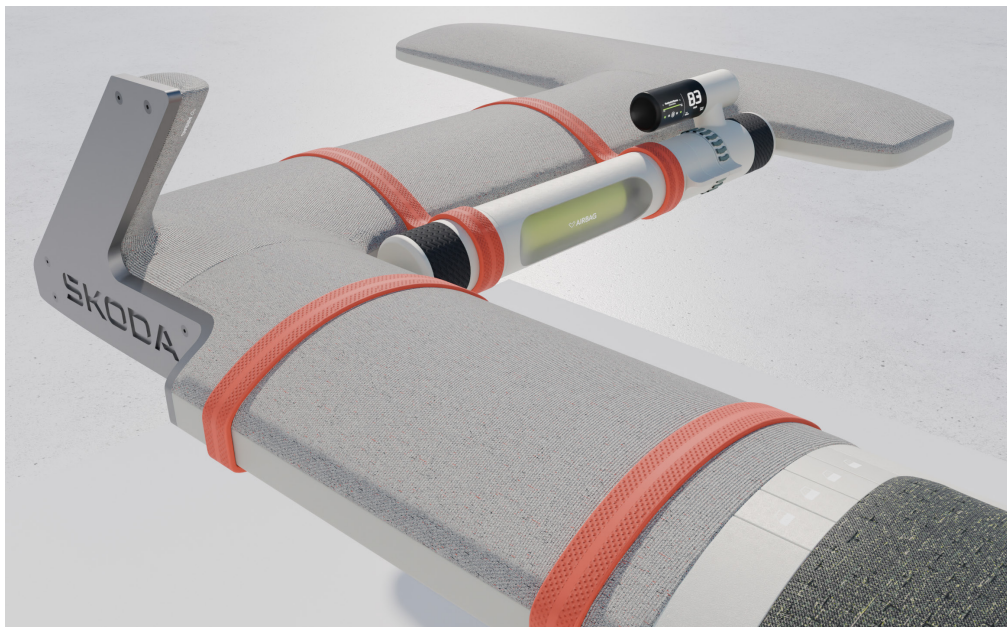
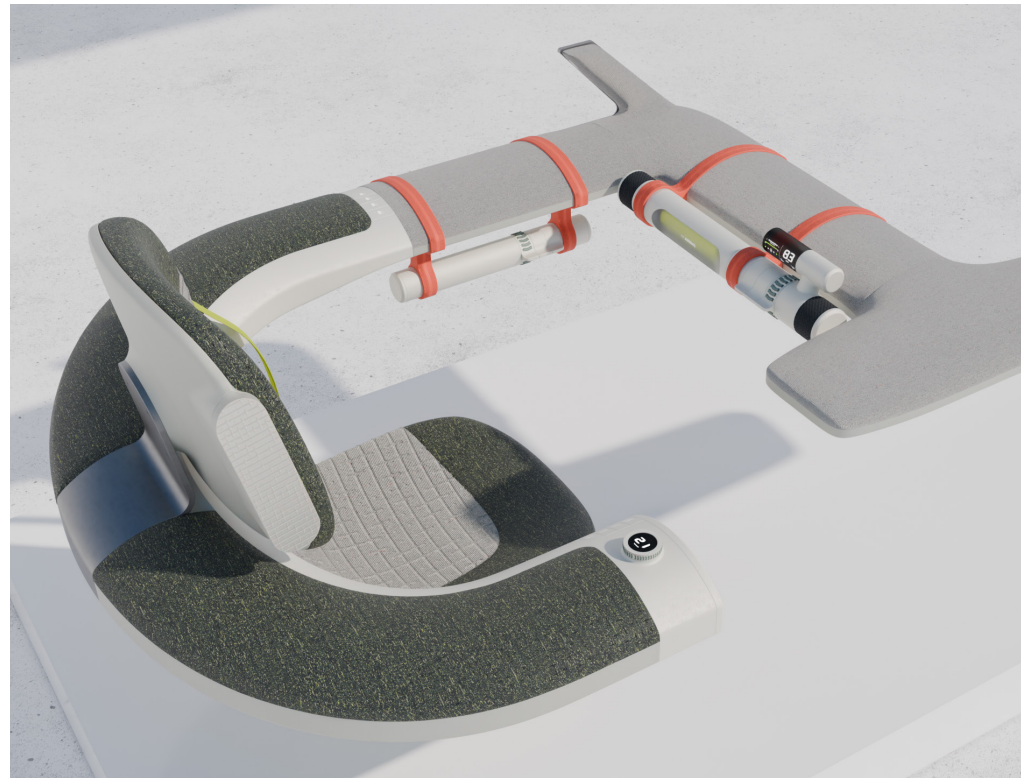
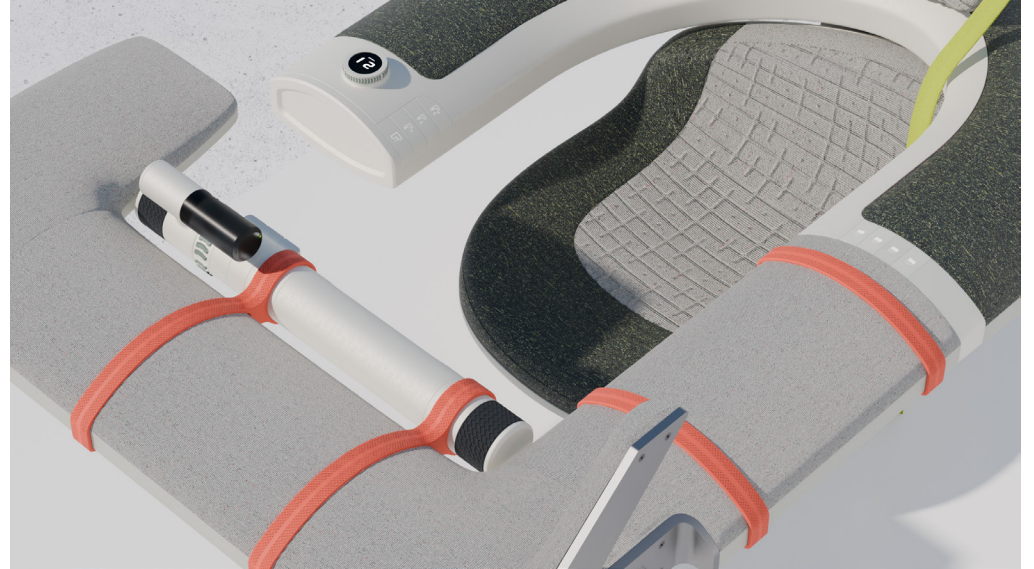
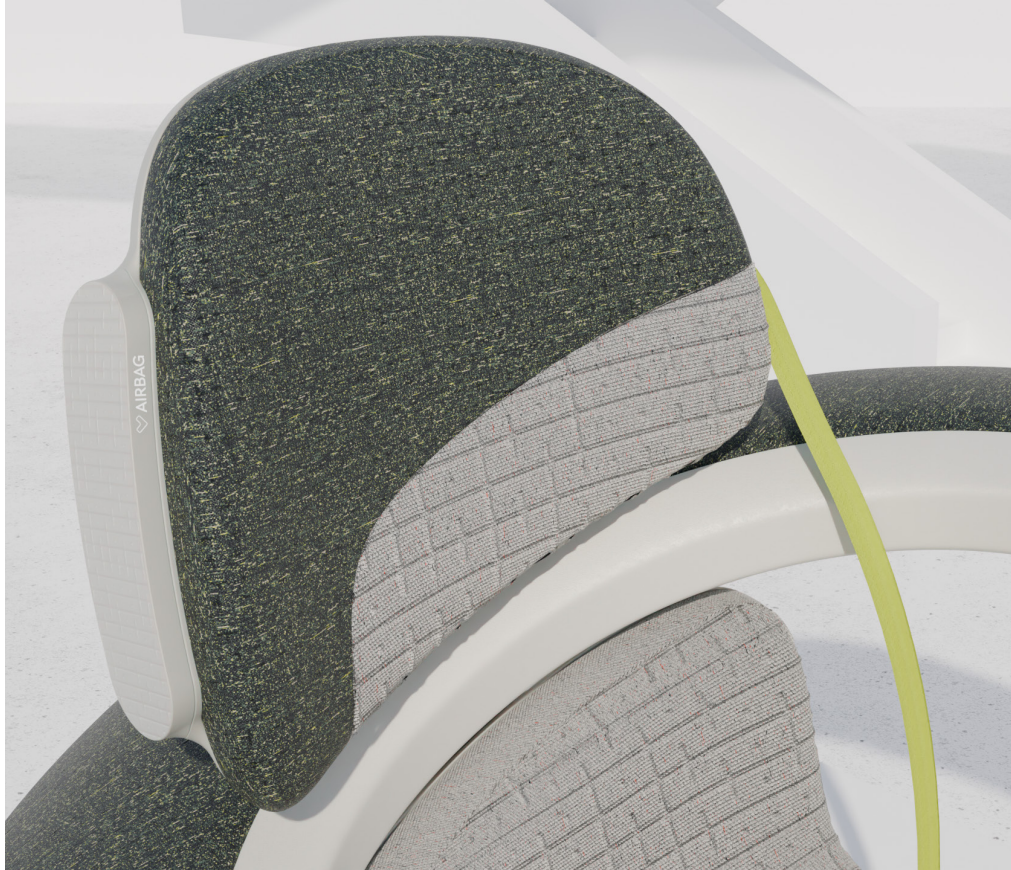


Figure 31. Control digital materials



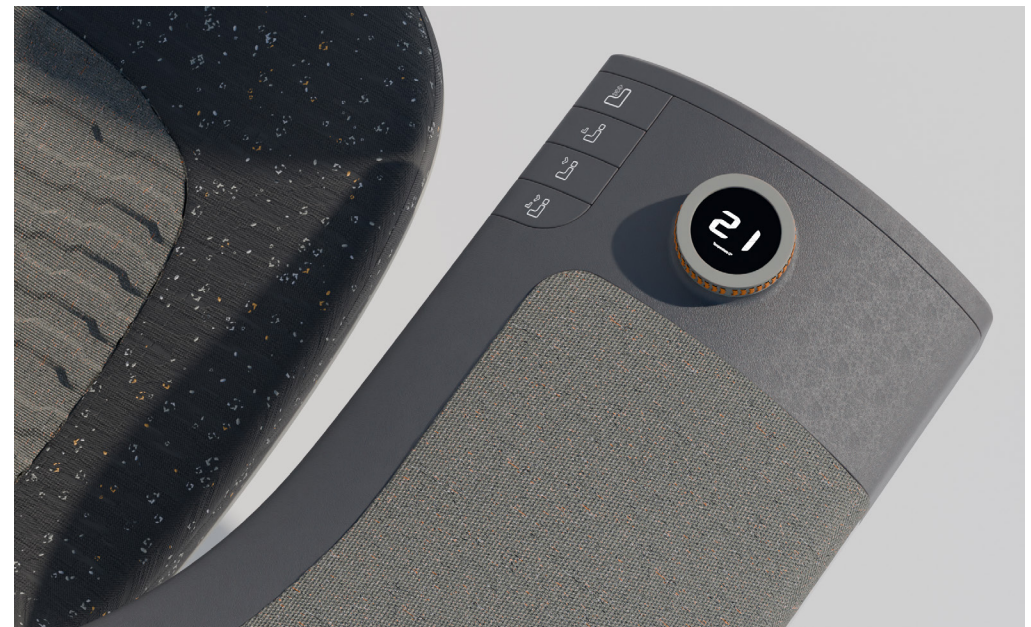
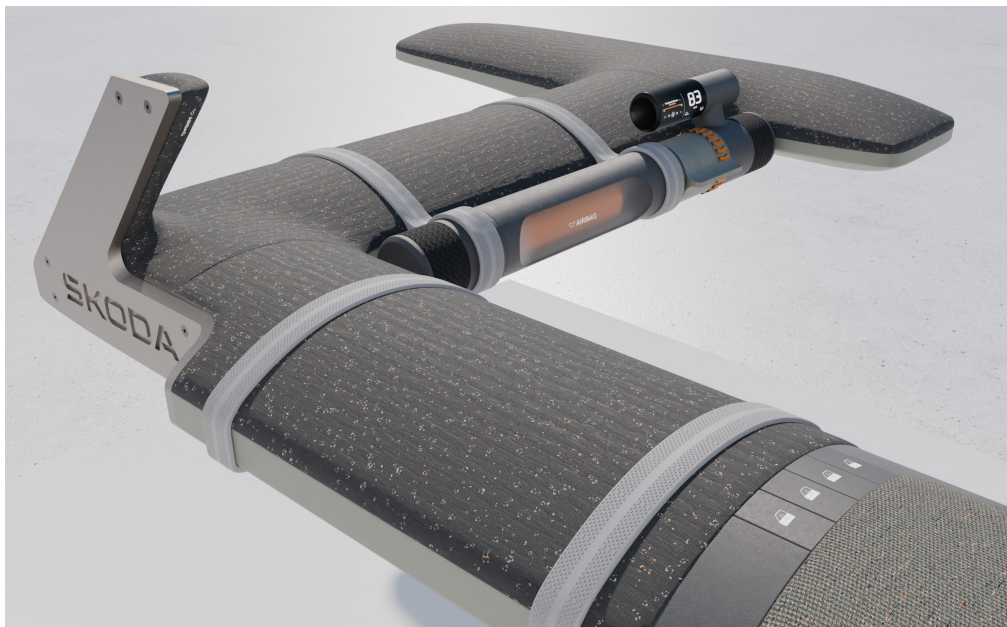


