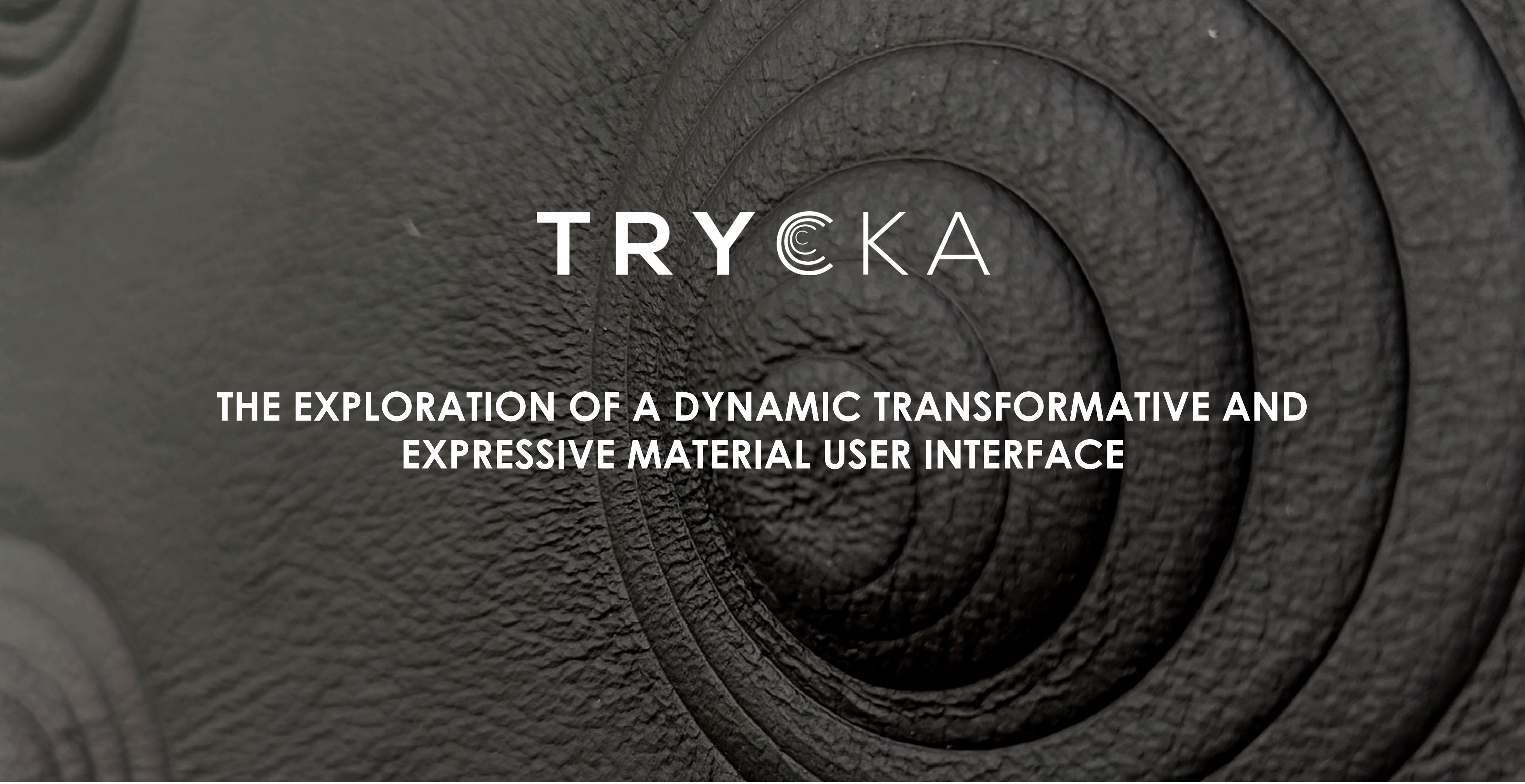

TRYCKA

THE EXPLORATION OF A DYNAMIC TRANSFORMATIVE AND EXPRESSIVE MATERIAL USER INTERFACE

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INTRODUCTION

Interactive technology is increasingly taking part in our lives. However, given the state of our planet, we have to rethink our relationship with the environment and our social surroundings. Therefore, we should explore how these interactions can be brought into the wider context by changing our expectations and broader our conception of how we design and understand interaction by exploring other functions and meanings of interaction [1]. As described by Weiser and Brown, what matters is not merely the technology, such as the computer itself, but its relationship with us [2]. Therefore, we have to shift our perspective on interfaces and design more with computers; not merely by perceiving interactive systems as something flat, temporal, and static, but rather by offering an interaction that is closer to how we naturally interact with our world. In order to develop new forms of interactions we should give shape to real-world artifacts that complement and support the (tangible) interactive quality of the relationship between the user, material, and environment by approaching the behavior and context as something inseparable [3].

As stated by Frens et al. when integrating an artifact its form needs to inform the function and interaction upfront, in order to ensure that the user understands the behavior of the artifact and knows how to act [4]. However, within the current development of HCI, perception, and actions are often taken apart. A social design example of this is ''hostile architecture''; hostile designs are labeled as designs in public spaces that deliberately exclude the unwanted, making certain actions impossible while also unintentionally affecting other vulnerable groups, such as children and the elderly [5]. As defined by Sward & Macarthur: ''UX is the value derived from interaction(s) [or anticipated interaction(s)] with a product or service and the supporting cast in the context of use (e.g., time, location, and user disposition)''.[6] This quote demonstrates why the situatedness and dynamic aspect, for example in the context of the public space, should be taken into account when creating novel (interactive) material experiences. As a response, we should re-examine our materials and explore more critically what is already before us instead of searching for new materials.

