SANDY: Interactive Materiality In A New Form

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Abstract
This annotated portfolio presents the process of explorating material properties towards creating a new interactive and shape changing interface. The goal was to create an interface that would contribute to a joyful experience of relaxation. The design process started based on a rotating/turning gesture and the transition of concealing towards revealing. The outcome of this exploration is SANDY. SANDY is a new material composed of Super Sand, small stones and iron powder. These materials combined give SANDY magnetic properties and a sandy texture while remaining soft to touch.

Authors Keywords
Interactive Materiality; Rotate; Playful; Interaction Design; Shape-change;

Introduction
Design for the future. Every day new technologies are developed and computer interaction becomes more and more important. Exploring Human-Computer Interaction (HCI) through haptic interaction design could be a way to open doors for new ways to communicate with newly developed technologies.

Materiality is described as the 'quality of being composed of matter' [12], which means that all the different qualities of a specific material together define a material. When one of these qualities is adjusted, another material, with other characteristics, is formed. These characteristics can,

for example, be the weight, the strength or the texture of this specific material. When materiality is coupled with haptic interaction design and HCI, interactive materiality be described as a way humans interact with technology through tangible interfaces.

In this annotated portfolio the Human-Computer Interaction (HCI) is explored through haptic interaction design in the subject to interactive materiality. The overarching goal is to investigate new ways to create a tangible interaction by exploring a variety of materials by the means of the research through design method [19].

Related Works

The authors of this annotated portfolio have explored different kinds of shape-changing and morphing materials like Shape Memory Alloys [18] and copper tape cut in different patterns [6]. Provided that using shape-changing interfaces and morphing materials aim to connect material science and HCI. The authors looked not only at shape-changing alloys but explored the possibilities of shape changes in Temporal Form as proposed by the research of Anna Vallgårda [7,14]. She states that the control of the shape change is either in the hands of the person who interacts with the object or the underlying system. However, she does not speak of an object where the control is shared with the underlying system as well as with the user interacting with it. During the design process of creating SANDY, the authors tried to create a design where the control is shared and how that would influence the experience of the material itself. Together with the shape-changing interfaces, the design offers the possibility to implement the Frogger framework [17]. The shape-changing interfaces could cause to shift the inherent feedforward (the communication of what kind of action is possible) towards functional feedforward (to reveal the function of the object itself). When these shape-changing interfaces are combined with the aesthetics that haptic design offers, the experience of the interaction can be enhanced [5]. Instead of designing from the function (how it works) the authors try to start from the experience they want to create (why would someone interact with it?). Haptic visuality [11] can support this experience and create a distinction between the feedforward of the expected tactile experience when looking at the object, and the feedback of actually touching it. The expectation of how it feels might differ from what the user will experience.

Design and, accordingly, interactive materiality is a way to change and influence people's behavior. However, the paper on changing behavior through interactive materiality [13] proposes examples that the author finds hard to link to interactive materiality. The author does see the added value of the auditory feedback, in the example with the ice-skater, when looking at embodied sensemaking [10]. However, the added auditory feedback does not change anything from the material itself.

To give shape to this project and design process the authors decided on an overarching goal to create an experience wherein the object draws the attention of the user, that the user wants to explore and wants to keep playing with it. With this in mind, the author wanted to explore many different kinds of materials and wanted to investigate materials that were not so obvious. By exploring the possibilities of these materials when combined with other materials, in order to generate a surprising experience.

Design process

The approach used to get to the final design of SANDY is described in the following paragraphs. Starting with the approach, followed by the wide exploration to be continued into the focus, to be concluded in the final design.

Approach

As a starting point, different gestures were explored as well as transitions that could create an experience of relaxation and playfulness. The gesture of turning/rotating was preferred over gestures like pressing and stroking, in which the rotating gesture could enhance randomness and in extension the playfulness of the experience.