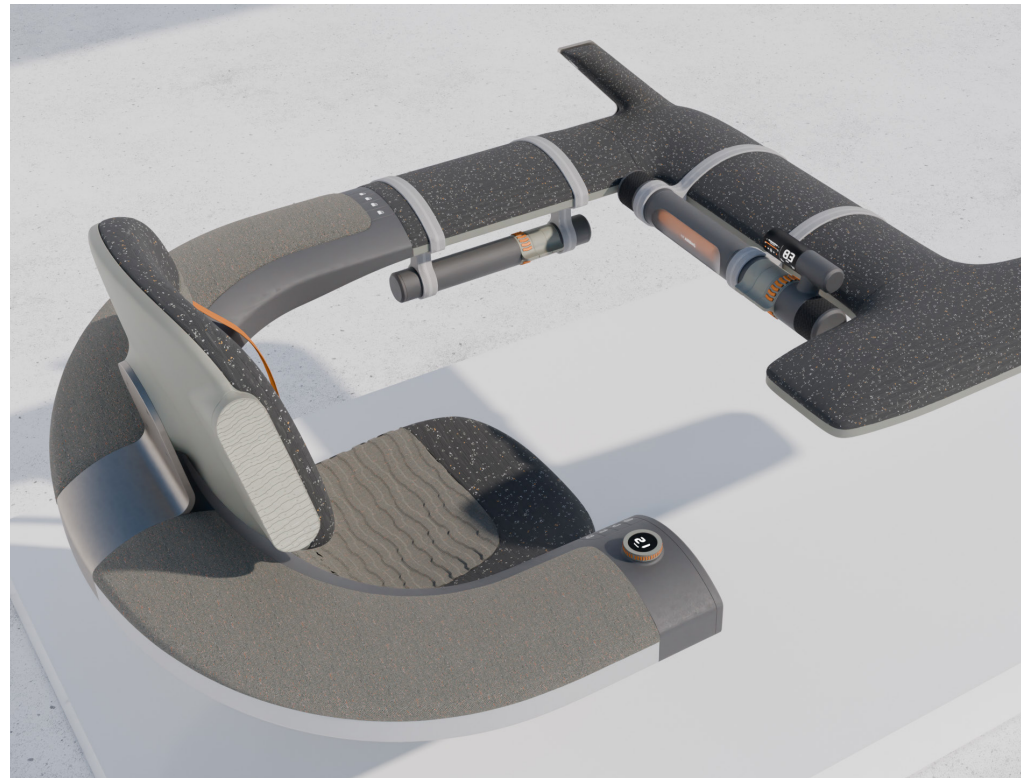
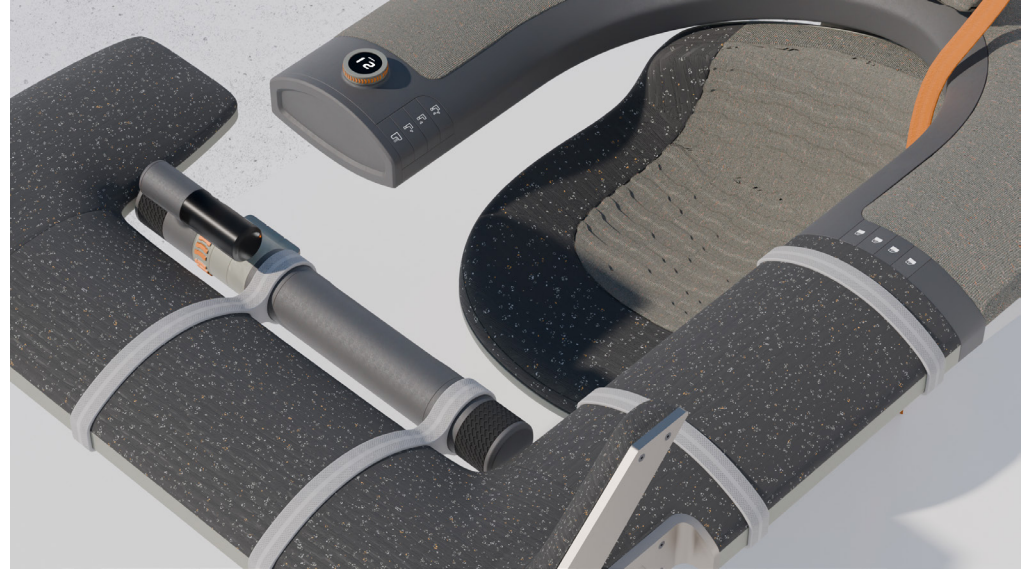
Awareness CMF way

This version has a dark bas colour in order to have the light up graphics be contrasting against the background. The seatbelt, visible airbag and rubber on the control knobs have been executed in the same distinctive orange colour for consistency. The embossing on the seat insert matches the rubber on the control knobs and also comes back on the side airbag. This consistent approach with highlight colours and patterns, makes users aware of safety elements, but importantly does not make them overwhelmed.



Figure 32. Awareness digital materials





5.3 Physical Material Samples

The Digital materials created with Adobe Substance Designer serve a solid foundation on which automotive suppliers can build to create physical materials. The output of a Substance file is just a series of repeat images, which are easily shareable and can be used in manufacturing machines without much tweaking to come to a real material.

Digital Material creation also changes the current relationship between suppliers and OEM's like Skoda. Where normally a supplier would develop a range of material samples and then the OEM would pick which sample they want to use for production. Now this relationship changes, as OEM CMF designers can create their own digital materials which then can be interpreted by a supplier to make it real. This encourages better collaboration between OEM's and suppliers and allows for materials to be custom designed to better fit the brand identity.

In collaboration with two automotive suppliers the Woven and Embossing digital materials were translated into real world material samples. The Samples created are realistic automotive materials however were limited by the colours that were in stock at the time.



Wovens

The fabric patterns and surface renderings designed for the peace of mind themes were, in collaboration with automotive supplier Kneitz, woven on a automatic loom with a variety of different yarns. By Combining different yarn material and thickness, fabrics with a wide range of qualities were created. One roll of Fabric was created by Kneitz, with about 40 different sample tiles within this roll, varying in colour, stiffness, shinyness, plushiness and roughness. See Appendix G for more colour and material variations of the woven samples.



Figure 33. Close ups of physical wovens

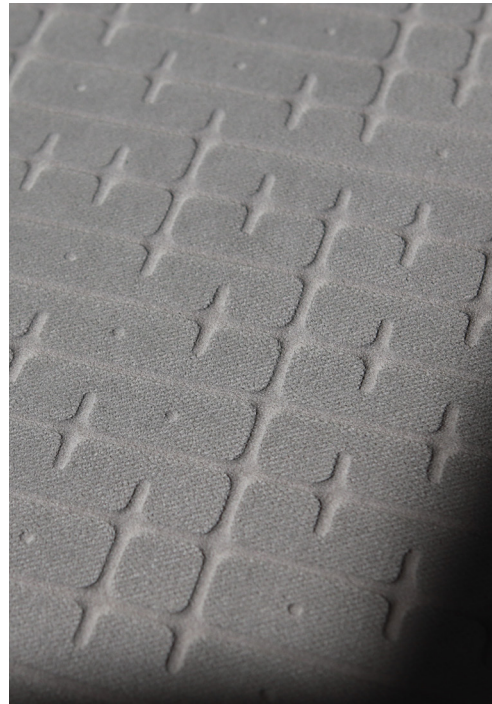
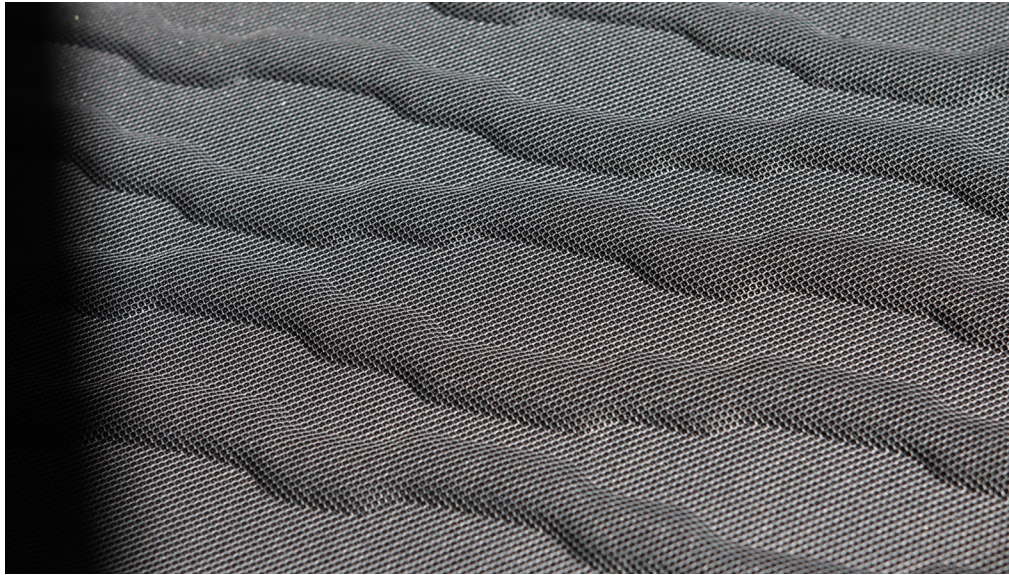


Figure 34. Close ups of physical embossings

Embossings

The protection patterns designed and explained earlier were made into a physical material sample through embossing foam backed fabrics. This was done in collaboration with Sage Automotive Interiors located in Strakonice, Czech Republic. For the embossing process a mould is needed. The mould is made by laser cutting a sheet of MDF in the desired pattern and attaching it to another sheet of MDF as a backing. 4 moulds were made each with their own embossing pattern.

By heating up the mould to anywhere between 100-200C° and pressing it top down on the foam backed fabric with a hydraulic press the pattern gets embossed in the foam. By playing with the temperature of the mould and the amount of time it gets pressed the foam melts in different amounts allowing for different surface finishes or bumpiness of the material. Next to that every fabric (that is the top layer of the material) reacts differently to the heat. With one mould and multiple fabric a lot of different results can be achieved. See Appendix G for more embossing sample images.

6. Discussion

6.1 Discussion

This project set out to improve both actual and perceptual safety through CMF design. The project ended up mainly focussing on the perceptual safety aspect as actual safety proved to be a difficult topic, and slightly outside the scope of Skoda CMF design. However perceptual safety did not prove to be much easier. There are a lot of aspects that go into creating the feeling of safety and this report is an overview of the most important aspects in accordance with CMF design. However there are still aspects unexplored, that could form a continuation of the project.