The aforementioned novel approach to design for interactive materials is not merely about understanding the sensorial; the design process also emphasizes that these tangible interactions are situated in the actual world[3]. This means that you as a designer also carry the responsibility for the way the interactive material influences the user's perceptions and how this guides the allied actions, which in turn could lead to large-scale changes, such as social connection. Although, giving shape to computational systems is highly complex due to their ability to change between states. Nonetheless, this can be tackled by applying form-giving practices such as the framework proposed by Vallgårda, which argues how interaction design practice is about shaping a whole through an ongoing negotiation between the temporal form, the physical form, and the interaction stalt [7]. What is more, in interactive systems, action and function are often not unified on practical aspects such as location, time, modality, dynamics, and expression. Therefore, designing interaction needs to also be about guiding the user by designing information through feedforward and feedback, while making a distinction between function, augmented, and inherent information [8].

This pictorial executes a novel approach to design for interactive materials. The work aims to explore expression, aesthetic qualities, interactions, and behaviors through an iterative Material-Centered Design Research process. The approach is rather unique since the research stresses materials as outcomes that can transform the world from a plain state to a preferred state, by integrating behavior into the interactive materials and enabling them to steer user actions. Following from this, the research question is formulated as follows; 'How can user action be steered through the inherent feedback of the interactive material?'

1.2 Method

The paper of Stienstra et al. led us to explore the interaction, behavior, and aesthetics in three defined steps: Analyzing; Synthesis; and Detailing [9]. During the first phase of our process, we approached the materials from a fresh and open perspective. We did this through an materials-oriented design (MOD) approach, where the material guided us through open-ended material explorations [10]. During this Analyzing phase, we iteratively explored the boundaries of the material by affirming the material, appreciating its current behavior, and providing critical insights on how we could unfold the interactive qualities of the material in order to let the material behave differently. This also meant that we did not want to go to the next step before we had a transition that fitted the material naturally. To have a better understanding of the relationship between the perception of the product's reaction and the person's action, critical insights were noted and based on the six practical aspects; dynamics, modality, expression, time, location, and direction [11]. The step that followed was design mapping for transformation of behavior (synthesis). We analytically explored different ways to transform the behavior of the material and experientially tried to figure out how we could amplify our feedback of transition through material property manipulation. The design mapping led to an action-perception loop that transformed into an alternative behavior without having an interaction that becomes present-at-hand. The last step focuses on the detailing; fine-tuning both the physical form and the interaction. This phase focuses on playing with subtle nuances, such as texture, and aiming for sensitivities and wonder grasp for attention by in- and outputs that match the human's emotional skills and perceptual-motor.

2

ANALYZING

In this chapter, we wanted to explore what action possibilities the material's inherent properties allow, and how manipulation of these materials could alter interaction possibilities or create new ones. This analysis was carried out in an explorative way without a pre-set plan, to allow us to approach the materials with an open view and mind. The aim of this exploration was to create an appreciation for the material's properties, both inherent and designed, and to find a material to continue the design process with. To give the exploration some direction, we focussed on the 'open close' transition, and use only black materials, to help us focus on the material's functional and aesthetical properties without being distracted by color.

2.1 MATERIAL EXPLORATION

We started experimenting with cardboard, Spacer mesh fabrics, non-woven spacer fabric, paper, and leather as can be seen in figure 1.
In exploration 1a-b, we manipulated the inflection point of the cardboard until 3 different levels of thickness were applied which resulted in different behavior of the material. Once let go, the cardboard with the thinnest inflection point remained unmoving, while the other moved away from the hand.
In Experiments 2a-c, 3a-b and 4a-c we analyzed the moving behaviors of 2 variants of Spacer mesh fabrics. We started with the woven spacer mesh fabric and wound a wire through the corners. When pulling on the strings, the material would curl up, and return to its flat shape once the strings were released. In 3a-b, the corners of the material were bound together to create a bounceable surface. Once pressed, the material would move down in a nice firm manner and bounce back once the hand moves away. For experiment 4a-c we used a different kind of spacer fabric; the non-woven kind. This material is more unreliable and behaves differently throughout the material. This property encouraged active exploration, curiosity, and surprise. We found that when tension is applied by pushing the material from its center to opposite corners, the internal tension in the material makes the other corners curl towards the center (see figure 1, 4c). However, when this tension is inter-

figure 1 I Material exploration

rupted by incisions made into the corners, the material ceased to show this curling behavior (see figure 1, 4b).
In experiment 5 we wanted to create an 'open close' transition by making the material roll in and out in a circular motion, slowly revealing the open space beneath the material. We first tried the transition with paper (see figure 1, 5a) but the material was too stiff and prone to keep its manipulated shape. When the same was tried with leather, the transition worked due to the leather's suppleness.
In experiment 6a, leather was used again to create an 'open close' transition (see figure 1, 6a-d). The suppleness of the leather made the transition fluent and returnable to its original flat state.
In experiment 7 we wanted to see whether the leather could be manipulated to take on a new 'original shape', by which we mean the state in which the designed material is at rest outside of transition and interaction. We started with stretching leather over circular surfaces (see figure 1, 7a), and found that it gave some semi-permanent results which could be moved up and down by the press of a finger.

2.2 CONCLUSION MATERIAL EXPLORATION

From the material exploration, we found experiment 7 most promising. By overstretching the leather, we gave it new properties that had the potential for a transition between 2 rest stages, up and down, making the transition reversible and interactive. To make our next design phase even more focused, we chose to specify our transition from 'open close' to 'pop-in pop-out'. In the next phase, we started experimenting with different emboss designs, meaning raised marks from its surface, and using moisturization and heat to increase the emboss permanent deformation (see figure 2).