Figure 1. Magnetic Curtain [9]

Figure 2. Origami Pleat [15]

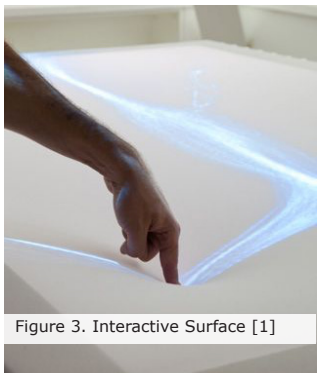


Figure 3. Interactive Surface [1]

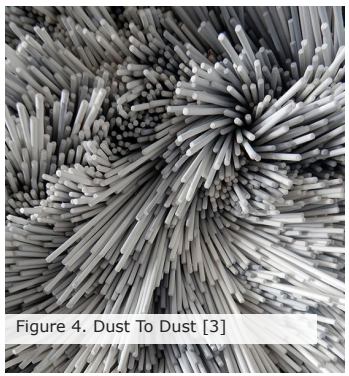


Figure 4. Dust To Dust [3]

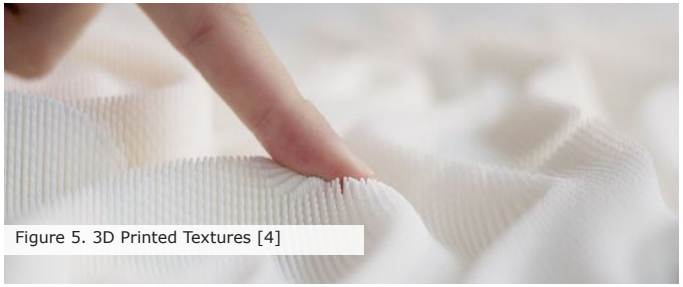


Figure 5. 3D Printed Textures [4]

To create an element of (positive) surprise, a transition was chosen that originated from hiding to exposing, from conceal to reveal. With this in mind, the design needs to draw attention when in a state of hiding to persuade the user to touch the design so that the design can expose itself. The goal is to provoke an experience where the user is drawn to the design and as soon as the user starts interacting with it he/she becomes compelled to keep interacting with the design.

The gesture of rotating/turning was explored and the transition of concealing to revealing as well by collecting materials and pictures with various fascinating elements. When scrutinizing the collected materials and pictures it was found that there was a common theme: interaction combined with surface manipulation as represented in figure 1, 2, 3, 4 and 5. As well as the interaction and manipulation of the surface the collected materials and pictures represented a form of haptic visuality [11]; by just looking at it, you can almost feel it. The aesthetics and the haptic visuality should invite the user to touch the object and interact with it.

All things considered, the haptic visuality and the traces that the user left behind by interacting and manipulating the materials were considered to be the most captivating/ interesting. The traces tell a story, it shows the history of the previous use, but also allows others to leave their own trace through interacting with it.

Exploration

Now that the goal, gesture and transition for the design have been defined, this all needs to be translated into a tangible design. To kick off, the exploration phase, all kinds of materials and patterns were analyzed and tested through different combinations.

Figure 6. Highlights of First Exploration

Exploration

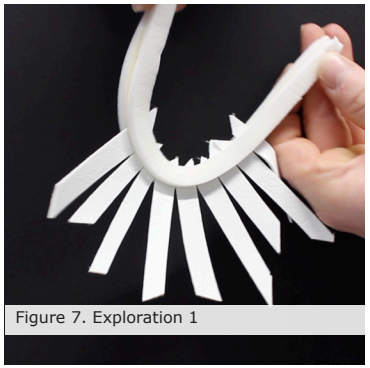


Figure 7. Exploration 1


Figure 8. Exploration 2

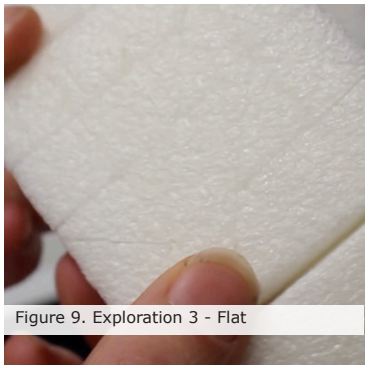


Figure 9. Exploration 3 - Flat

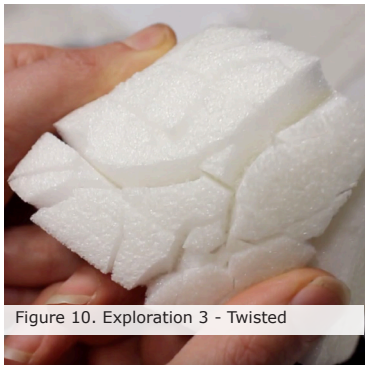


Figure 10. Exploration 3 - Twisted

Figure 6 shows the highlights of this exploration. For instance, the sample of three different pattern cutouts. Nothing interesting is shown, only when rotating the different layers over each other a certain pattern reveals itself and because of the continuous dynamic, the transition stays interesting to look at as shown in figure 7 and 8.