Recommendations

Evaluation

To fully close off the project an evaluation with car drivers would be valuable. This was originally the plan but due to some unforeseen circumstances and lack of time, no evaluation of the design was performed.

Ideally this would be done in virtual reality, where the digital sculpture could be used as a car interior and the 4 CMF ways could be evaluated and compared against each other. Participants would be seated in a real automotive seat and would be touching physical material samples corresponding to the VR model. The tactile feeling of the materials might not match exactly the look of the the digital materials in the sculpture, so this might be confusing to the participants. However some of the samples are definitely close enough to the digital materials to have a valid evaluation.

Pattern application

Not all of the material patterns designed for the safety themes where applied in the final CMF ways no the sculpture. It was decided against using all the patterns as the model would be become to busy and might be perceived as overwhelming. Next to that it could have been useful to make sure that the patterns relate to each other between themes. Now some of the patterns feel far of from each other in design languages, making it hard to pair them in one car interior. In the current sculpture this is mostly solved by a colour pallet tying everytingg, but there could be more attention to detail in between patterns.

Realistic colour

The car industry is quite conservative, which means some of the colour pairings in the final sculpture could be considered to 'wild' to be realistic in a production SKoda. However the sculpture also is meant to serve as an inspiration of what could be done and a push away from the boring all black&grey interiors commonly found in automotive industry.

Material Sample Testing

The touch & perceptual safety test was very valuable to me to gain insight into how different people experienced safety differently. However the participant pool of 17 people is not big enough to give a definitive answer on what materials are consistantly seen as more 'safe'.



6.2 Reflection

Research

The project started with a very open assignment, which was both a curse and a blessing. At the start I wanted to approach the project using the Vision in Product design method, as this was something that I knew could give structure to the project. However Elmer was quick to push me out of my comfort zone, doing more explorative research interacting with real samples available at Skoda design. Through this explorative research the project quickly became more clear, and by the midterms I was able to present the safety framework.

Planning

Planning proved to be my biggest enemy during the project. I would often underestimate how much time some aspects of the project would take. For example the sample touch testing cost me more than a week to get only 17 participants. Also the production of physical samples comes with deadlines weeks in advance of when the samples were needed. This sometimes lead to some stressful or long days at the office. However it was all worth it in the end as I learned a lot during the process and the physical samples look great.

Time Abroad

The whole project was executed in Mlada Boleslav Czech republic, which meant as a TU Delft student I was mostly alone. This meant I was quite independent in my work, but also made it a bit difficult to ask a quick question to a friend or to express my

ideas more clearly than in an online call. However it was a valuable experience to work abroad and getting to interact with many people from different backgrounds.

My final presentation at Skoda Design was exciting and a bit daunting, presenting on an enormous screen and having all the samples splayed out in front. I received compliments on the project and will be staying for another 3 months of internship to gain more experience in CMF design.

Academic balance

It proved to be quite difficult to balance the academic requirements of creating a scientific project/report and the more artistic requirements from the car industry. I still am not so sure if I managed this well enough, as I feel that the research phase could have gone deeper.

Overall I feel quite content with how the project turned out and will happily put it in my portfolio. I would have done the same project all over, I would have done it mostly the same keeping in mind the planning a bit better.



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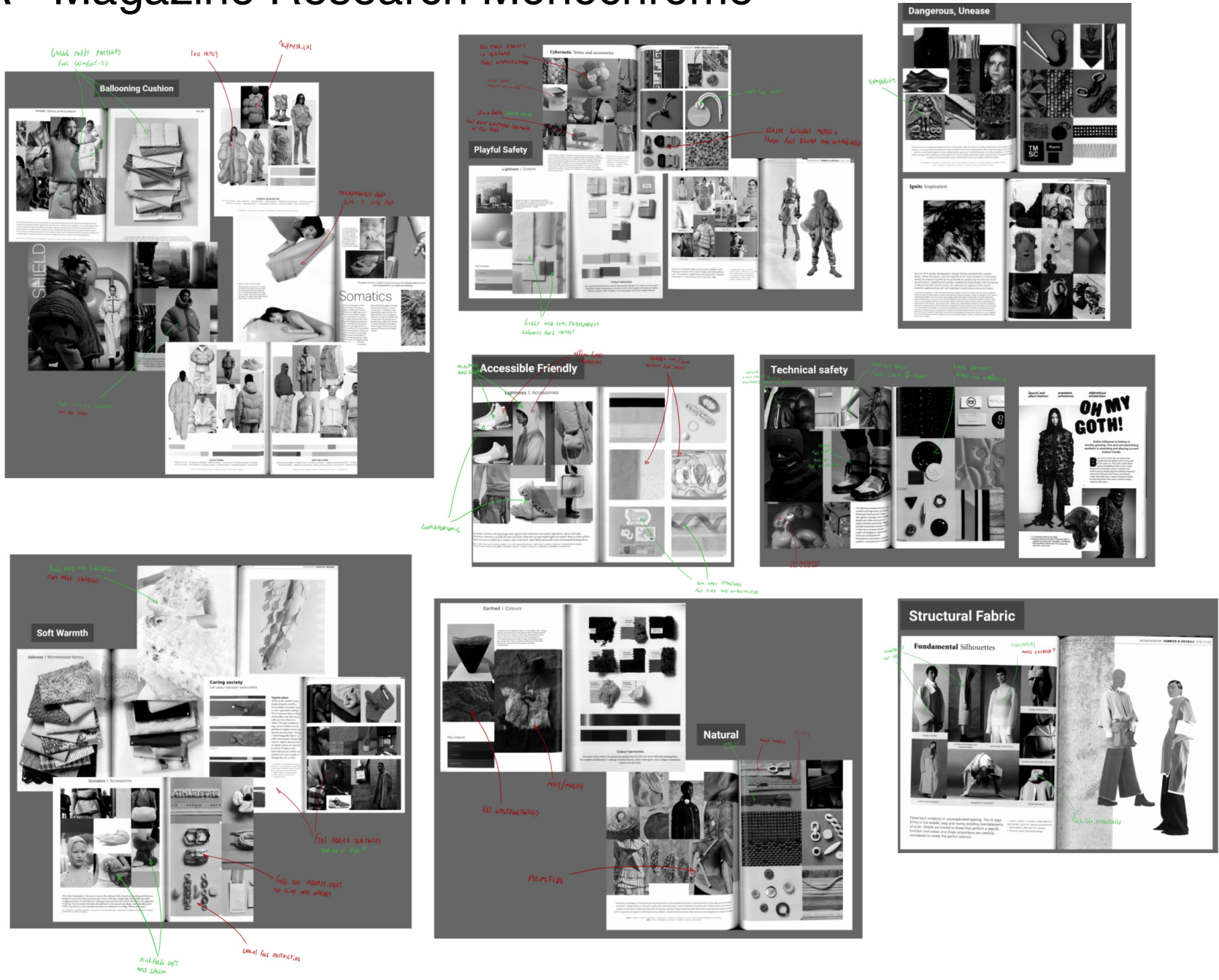
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8. Appendix

Appendix A - Magazine Research



Appendix A - Magazine Research Monochrome



Appendix B - AI interpretation

Prompt	50%	20%	10%	No reference image					
Scary scissors, with scary colours and scary texture. White background					Airy scissors, with airy colours and airy texture. White background				
Dangerous scissors, with dangerous colours and dangerous texture. White background					Secure scissors, with secure colours and secure texture. White background				
Cozy scissors, with cozy colours and cozy texture. White background					Structured scissors, with structured colours and structured texture. White background				
Comforting scissors, with comforting colours and comforting texture. White background					Clean scissors, with clean colours and clean texture. White background				
Protective scissors, with protective colours and protective texture. White background					Symbolic scissors, with symbolic colours and symbolic texture. White background				
Honest scissors, with honest colours and honest texture. White background					safe scissors, with safe colours and safe texture. White background				

Appendix B - AI interpretation

Prompt

50%

20%

10%

No reference image

Scary stool, with scary colours and scary texture. White background



Airy stool, with airy colours and airy texture. White background



Dangerous stool, with dangerous colours and dangerous texture. White background



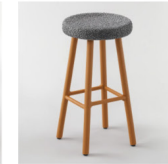
Secure stool, with secure colours and secure texture. White background



Cozy stool, with cozy colours and cozy texture. White background



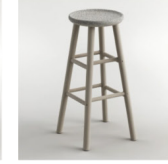
Structured stool, with structured colours and structured texture. White background



Comforting stool, with comforting colours and comforting texture. White background



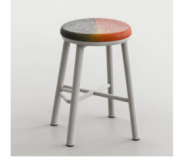
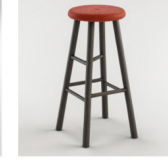
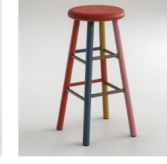
Clean stool, with clean colours and clean texture. White background



Protective stool, with protective colours and protective texture. White background



Symbolic stool, with symbolic colours and symbolic texture. White background



Honest stool, with honest colours and honest texture. White background



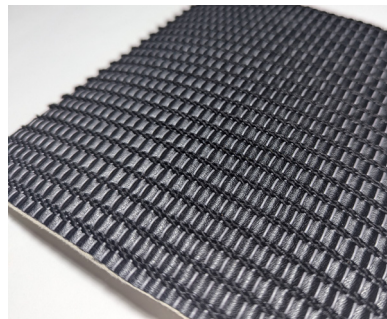
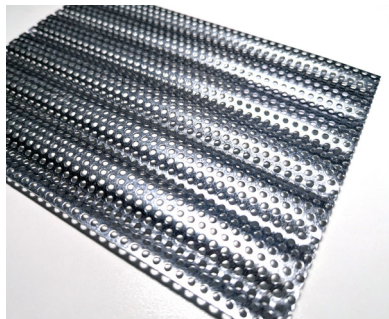
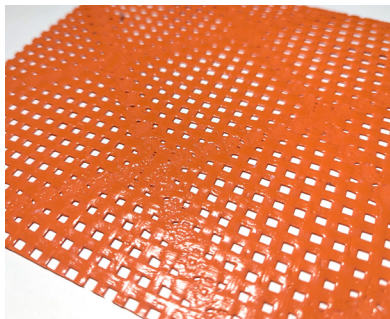
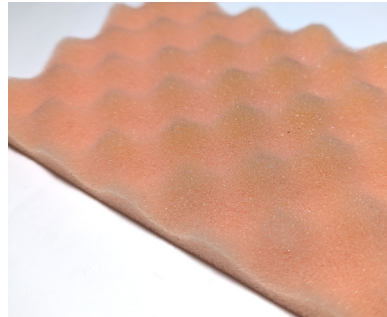
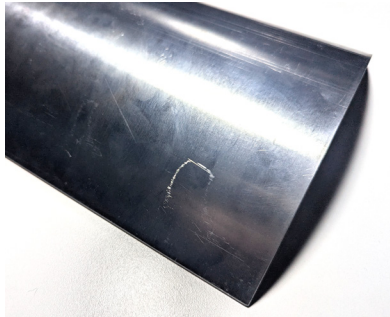
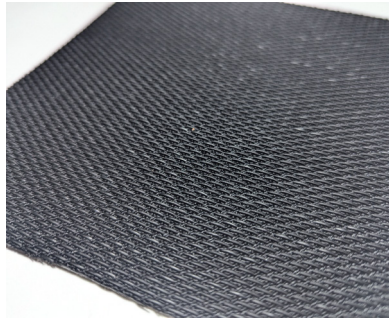
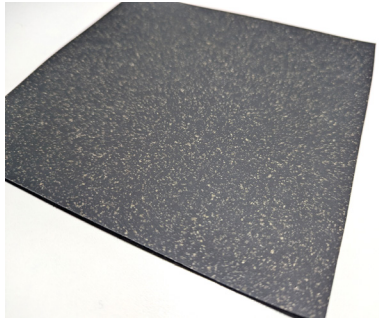
safe stool, with safe colours and safe texture. White background