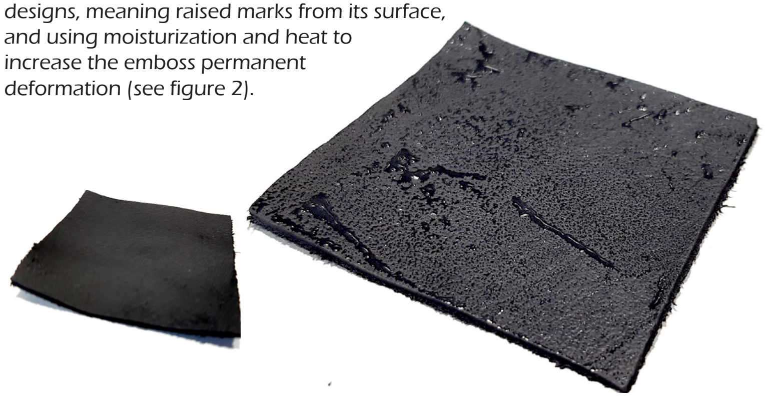


figure 2 | Leather manipulation

3 SYNTHESIZING

In this chapter, we take a more analytic approach to our material exploration, by going more into depth into the manipulation possibilities of the leather, using molds to form new 'original shapes' and mapping our findings to 5 categories; 'Manipulated material', 'Material properties, 'Temporal form', 'Haptic Experience', and 'Symbolic notion'.

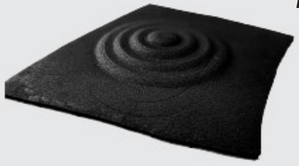
3.1 SYNTHESIZING PROCESS

From the Analyses stage, we knew we wanted to create a transition in the leather that moved from popping-in, to popping-out. This we wanted to create by stretching and drying the leather until a permanent deformed stage was achieved in the form of embosses rising from the material.
There were various technical variables to consider that could influence the deformation of the leather.
firstly, the varying inherent properties of the leather could cause the material to behave differently. We were given two kinds of leather; a more 'supple' and 'fine' variant, and a more 'sturdy' and 'coarser' kind, which per piece also varied in thickness. Secondly, the temperature and length of soaking time in which we prepared the leather impacted its behavioral and deformation properties. When heating the coarser leather for over 2 minutes at 100 degrees Celcius, the leather shrank and lost its movable qualities as can be seen in figure 2. Thirdly, the drying time in the molds, and lastly, the shape and size of the molds designs influenced the leathers deformation.
To explore different aesthetical and experiential qualities, we designed various shapes, from natural to geometric forms, and placed them in different patterns, ranging from with static, dynamic, directional, and scattering patterns. We analyzed the differences in shapes and patterns in the first Material mapping (see page 5), and later wend more into depth by analyzing differences in sizes, drafts, and edges (see page 6) .

3.2 MATERIAL MAPPING

Material propperties I Designed material I Temperal form I Haptic experienceI I Symbolic notion

1 2 3 4 5



CIRCULAR LAYERS

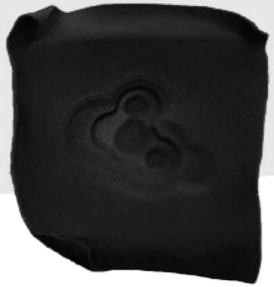
1 60-80 temp. | 0.9 thickness | 2/5 volume | fine surface

2 The leather has a smooth surface and is thin and supple making it easy to make fluent movements.

3 The circular layers have a resting state in both pop-in and -out, and move layer by layer in transition between stages, creating an aesthetical play of light and shadow.

4 The shape invites pressing in and out, as well as circular caresses around the layers and from top to bottom. When the material moves between stages, each time one layer is surpassed, this is felt by a small vibration in the material.

5 The cleanness of the shape communicates clear points of interaction due to its clear center and the layers offer a guided experience of commitment and exploration. One could decide to press all the way, or try out layer by layer instead.



ORGANIC LAYERS

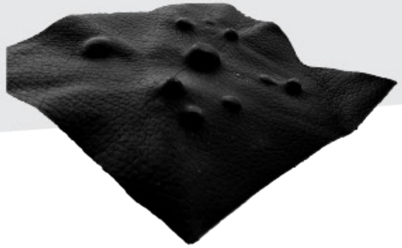
1 60-80 temp. | 1.8 thickness | 0/5 volume | coarse surface

2 The leather is thick and stiff, making movements more explosive and requiring more force. Its surface structure is a bit coarse in a way that you can feel its structure when stroking over the material.

3 When pressing the material up or down, the material always returns to its original state that was formed in the mold. The transition is thus moving from its original state following the speed of the finger press, and returning fast to its original state when let go.

4 The unpredictable shape of the emboss, invites explorative stroking over the surface due to its different shaped levels, and lines.

5 The unpredictability of the shape can stimulate the experience of surprise and curiosity in its interaction.



KNOB PATTERN

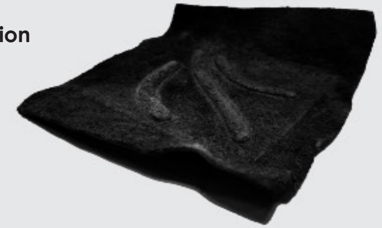
1 80-90 temp. | 0.9 thickness | 2/5 volume | coarse surface

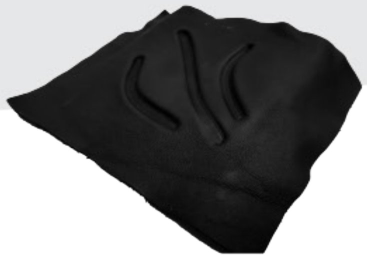
2 The leather is a bit stiff, with a coarse surface. Due to its thinness, the material is in between 'circular layers' and 'organic layers' when it comes to the materials ease of movement.

3 Each knob moves and behaves in a different way. The smaller return to their original state after pressing down. The slightly bigger one on the left lingers a bit after being pressed down and then returns at a faster pace than the smaller ones. The biggest moves between 2 resting stages, pop-in, and -out, and has a slow returning transition, which makes the transition visually interesting, since the movement of the leather is easy to follow.