Similarly but differently, figure 10 exposes a pattern that only appears when the foam piece is twisted. When the foam lays on a flat surface, there is no pattern visible as shown in figure 9, giving it a high potential to be concealed or revealed.

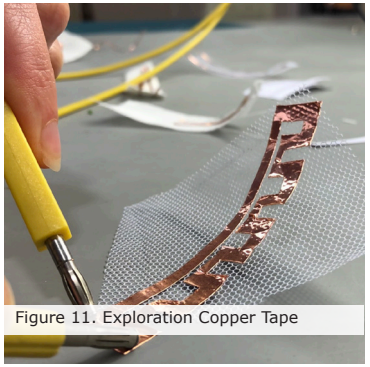


Figure 11. Exploration Copper Tape

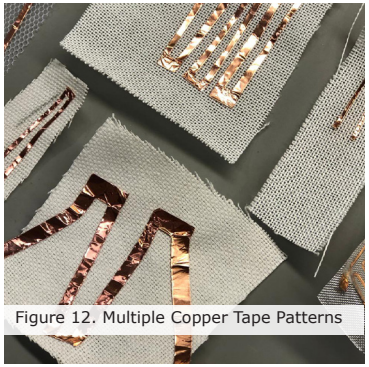


Figure 12. Multiple Copper Tape Patterns

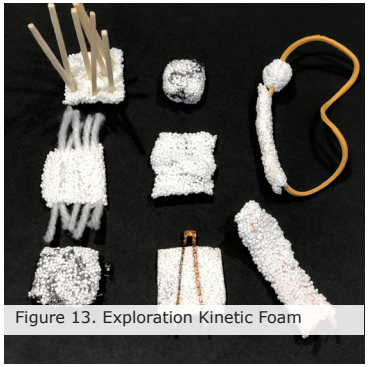


Figure 13. Exploration Kinetic Foam

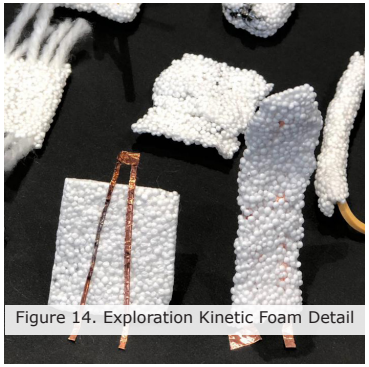


Figure 14. Exploration Kinetic Foam Detail

To create revealing patterns, the materials needed to be manipulated or actuated. One of the explorations to manipulate different types of fabric was using copper tape as shown in figure 11 and 12. After testing different shapes and voltages, it was concluded that the movement of the material was too slow for its purpose. Nonetheless, further experiments with copper tape in combination with other materials have been executed. For instance,, the usage of kinetic foam. However, tests show that copper tape in combination with kinetic foam did not create an optimal effect. Yet, the structure of kinetic foam was quite interesting in combination with a different application, as presented in figure 13 and 14. For example, adding magnets within the kinetic foam. The movements of the kinetic foam when added the magnets created an interaction that was random and unpredictable and therefore became playful. Unfortunately, the kinetic foam hardened overnight and became non-pliable after being exposed to air for a couple of days.

Focus

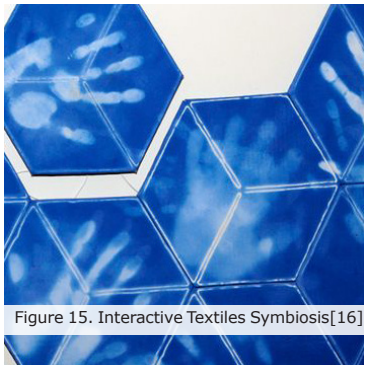


Figure 15. Interactive Textiles Symbiosis[16]

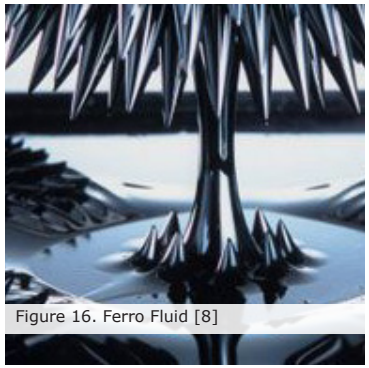


Figure 16. Ferro Fluid [8]