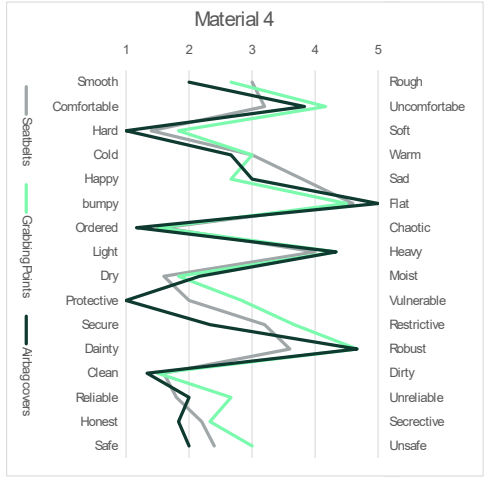
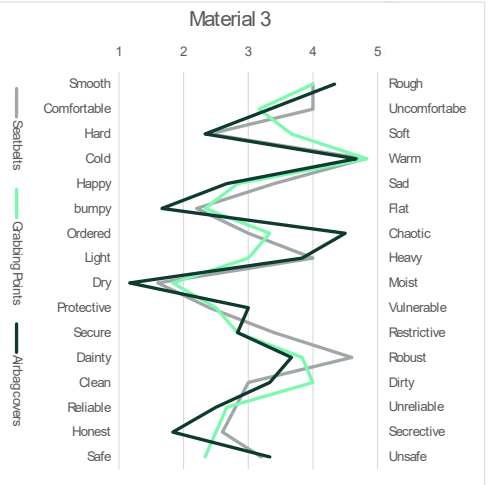
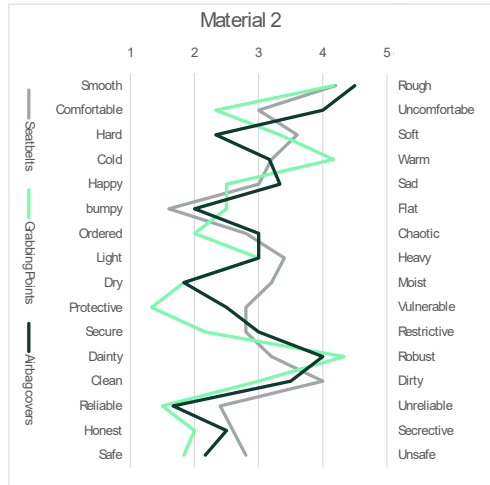
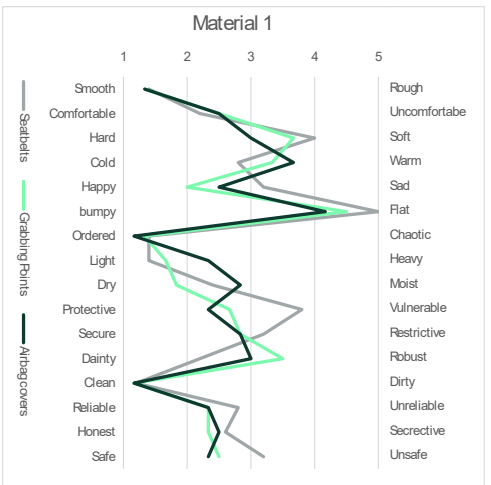
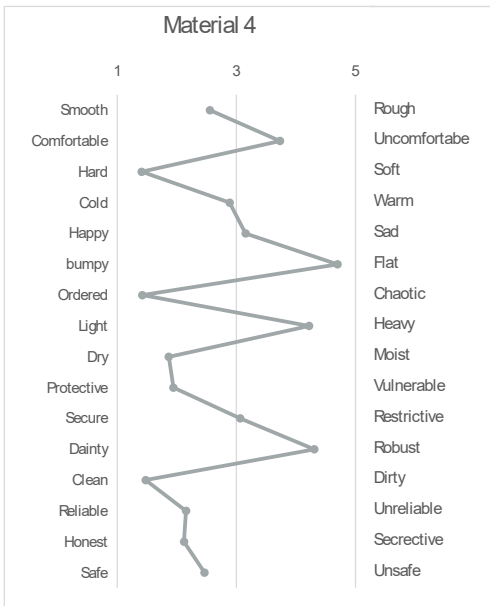
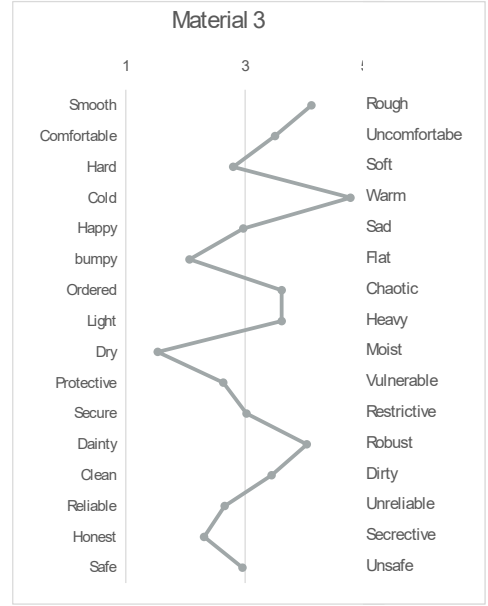
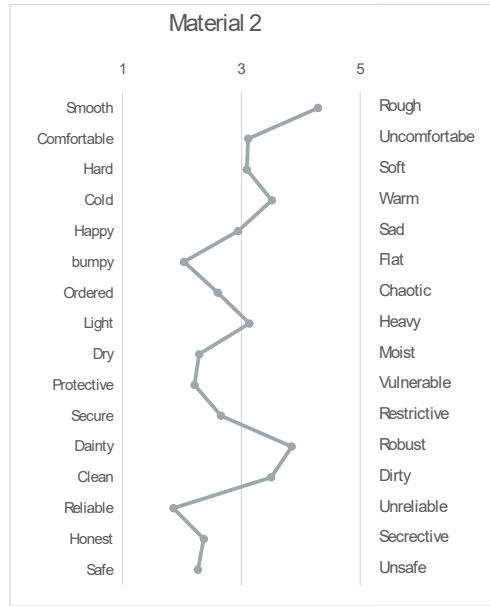
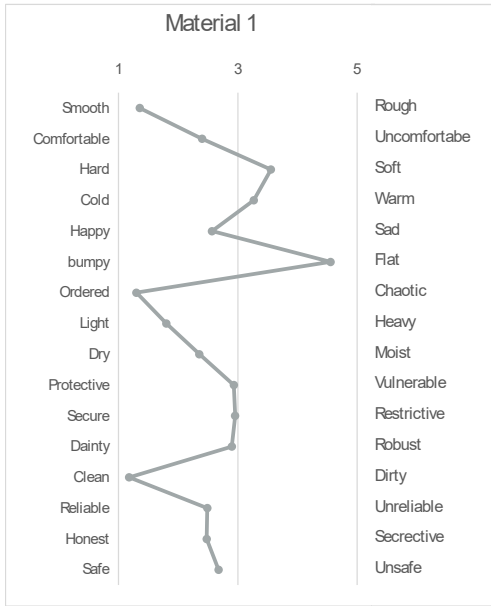
Appendix B - AI interpretation

Prompt	50%	20%	10%	No reference image				
Scary shoe, with scary colours and scary texture. White background								
Dangerous shoe, with dangerous colours and dangerous texture. White background								
Cozy shoe, with cozy colours and cozy texture. White background								
Comforting shoe, with comforting colours and comforting texture. White background								
Protective shoe, with protective colours and protective texture. White background								
Honest shoe, with honest colours and honest texture. White background								
Airy shoe, with airy colours and airy texture. White background								
Secure shoe, with secure colours and secure texture. White background								
Structured shoe, with structured colours and structured texture. White background								
Clean shoe, with clean colours and clean texture. White background								
Symbolic shoe, with symbolic colours and symbolic texture. White background								
Safe shoe, with safe colours and safe texture. White background								

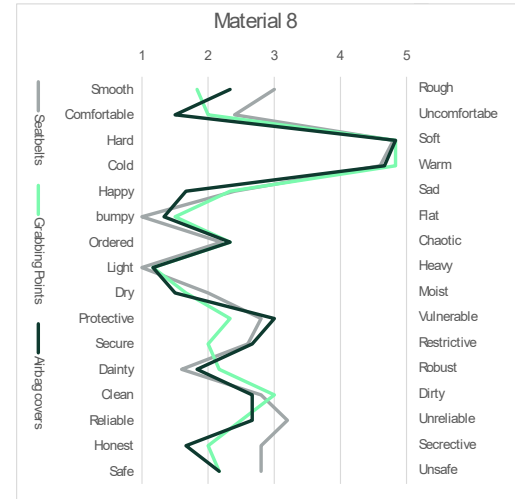
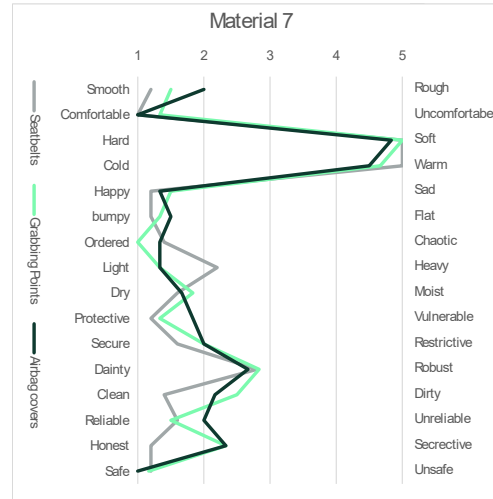
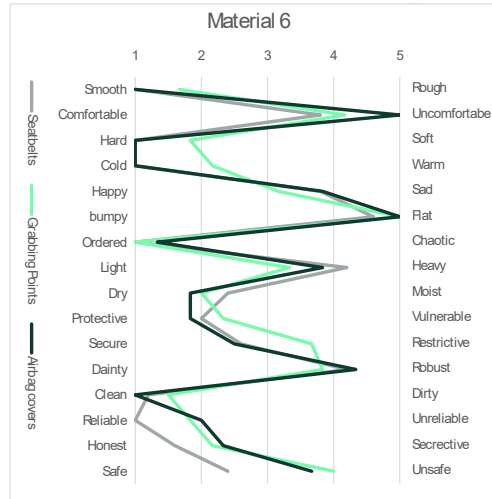
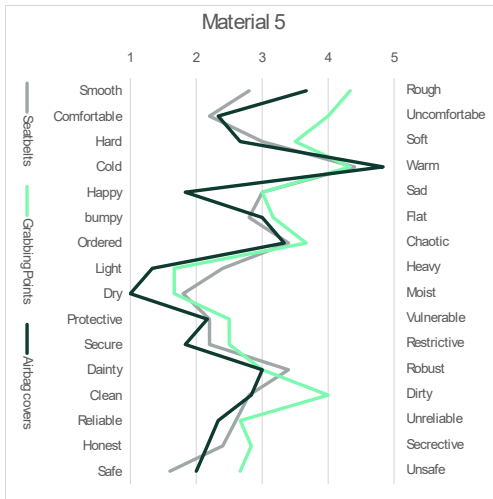
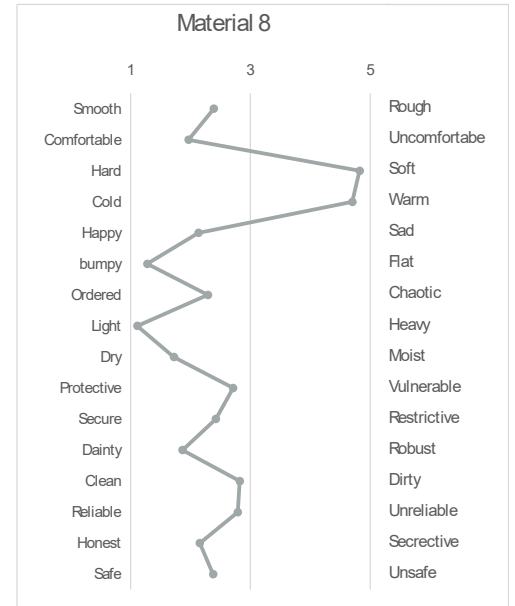
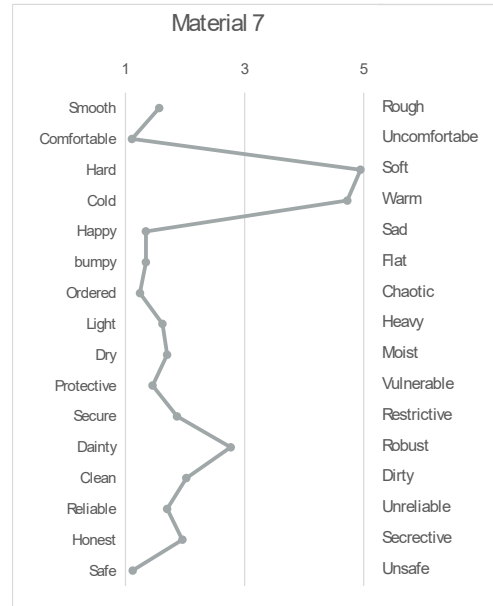
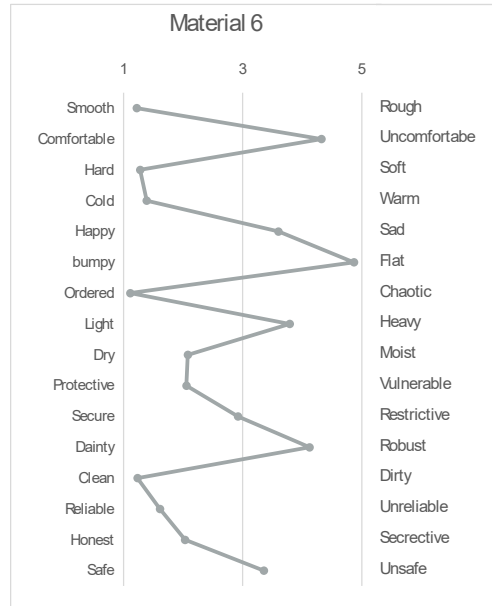
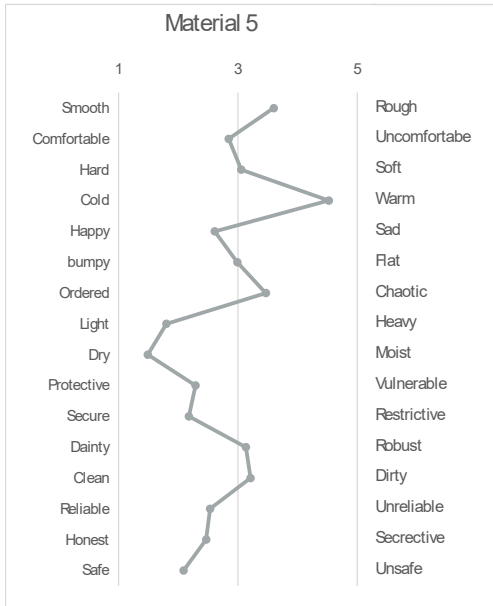
Appendix C - Sample range