4 The small ones are hard to press and give little haptic satisfaction due to the missing feedback in the material. The bigger ones for example give a better haptic experience due to the lingering of the pop-back of the middle knob, and the pop-in state of the biggest knob. Also, the accompanying sound the pops generate heightens the haptic experience of the press.

5 The naturalness of the shape and the randomness of the pattern together with the imperfection in the leather caused by overstretching in the molds stimulate the association of warts and boils. This feeling of disgust is accompanied by anticipation and curiosity for what would happen once the knob is popped. The popping itself could stimulate the feeling of satisfaction, once the task is completed.





LINE PATTERN

1 60-80 temp. | 1.8 thickness | 0/5 volume | fine surface

2 The leather has both a smooth(b) and soft/coarse(a) surface. The material is a bit stiff due to its thickness but remains quite fluent in its movements due to the fineness of the material.

3 The shape of version a is pressable and returns to its original state after pressing. Version b has no temporal form.

4 The lines offer direction to possible interactions. They invite the user to stroke the leather by following the lines. With version a, the material facing the user invites a more caressing approach due to the visibility of the material's individual fibers, while the shape stimulates pressing down. Version b invites stroking over the lines due to its hollow shape and defined lines, which are better visible due to the lighting and the smoothness of the surface.

5 Due to the conflicting feedforward in surface texture and shape, the interaction with the lines of version a is more likely to be explorative, accompanied by anticipation and curiosity. While stroking version b stimulates a sense of calmness due to its clear path with little resistance.

OVAL LAYERED PATTERN

1 60-80 temp. | 1.3 thickness | 2/5 volume | coarse surface

2 The leather has a coarse surface, and is semi-thick and stiff, resulting in a strong defined design with explosive movements.

3 Due to its large surface in relation to its height, 2 of the 3 ovals did not want to pop to the second rest state but moved right back to their original shape. The one in the upper right corner, however, did want to be popped-in, but only one level down.

4 The layers of the shape, seem to guide the finger toward its center point, where the embosses are pressed down. The emboss that works, gives a very sudden and fast haptic experience. This is because the little force and distance that the press requires in order for it to 'pop' away from the finger.

5 The popping feels fast and therefore slightly uncontrollable, and the sound that accompanies the pop increases this experience. Emotions that belong to this experience, can range from surprise to distrust.

3.3 MATERIAL MAPPING

BUTTON EMBOSSES

1 

2 The leather has a coarse surface, and is semi-thick and stiff, resulting in a strong defined design with the soft side up.

3 None of the 'buttons' reach the second rest state and all return to their original state after pressing down.

4 Due to its large surface, buttons 3a-b were pressable but did not pop-in completely or satisfactionally. Especially 3a, which had no draft angle, was found lacking. The higher the draft angle the better the pressing interaction became since it reduced the emboss surface diameter. Button 1a-c were not only lacking in probability, but pressability as well. Here button 1a functioned best, in pressability, since it faced a little less resistance from the material itself. Buttons 2a-c have the most explosive press and pop and produce the loudest sound. Here, 2a has the fastest pop with the hardest and sharpest sound, while 2c is more fluent and produces a softer lower sound. The higher draft angle makes the pressing of the button more smooth than 2a's and 2b is a bit in between 2a and 2c regarding sound and pressing experience.

5 When looking at the symbolic experience of 2a-c, we see that interaction with 2c gives a very mellow and relaxing experience. 2b feels pleasant, and 2a feels sudden and empty.

3.4 FINDINGS

In the first Material mapping (see page 5) we found many differences between the popping experiences of each emboss design. Overall there seemed to be a correlation between the height and width of the emboss, where higher embosses were more likely to obtain a second resting-state beside their original state. Also, the emboss requires a certain width size in relation to the materials thickness and structural properties, in order for it to obtain this second resting state or linger before popping back (see knob pattern page 5) and produce a popping sound. However there are still many variables, like the embosses shape and the material's thickness, structure, and heating process, that could have influenced the popping properties in our iterations.

Therefor we designed a new mold, where we could analyze the pop ability among 2 variables; width, and draft angle. We found that the level of draft angle in combination with its size influences the pressing experience and the sound and volume of the pop. The widths of buttons 1 were too small for the material and did not allow enough space to move, while the width of buttons 3 were too wide resulting in a lacking pressing experience. Buttons 2 were found to be most enjoyable since they gave the best feedback. You could feel the moving of the material better than in the buttons of 1 and 3. Lastly a slight draft in the material is desired for a more fluent button-press experience, but not too much since it reduces the haptic feedback and volume of the popping sound.

3.5 CONCLUSION

Because of these findings, we chose to continue with the coarser material, since it creates more defined and permanent shapes than the finer leather does. Also, the coarser leather creates a more explosive 'pop' in both sound and movement which makes the interaction strong and decisive. since our aim for our design was to create a satisfying popping experience that invites the popping interaction, the circular shape was chosen over the oval. We felt that the circular shape had a stronger feed-forward for pressing down, and also created a better 'pop' due to its ability to obtain a second rest state. Lastly, we chose to include the layers in our final design as well, since these layers add a visually pleasurable experience to the interaction and feedforward to the user that different press distances are possible. Also, the vibrations in the material each time a layer is surpassed confirm to the user that their efforts have an impact. Lastly, the individual rings need a height of 2mm or higher and have a draft angle between 5 and 25 degrees, to improve the smoothness of the press, while keeping the volume of the popping sound.

4
DETAILING

In this chapter we are going to finetune the physical form and interaction gestalt of our chosen concept from the material synthesis until our final design TRYCKA was formed.

4.1 FINETUNING EMBOSS DESIGN

We wanted to design embosses that create a feedforward that shows the embosses can be touched and attracts people to touch them with attention. It is worth mentioning, that this artifact does not offer a knob or a button, because a button has a function and that was not our aim for our final design. Bearing this in mind, we deviated from the knob image by delving into the form details. We explored how the different layers relate to each other and how these details affect both the feedforward and feedback.

This resulted in the following; each circular layer is not located in the middle of the layer below as can be seen in our previous design (see figure 4). Instead, the path of the circular layers is off-centered and directed in a particularly straight line (see figure 3). Due to the off-centered pattern and related changing size and shape surfaces, the form feedback is changed depending on how you stroke your finger across the different layers. For example, when stroking from the outer circle to the inner circle, it differs from where you start stroking, which is not the case when the layers are centered. Having these different ways of stroking the embosses also affects how smooth the touch of the embosses is experienced. In addition, the dimensions of the off-centered emboss also influence the push feedback; while popping-in takes less time (easier) to push the top layer of the emboss instead of pushing the very center of the outside layer of the emboss.

Because each circular emboss shows a visual direction independently, we explored how these different 'lines' can be visually merged and how they can work together. We designed a few images (see appendix 6.1, p.12/13) that illustrate these visual options where the size and location of the embosses were not changed during the exploration for the sake of consistancy. The reactions to these visuals were mixed, some people

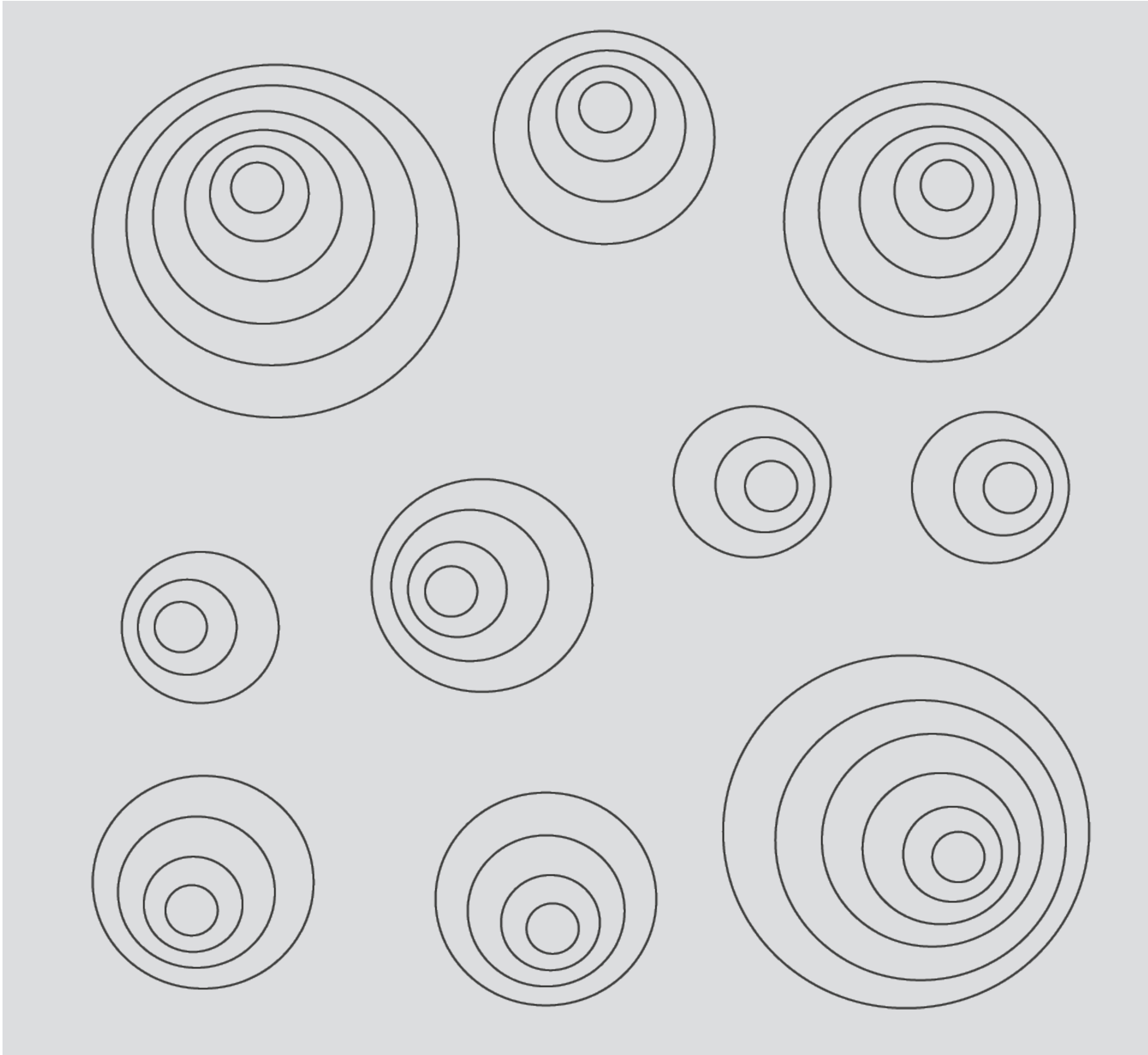


figure 3 I Exploration of direction

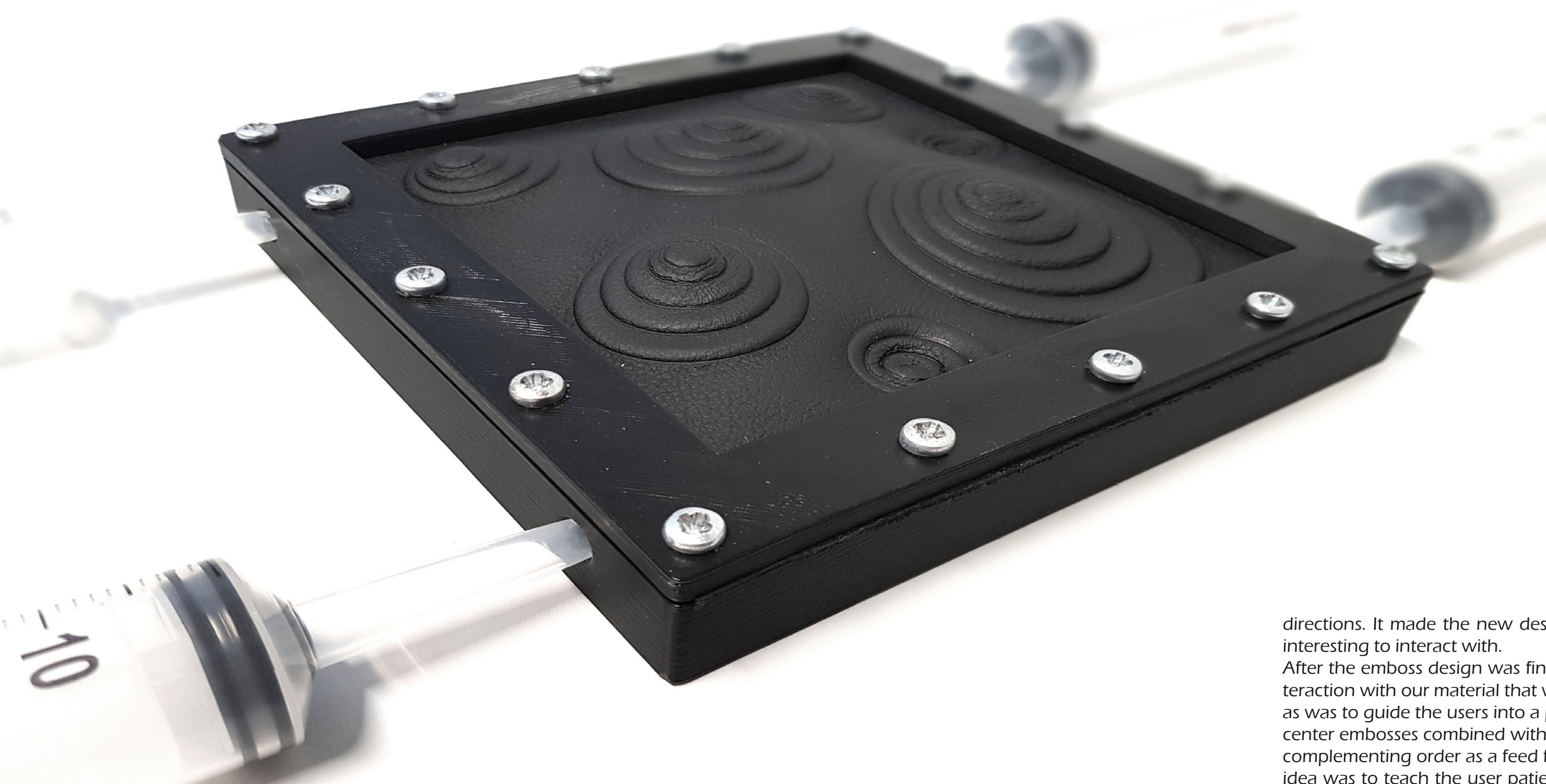


figure 4 I testing of the circular layered pattern

were drawn to the embosses that were more directed, had a focus point or some level of regularity because that was ''easier to understand''. Whereas others were drawn to a more random order. As a result, we concluded that the direction is not leading in the visual attraction, but the amount and size of the embosses and how these relate to the surface size of the artifact are. One overarching theme that came forth after analyzing people's experiences about their visual interaction with our demonstrators was ''calmness''. As a next step, we have embraced this theme because it complements our interaction. We accomplished this by making the surface slightly bigger and by changing the space in between the embosses, giving the total surface more ''white space''. In addition, we enlarged some of the embosses and reduced the number of embosses by half, 5 instead of 10. Resulting a less crowded design (see figure x). Furthermore, we direct the embosses to each other, as if they were looking at each other. As a final adjustment, we changed the center of gravity by adding a slight unevenness; done by positioning two of the embosses slightly closer to each other. Overall, the pattern of embosses became easier to grasp and showed to be more in line with the randomness we are aiming for.