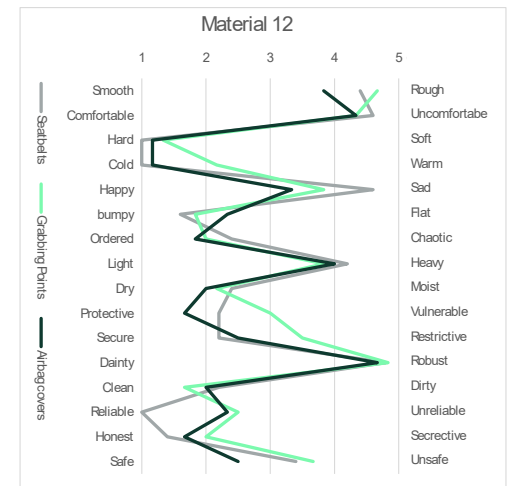
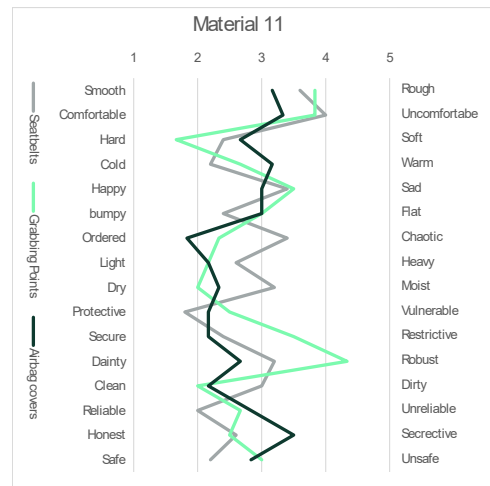
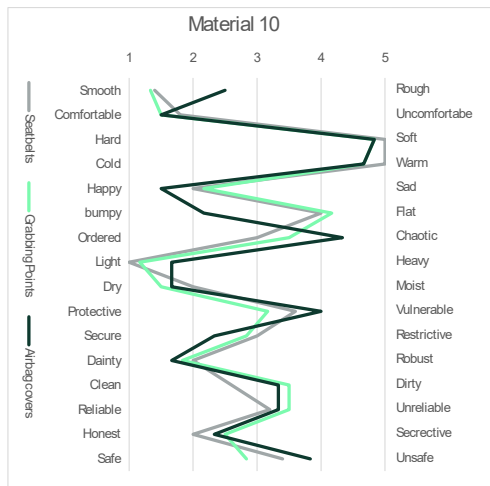
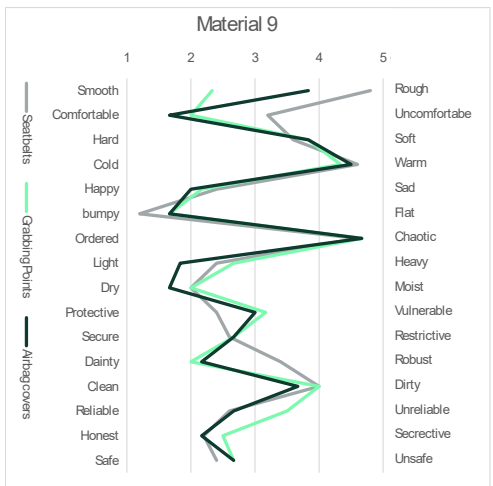
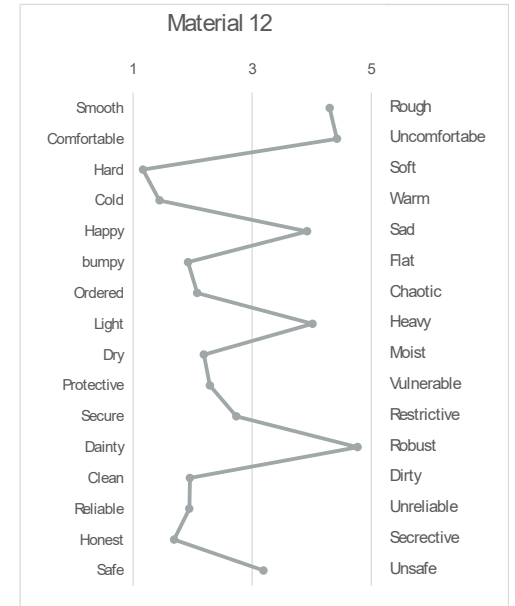
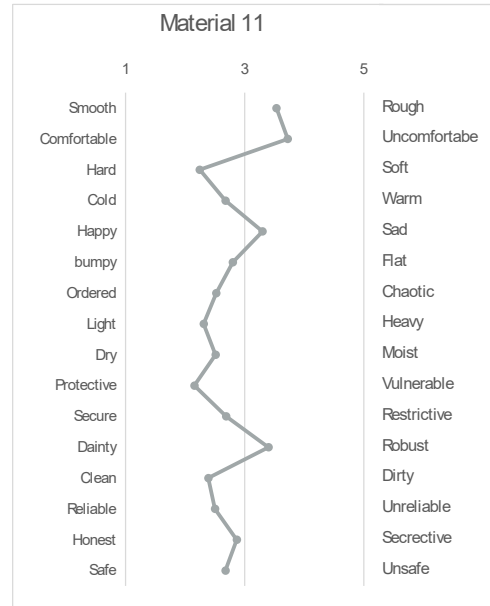
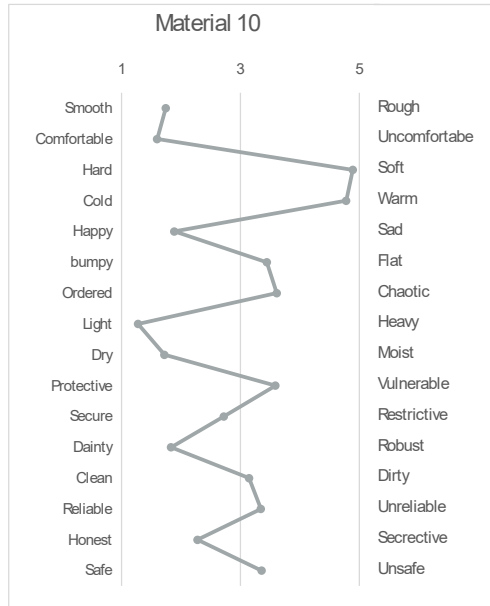
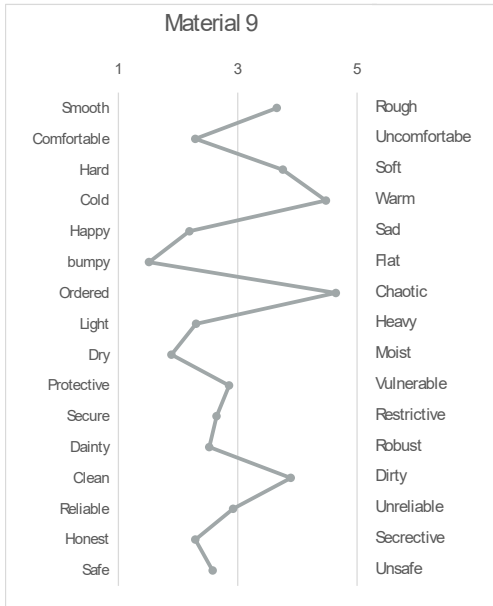
Appendix D - Quantitative results



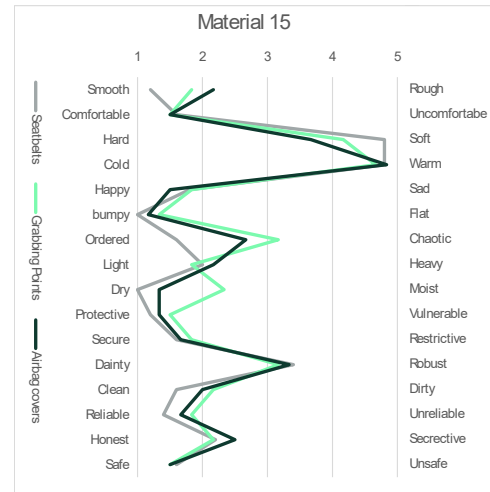
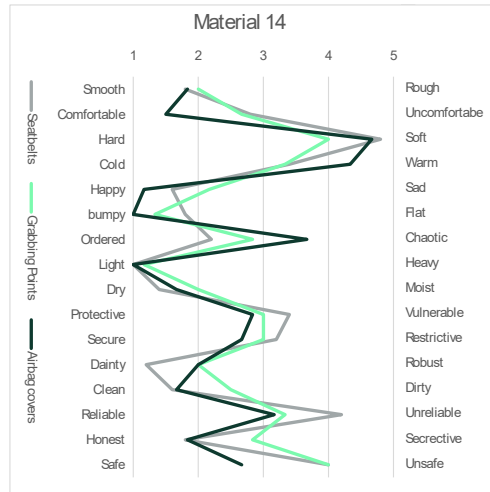
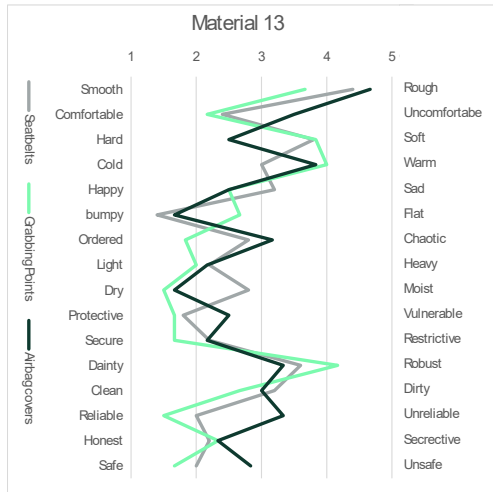
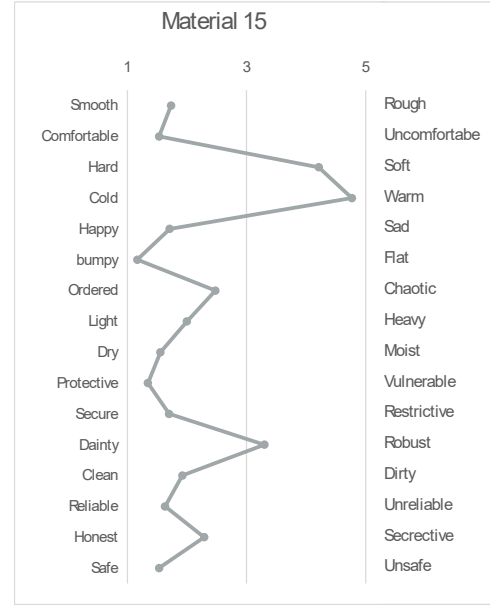
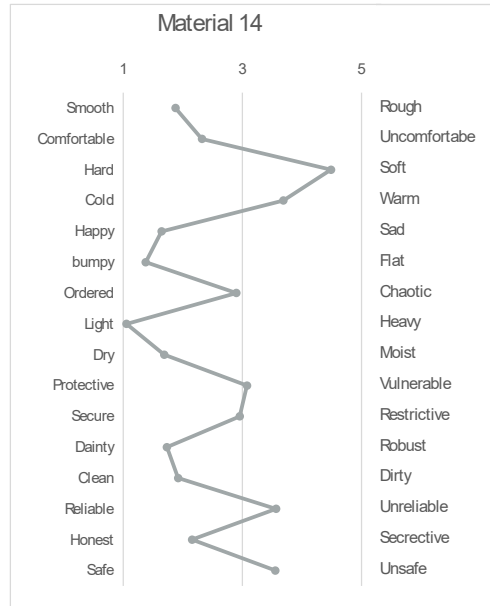
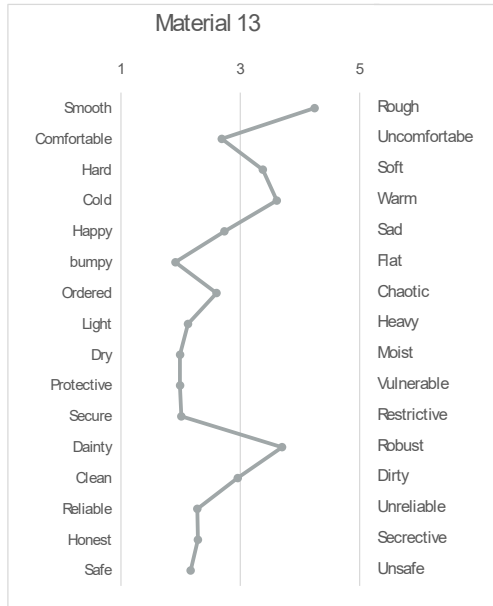
Appendix D - Quantitative results