4.2 FINETUNING INTERACTION

The change from centered layered circular embosses to the off-centered design, communicated different feedforward to the user. Where the centered variant stimulated mostly pressing down, with an occasional circular stroke around the rings, the off-centered design motivates users to stroke the rings in different manners, along the rings, up and down on different sides, and of course pressing down in different areas and directions. It made the new design more diverse and therefore more interesting to interact with.

After the emboss design was final, we thought of different ways of interaction with our material that we wanted to provoke. One of the ideas was to guide the users into a pattern, using the directions of the off-center embosses combined with the popping-out of the embosses in a complementing order as a feed forward to the interaction. The second idea was to teach the user patience by slowing down action possibilities. An emboss would only be inflated once the user approached the emboss with care and did not pop every emboss at once. The third idea was to let the users freely choose which emboss to press and in what manner. This allowed freedom of expression from user to the material, while the randomness of inflation, gave the material also expressional qualities, stimulating a relationship between user and product, which we found the most valuable interaction to work out.

To deepen the relationship between user and product, we aimed to give the material even more expression, by playing with the inflation time in the embosses. By slowing this down, the user can press during inflation, and will be met with some resistance. Creating more interplay, and an almost negotiation like experience. While pressing the embosses later makes for an easier and decisive pop. To make this subtleness in haptic feedback noticeable we changed to a slightly thinner leather which our small air pump could manage.

TRYCKA

The interaction between the audience and TRICKA is partly determined by its visual (manufactured) inherent qualities. The visual aesthetics of the shaped material invites or repels people at the first glance. Considering this quality, we shaped our interaction to fit with each element. Next to visual qualities, TRYCKA has auditive and dynamic (movement) queues to play with. Auditive qualities arise from the noise of the emboss "popping" and the sound of the air pump while being on. The dynamic qualities come from the shape-changing of the embosses, changing angles of light and contrast.