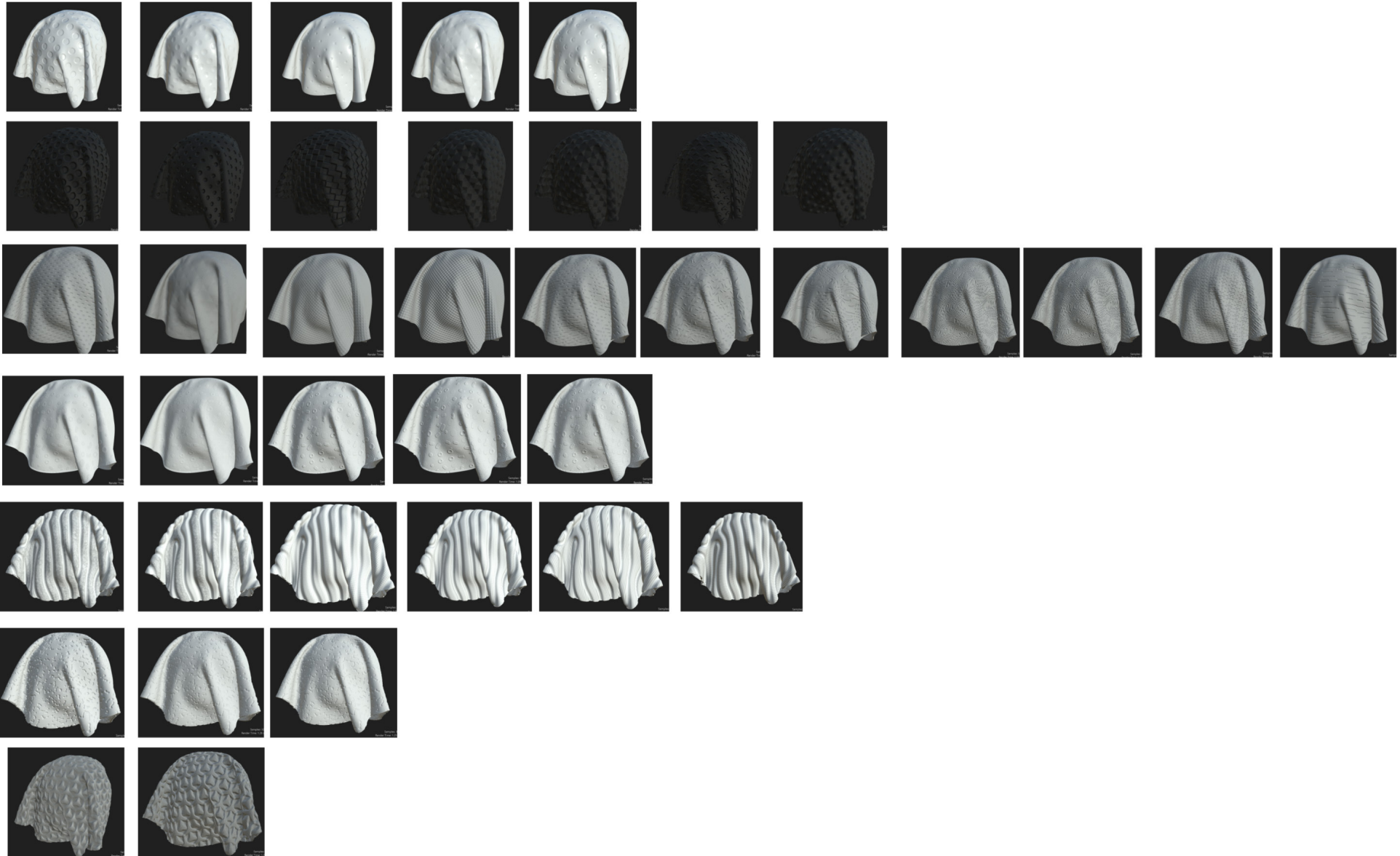
Appendix D - Quantitative results



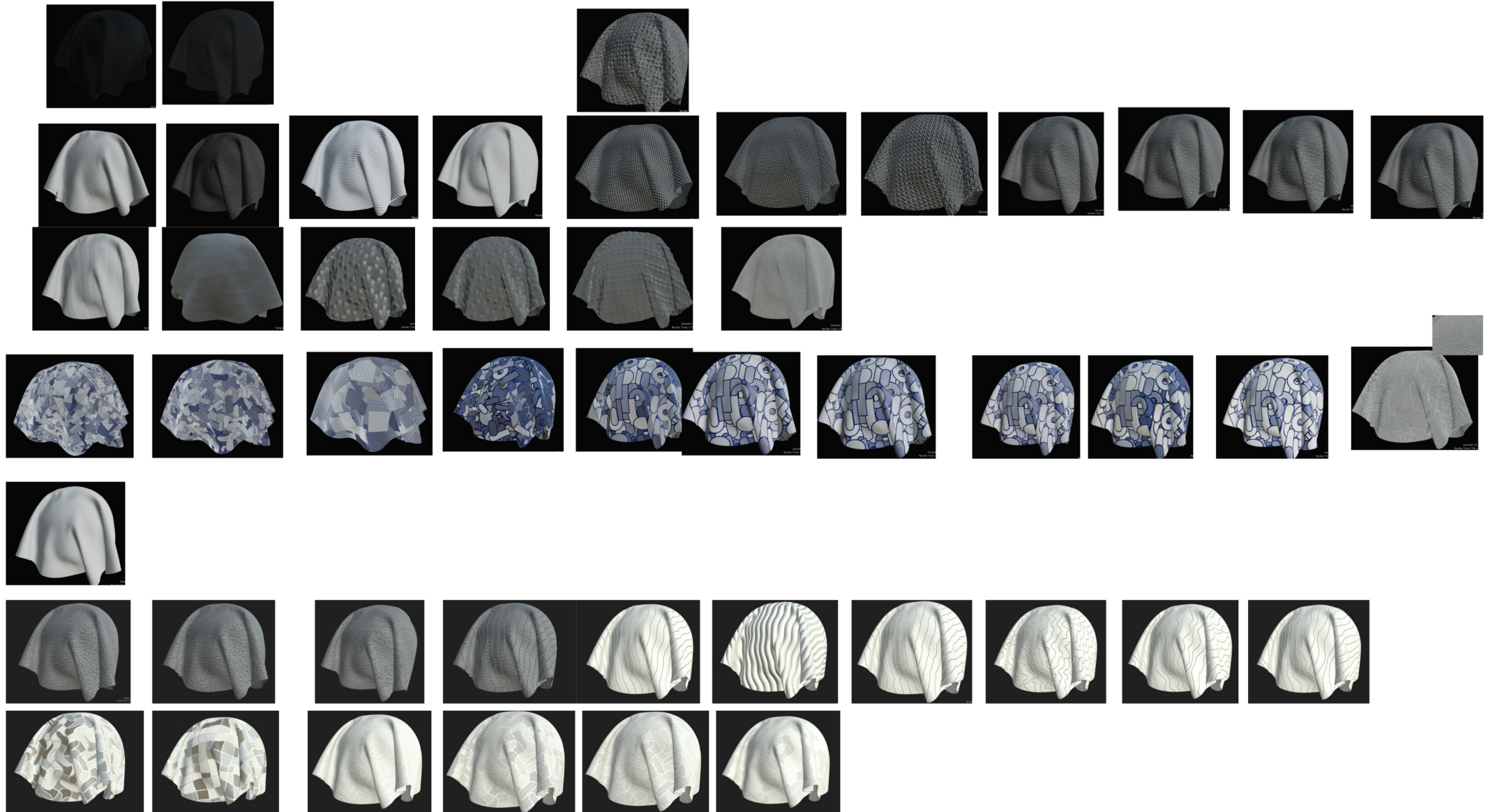
Appendix D - Quantitative results



Appendix F - Substance Material alternatives



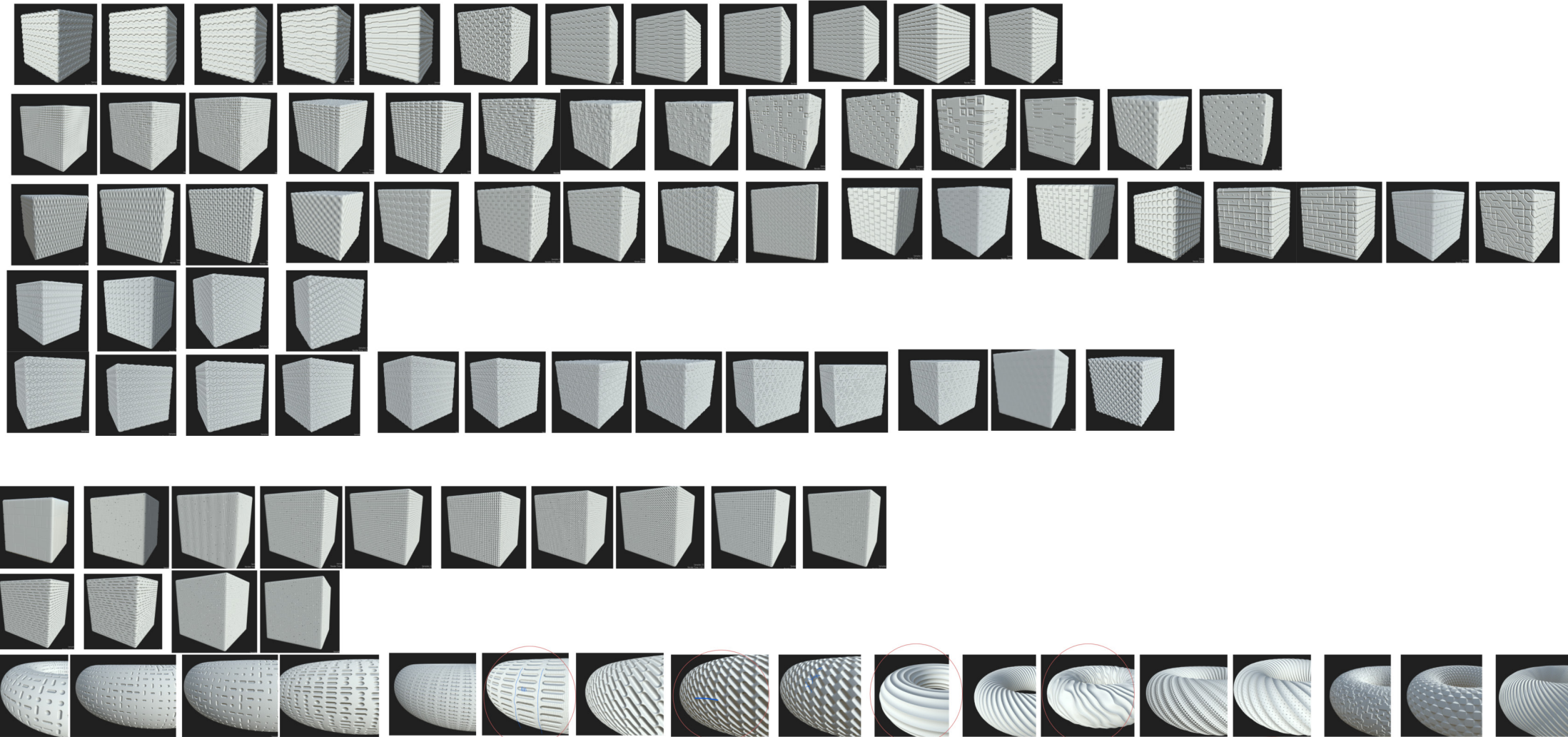
Appendix F - Substance Material alternatives



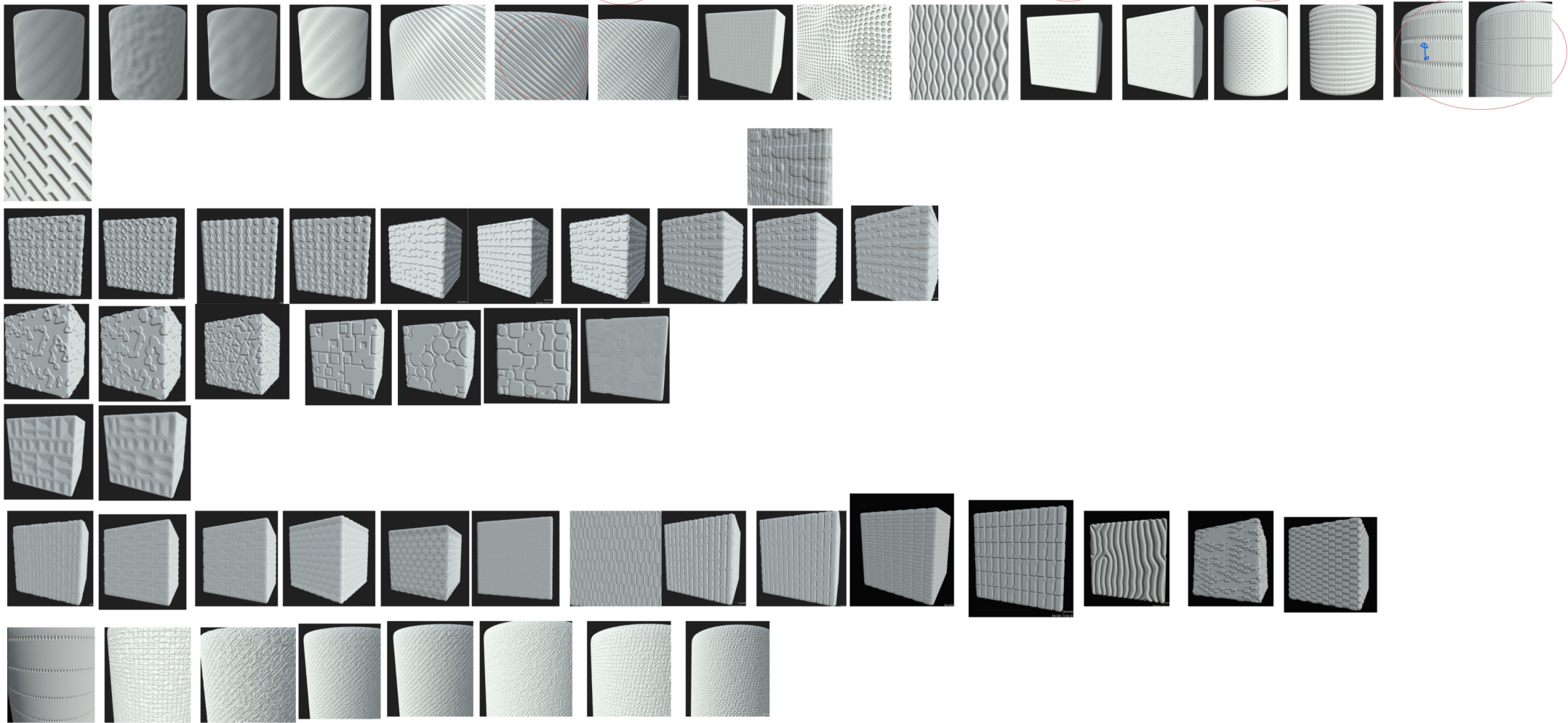
Appendix F - Substance Material alternatives



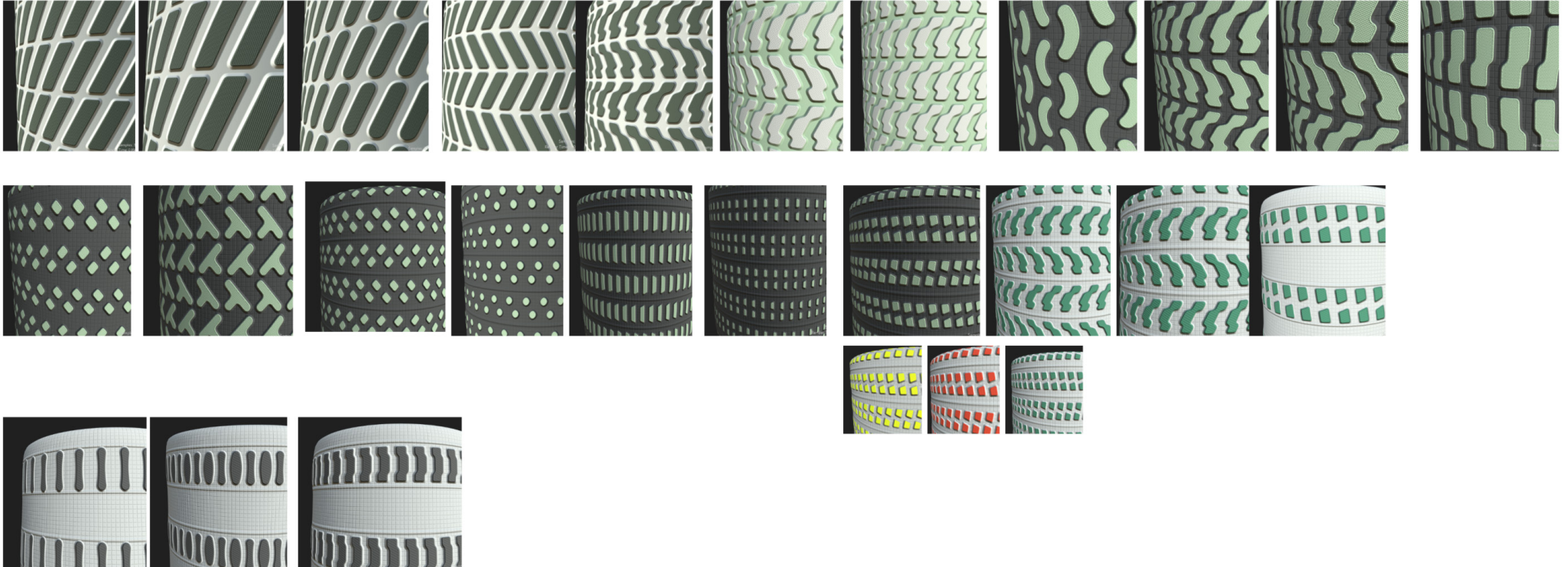
Appendix F - Substance Material alternatives



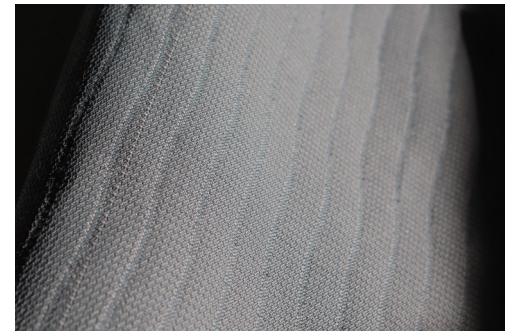
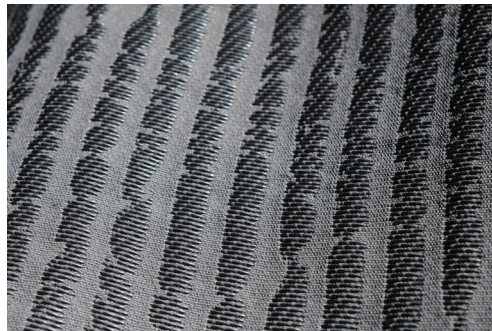
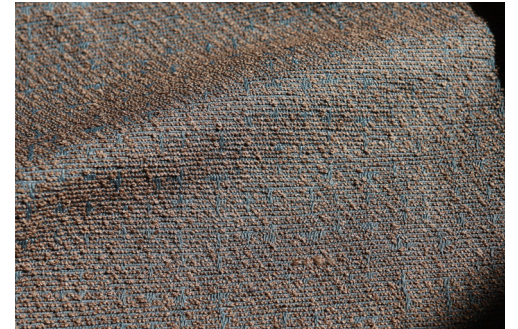
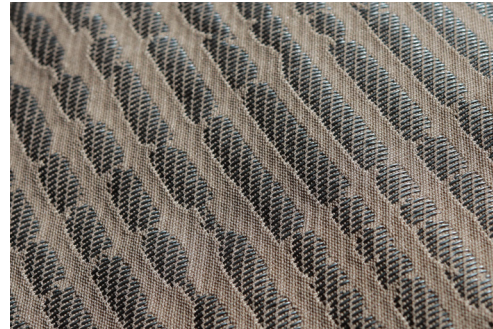
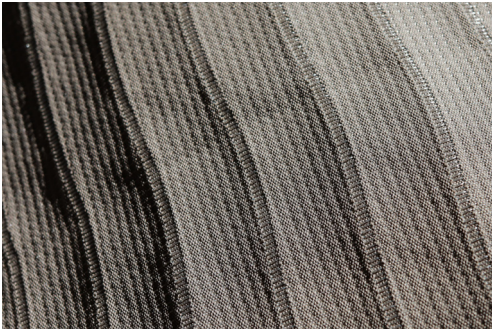
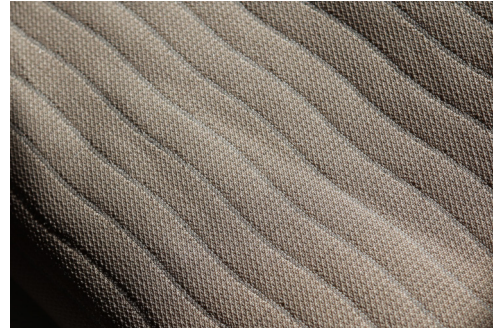
Appendix F - Substance Material alternatives



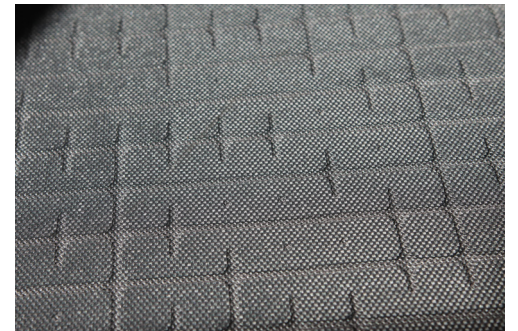
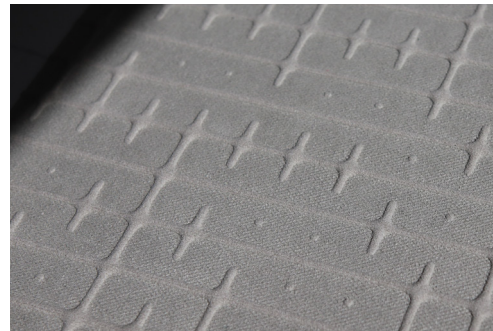
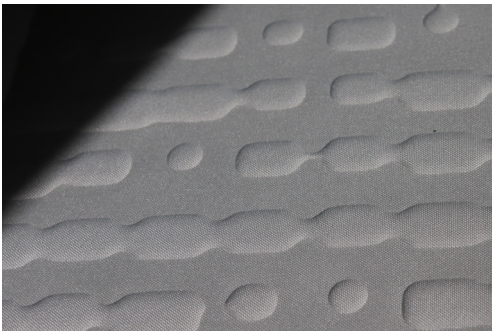
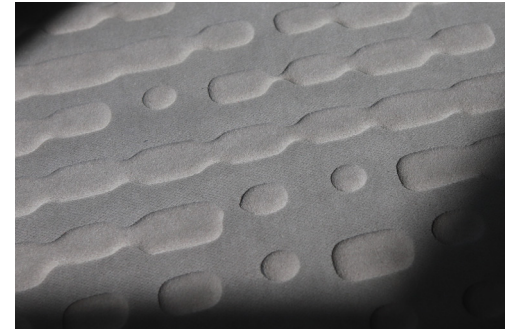
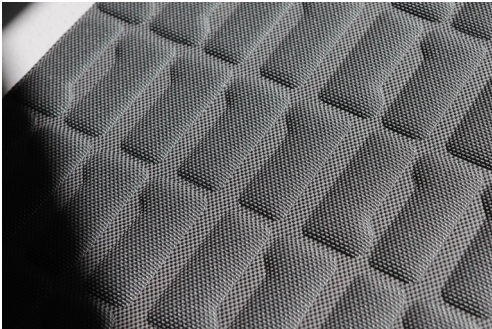
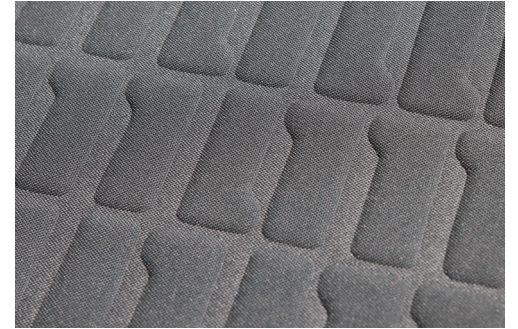
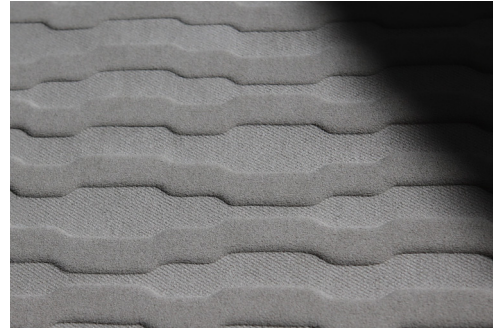
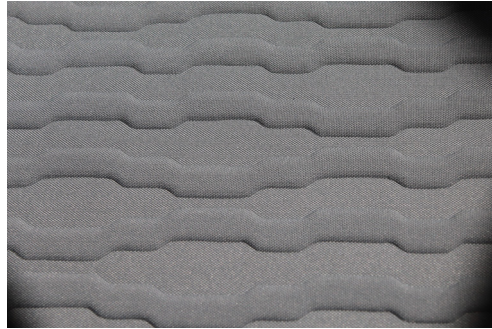
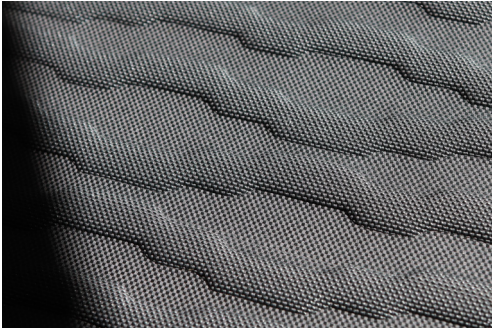
Appendix F - Substance Material alternatives



Appendix G - Physical Material Samples



Appendix G - Physical Material Samples





IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

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

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

STUDENT DATA & MASTER PROGRAMME

Complete all fields and indicate which master(s) you are in

Family name	Westhoff	IDE master(s)	IPD <input checked="" type="checkbox"/>	Dfi <input type="checkbox"/>	SPD <input type="checkbox"/>
Initials	M.S.	2 nd non-IDE master			
Given name	Matthijs	Individual programme (date of approval)			
Student number	5072301	Medisign	<input type="checkbox"/>		
		HPM	<input type="checkbox"/>		

SUPERVISORY TEAM

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

Chair	Elmer van Grondelle	dept./section	HCD/DA	! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.
mentor	Sam Franklin	dept./section	HCD/DA	
2 nd mentor	Stefan Webelhorst			
client:	Skoda Auto			
city:	Mlada Boleslav	country:	Czech Republic	! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.
optional comments	Both the chair and the mentor are from the same section, however I think they both bring different valuable perspectives to the table. Elmer will have valuable knowledge about automotive/semiotics, and Sam will offer an interesting historical/cultural perspective.			
				! 2 nd mentor only applies when a client is involved.

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

Sign for approval (Chair)

Name Elmer van Grondelle Date _____ Signature _____

Elmer van Grondelle - IO Digitally signed by Elmer van Grondelle - IO Date: 2025.10.29 16:21:43 +01'00'

CHECK ON STUDY PROGRESS

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


Master electives no. of EC accumulated in total _____ EC

Of which, taking conditional requirements into account, can be part of the exam programme _____ EC

<input checked="" type="checkbox"/>	YES	all 1 st year master courses passed
<input type="checkbox"/>	NO	missing 1 st year courses

Comments: _____

Sign for approval (SSC E&SA)

Name M.J.H. Neeleman-Smits Date 03-11-2025 Signature 

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

Does the composition of the Supervisory Team comply with regulations?

YES	<input checked="" type="checkbox"/>	Supervisory Team approved
NO	<input type="checkbox"/>	Supervisory Team not approved

Comments: _____

Based on study progress, students is ...

<input checked="" type="checkbox"/>	ALLOWED to start the graduation project
<input type="checkbox"/>	NOT allowed to start the graduation project

Comments: _____

Sign for approval (BoEx)

Name Joni Schuurman Date 05-11-2025 Signature 



Personal Project Brief – IDE Master Graduation Project

Name student Matthijs Westhoff Student number 5,072,301

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

Complete all fields, keep information clear, specific and concise

Project title Safety Aesthetics - Designing Visual and Tactile Cues for Trust and Responsibility in Mobility

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

Introduction

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

Research has shown that safety and the perception of safety in consumer vehicles are one of the most important factors when making a purchasing decision. Koppel et al. (2007) finds that consumers often equate vehicle safety with the presence of specific vehicle safety features or technologies rather than the vehicle's crash test results.

While perception plays a role in how vehicles are chosen, the greater design challenge lies in strengthening the actual safety experience for occupants during use.

Currently many safety features are deliberately hidden to preserve design appeal and maintain a 'peace of mind' narrative that avoids reminding passengers of potential danger. However, with the rise of semi- and fully autonomous driving modes, this approach introduces new complexities. Safety today is not only about protection but also about clarity of responsibility. Occupants need to understand when they are in control, when the vehicle is in control, and how to transition smoothly between the two.

The project investigates how to make safety related component visible, tangible and meaningful, not just to reassure but to actively support safer human-vehicle interaction. The aim is to enhance both actual safety and perceived safety by creating awareness of each individual's role within a shared system using CMF design as a means between the two. All of this within the interior of a car, no exterior safety relevant components will be explored (e.g. radar placement, mirror shaping)

Main stakeholders: Skoda Auto, Customers of Skoda (Individuals, Parents, Children)

Koppel, S., Charlton, J., Fildes, B., & Fitzharris, M. (2007). How important is vehicle safety in the new vehicle purchase process? *Accident Analysis & Prevention*, 40(3), 994–1004. <https://doi.org/10.1016/j.aap.2007.11.006>

→ space available for images / figures on next page



Personal Project Brief – IDE Master Graduation Project

Problem Definition

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

While Carsten and Martens (2018) demonstrated that HMI affects understandability in a automated cars, and formulated principles that can help in the creation of more understandable and therefore safer human-machine interfaces. However guidelines specifically targeting the role of colour, material, and finish in shaping user perceptions and behavior are still lacking.

There is an opportunity to build new knowledge on how CMF design communicates safety in ways that are intuitively perceivable and emotionally resonant. Understanding these mechanisms could lead to automotive design strategies that enhance both perceived safety and actual safety.

Research questions:

- What role do colour, material, and finish choices play in shaping user awareness and behavior in safety-critical HMI scenarios?
- How can CMF design be leveraged to enhance both perceived and actual safety in automotive human-machine interaction?

Assignment

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

Create an interior CMF design approach that can make human-machine interaction more intuitive in order to strengthen user's trust and sense of shared responsibility (between the user and the vehicle) while increasing real safety.

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

The project will make use of a research through design approach: Literature review that includes perceptual safety, semiotic design, HMI design, moodboards and benchmarking of safety-related materials and components, design of graphics, surface treatments and tactile details. Through the creation of physical and digital mock-ups design concepts will be evaluated and iterated upon. The final outcome will be a design approach that can guide design teams in making perceptible and emotionally reassuring safety features which will be demonstrated on a physical prototype.

Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting, mid-term evaluation meeting, green light meeting and graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting 14 Oct 2025

Mid-term evaluation 2 Dec 2025

Green light meeting 3 Feb 2026

Graduation ceremony 6 Mar 2026

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	<input type="checkbox"/>
For how many project weeks	
Number of project days per week	

Comments:

Motivation and personal ambitions

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

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

During my time abroad I attended a course about automotive CMF and this inspired me to start looking for graduation opportunities in this direction. This particular project sparks my interest by having an unconventional approach to automotive and safety design.

As an IPD student that has always been interested in transportation design this project aligns well with my ambition to work in the automotive field after graduation. My dream job would be related to automotive interior design, as this is where product design, user experience and automotive design come together, but importantly something where I would have freedom to explore different types of projects, variety is key. That's also why I would see myself starting my own design firm with a small team at some point.

Learning ambitions:

- Become a more experienced CMF designer by gaining more technical knowledge in the field of CMF and working with real materials and samples.
- Become a proficient modelmaker, that can create physical as well as digital models that are realistic and can be used as explanatory material within a company.
- Experience working in an automotive environment and dedicated design team and see if this something that I would like to do as my professional career after graduation.