With these qualities we aimed for an interaction to tease, wonder grasp for attention, while still keeping the calmness embedded into the interaction. Creating an interaction loop that continuously seeks the attention of the viewer and changes the behavior from rushed to calm. The interaction follows a simple, yet effective loop for this goal. TRYCKA starts with its embosses in their "popped-out" state to attract attention. When the person approaches the device within 200 cm of the sensor located at the bottom, the programmed loop will start. The loop will wait a random time between 6000-20000 Ms, giving the viewer time to interact with TRYCKAS embosses. After this random given time, the device will start blowing up the embosses for a time between 1000-6000 Ms. After this, the sensor starts to detect if there is still any person located within the range to start over again. With this setting we aim for an approach where the embosses will visually attract attention by being popped out and create a randomized loop to interact while engaged with a person to keep the interaction surprising. While at last, the TRYCKA resets itself for the next interaction teasing the user with the sound accompanying the popping-out to continue their interaction.

The multiple sensorial feedback of the material between the embosses transition stages makes the experience of the interaction wholesome since the auditory feedback of the pop strengthens the haptic experience of pushing the material and serves as a confirmation of a well-executed action. To keep the interaction with TRYCKA interesting, the auditory and haptic feedback also differs from emboss to emboss, and resistance can be felt through different stages. Pops can be heard on the popping out or popping in. While eventually, the randomness of the pump will eventually call for attention by the means of its auditive cue.

The context of the device is important to determine the timing on the device. For a more domestic setting, a slower approach would be more suitable, whereas for a more demonstrative setting, the mentioned above setting would be suitable or even faster timing.

5

DISCUSSION

For this study, an interactive artifact Trycka was presented in which shape-changing material was used for interaction. The artifact was used to gain insight into how user action can be steered through the inherent feedback of leather. The leather was explored and designed towards a physical and temporal form, which embraces the intended transition of pop-in and pop-out [7]. The exploratory results show that designing this transition through embosses creates a unique situation, where both the feedforward and feedback naturally complement each other through shapechanging. We discovered that the visual feedforward of the embosses resonates with the auditive popping sound feedback, which as a result creates a calm experience. In this way, the feedback is inherent to the action of pressing the embosses [12].

Furthermore, leather can be labeled as a natural and in general familiar material, which we even possess ourselves; skin [13]. This means that leather could provoke reliability and may over time also arouse expressivity; this refers to the extent to which an artifact may cause the user to experience feelings or emotions, or how an artifact can allow the user to express themselves emotionally [14,15,16]. On top of that, the more the artifact is interacted with, the more the touch and visual appearance of the leather transforms over time. This phenomenon is, for example, also seen with old car seats, which become more creased and wrinkled over time; such an interplay between the interaction of the user and the transformation of the artifact could possibly support a better fit between the user and the leather [17].

Bearing this in mind, a specific circular layered shape and pattern of embosses was designed in order to provoke a visually pleasurable experience, but also to inform people about the kinds of action possibilities Trycka possesses. In addition, one key design value within the final process of developing Trycka concerns that the detailing of the interaction must respect the inherent information that provokes natural calmness. As a result, Trycka has shown a subtle integration of an interaction loop that behaves on the behalf of the emotion.

Overall, the exploration of the artifact shows how the inherent feedback strengthens the coupling between the action and the feedback [11]. The sensory richness of the leather and the action of the artifact acted as carriers of meaning, embedded in the subtlety of the interaction.

Evaluating the process in retrospect shows that the analytic material mapping played a crucial role in making well-considered design steps. However, during the Syntheses process, an in-depth understanding of the leather limitations was exposed, which showed that crafting the material into the desired shape is a complex and time-consuming process due to the somewhat unpredictable material properties. This also demonstrates how intertwined this design process was in terms of understanding different disciplines, such as material science and chemistry [18,19]. On that note, the Syntheses should be executed more precisely, using particular tools that can measure in an adequate manner. For example, measuring the temperature with an accurate thermometer and tracking the time the leather has to dry would be beneficial. By using more refined tools, the qualities of the interactions that are critical in particular contexts can be stretched, so that the current behavior of Trycka can be analyzed. Especially considering the implementation into practice there is much more to explore, such as how this particular interaction loop is associated with specific emotions.

Lastly, most of the design process took place in a lab. It is therefore recommended to do user tests and apply Trycka in different environments, application areas (on the wall for example), and fields given that these seem extensive [9].

5.2 REFLECTION

I believe we cannot hold onto our definitions of our relationship with the environment. We have to take a new and more sustainable path and be more space-efficient. I like to position myself as someone who is drawn by social settings and creating interactive experiences by exploring how these experiences contribute to the perception and behavior of people visiting public spaces. I envision designing new symbiotic dimensions for public experiences, targeting both the user and the environment. Interactive Materiality is a design field, which I had not yet explored. I used to approach materials more as something ''flat'' by means of perceiving it as a design decision, like (visual) aesthetic pleasure or sustainability, instead of an object that can be dissected and experimented with. I learned that the (interactive) material can also become the key value to connect or support the relationship between the user and environment, thus revealing new opportunities and experiences. The process and literature helped me to look at materials through a critical lens while having a theoretical perspective.

On top of that, I learned to iteratively explore, analyze, affirm and appreciate the behavior and context of material by delving into phenomenology, and making distinctions in form, feedback, property information, and practical aspects. Something that became very clear to me during the process of framing materiality is that it is about making concessions between the availability of the technology and the limitations of the material. That being said, in order to make an aesthetic experience you have to become sensitive to the subtleties of the material to get to the desired ''material interaction'' instead of being merely driven by the technology you know.

I think these insights could definitely be integrated into my current and future work, which is mainly societal-driven. My main learning goal during this course was to understand and discover how materials can be coupled aesthetically with social sustainability and environments. The course has definitely helped me to grasp this exploration after being introduced to the 'Frogger framework' and the 'Expressivity in Interaction' framework. At first, I thought the size and context of public space might be a bit overwhelming for this materiality context. However, after this course, I think it would be rather valuable within my work to explore the social layers of aesthetics in the architectural environment and couple these with the social context of material interactions. Furthermore, I can imagine that merging the aesthetics of both the environment and the material during the early stage of the design process might lead to more comprehensive, sustainable, and reciprocal designs. It would for example be interesting for me to go after materials in natural settings and design the interactive material experience from there. All in all, the course helped me to define interactive materiality, to be critical and to broaden my perspective within the area of aesthetic quality. As a final note, I am eager to see how our prototype can be elaborated on and can be suitable in real-world contexts.

REFFERENCES

1.Hallnäs, L. & Redström, J. 2002. From Use to Presence: On the Expressions and Aesthetics of Everyday Computational Things. ACM Transactions on Computer-Human Interaction 9, 2: 106–124. https://doi.org/10.1145/513665. 513668

2. Weiser M, Brown JS. The Coming Age of Calm Technology. Beyond Calc. 1997;01(July):75–85.

3. Merleau-Ponty, M. Trans: Smith, C. Phenomenology of Perception, Routledge, London, UK. 2005.

4. Frens JW, Djajadiningrat JP, Overbeeke CJ. Form, interaction and function : an exploratorium for interactive products. In Integration of knowledge, kansei, and industrial power : 6th Asian design international conference, Tsukuba, 14-17 October, 2003. Tsukuba, Japan: Science Council of Japan (SCJ). 2003. (Journal of the Asian Design International Conference).

5. De Fine Licht K. "Hostile architecture" and its confederates: A conceptual framework for how we should perceive our cities and the objects in them. Can J Urban Res. 2020;29(2):1–17.

6. Sward, D. & Macarthur, G. Making User Experience a Business Strategy. 2007.

7. Vallgårda A. Giving form to computational things: Developing a practice of interaction design. Pers Ubiquitous Comput. 2014;18(3):577–92.

8. Wensveen SAG, Djajadiningrat JP, Overbeeke CJ. Interaction frogger: A design framework to couple action and function through feedback and feedforward. DIS2004 - Des Interact Syst Across Spectr. 2004;177–84.

9. Stienstra J, Alonso MB, Wensveen S, Kuenen S. How to design for transformation of behavior through interactive materiality. Nord 2012 Mak Sense Through Des - Proc 7th Nord Conf Human-Computer Interact. 2012;21–30.

10. Winters AKM, de Waart SG, Bruns M. Tension-and-Release: A Design Principle for Dynamic Materials. International Journal of Design. 2022 Aug 31;16(2):1-14. doi: 10.57698/v16i2.01

11. Djajadiningrat JP, Overbeeke CJ, Wensveen SAG. But how, Donald, tell us how? on the meaning of interaction design through feedforward and inherent feedback. In MacDonald N, editor, DIS '02 Proceedings of the 4th conference on Designing interactive systems: processes, practices, methods, and techniques, London, England, June 25 - 28, 2002. New York: Association for Computing Machinery, Inc. 2002. p. 285-291 doi: 10.1145/778712.778752

12. Laurillard, D. Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies (1st ed.). Routledge. 2002. https://doi.org/10.4324/9780203160329

13. Moore & Giles: History of Leather. www.mooreandgiles.com/leather/resources/history.

14. Bruns M, Ossevoort S, Petersen MG. Expressivity in Interaction: a Framework for Design. In n CHI Conference on Human Factors in Computing Systems (CHI '21). New York, NY, USA: Association for Computing Machinery, Inc. 2021

15. Ståhl A, Sundström P, and Höök K. A foundation for emotional expressivity. In Proceedings of the 2005 conference on Designing for User eXperience. AIGA: American Institute of Graphic Arts, New YorkNYUnited States. 2005.

16. Wensveen SAG, Overbeeke CJ, Djajadiningrat JP. Touch me, hit me and I know how you feel: a design approach to emotionally rich interaction. In Boyarski D, Kellogg WA, editors, Designing interactive systems: processes, practices, methods, and techniques. New York, NY, USA: Association for Computing Machinery (ACM). 2000. p. 48-52

17. 1. Forlizzi J, Battarbee K. Understanding experience in interactive systems. DIS2004 - Des Interact Syst Across Spectr. 2004;261–8.

18. M. A. McEvoy and N. Correll. 2015. Materials that couple sensing, actuation, computation, and communication. Science 347, 6228: 1261689–1261689

19. Qamar IPS, Groh R, Holman D, Roudaut A. HCI meets material science: A literature review of morphing materials for the design of shape-changing interfaces. Conf Hum Factors Comput Syst - Proc. 2018;2018-April:1–23.

6

APPENDICES

6.1 PEER REVIEW

Looking back at this project, I am definitely proud of what we have achieved as a group. First of all, we did not stick to our initial version; we analyzed our shapes extensively, even when we knew we already had a promising shape before that. We worked communicatively, meaning each of us was very open to giving and receiving feedback and openly processed this as well. Each week we came together to brainstorm, discuss our process, and rationalize why we made certain decisions. Each of our group members had his or her own field of interest during the design process. Brent was mainly working on the technical part of the prototyping and carried responsibility for the coding. Roos and I on the other hand were more focused on the aesthetics, visual content (videos, pictorial) and analytic part of the process. Overall, we assisted each other and analyzed each other's contributions to the project. My main contribution involved associating the material with certain experiences and lines of thought while trying to express this in a "romantic" way. This means that I brought examples to the table that inspired us to go in a more unique direction of experience. Roos was consistent in seeing the process from a top-view perspective, by means of sensing when to move forward and when to take a step back and reflect, while rationalizing this. Brent was very skilled in making our ideas tangible, by being proactive and hands-on.

6.2 EXPLORATION OF DIRECTION