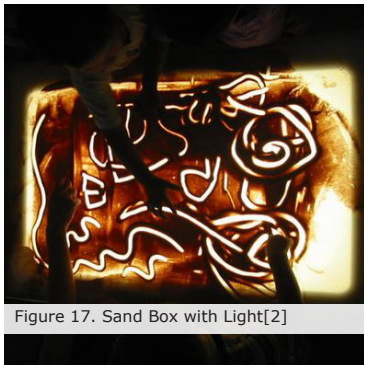


Figure 17. Sand Box with Light[2]

The earlier explorations did not fully satisfy the envisioned result, therefore other possibilities were explored with the idea to think beyond fabrics. A broad exploration was executed to find out what other materials could fulfil the envisioned goal, both visually as well as haptically. As mentioned before, the goal was to create something that the user wanted to keep playing with and something that leaves traces. The resulting examples of this brainstorm, as presented in figure 15, 16 and 17, was a broad range of materials. This is a playful way of leaving traces but the sandbox example would need the input from a user and there is no actuation.

With this in mind, an exploration to different types of sand, such as Super Sand was preformed. Super Sand has a very soft texture that almost feels like silk. It can be manipulated and moulded into different shapes. The adherent properties give it the capability to be piled up and freely formed to different shapes and on the other hand to be torn apart to individual grains of sand. This property makes it especially interesting to experiment with the material because this means that it has also a 'mind of its own' when it comes to forming patterns and that it is not only depending on the user. However, to make the design more random there needed to be another layer of interaction.

Provided that the Super Sand and the magnetic effects could give the desired effect, different samples of material combinations were made. When adding iron filings to the Super Sand, the newly formed material got magnetic properties and when exposed to magnets a clear effect visible. Twelve samples have been tested in total as shown in figure 18. Six samples were considered as a user-friendly mixture. 23 people tested these mixtures and voted their favourite. The mixture of 30 percent of Super Sand, 40 percent of small stones and 30 percent of iron filings, have voted to be the most interesting in terms of the haptic visualization and sensation.

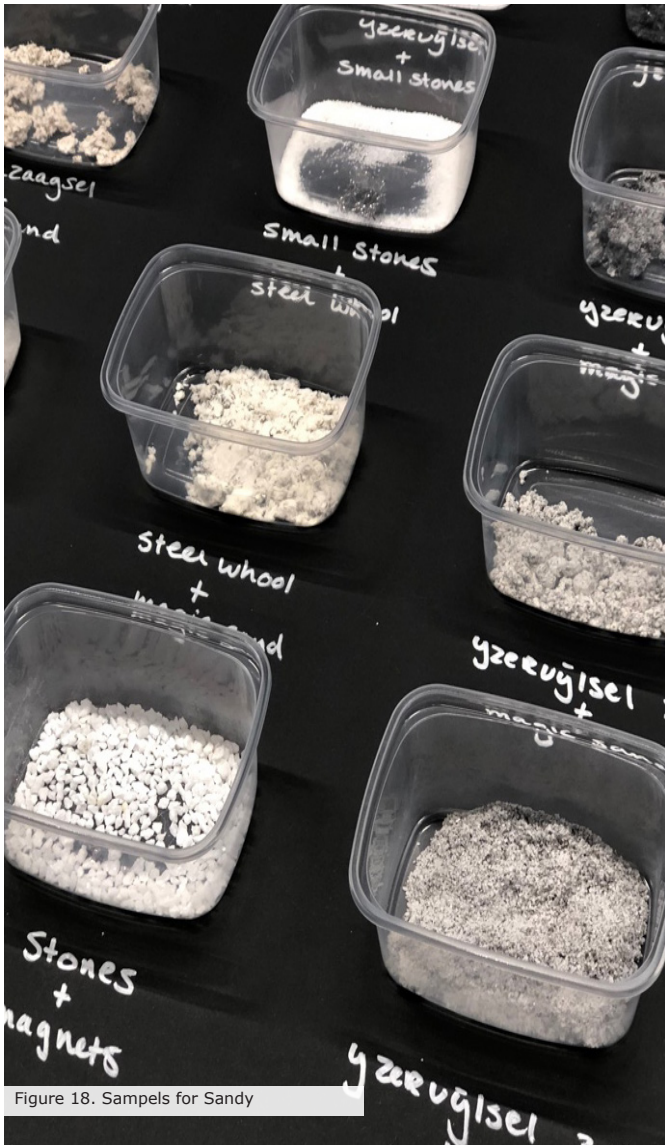
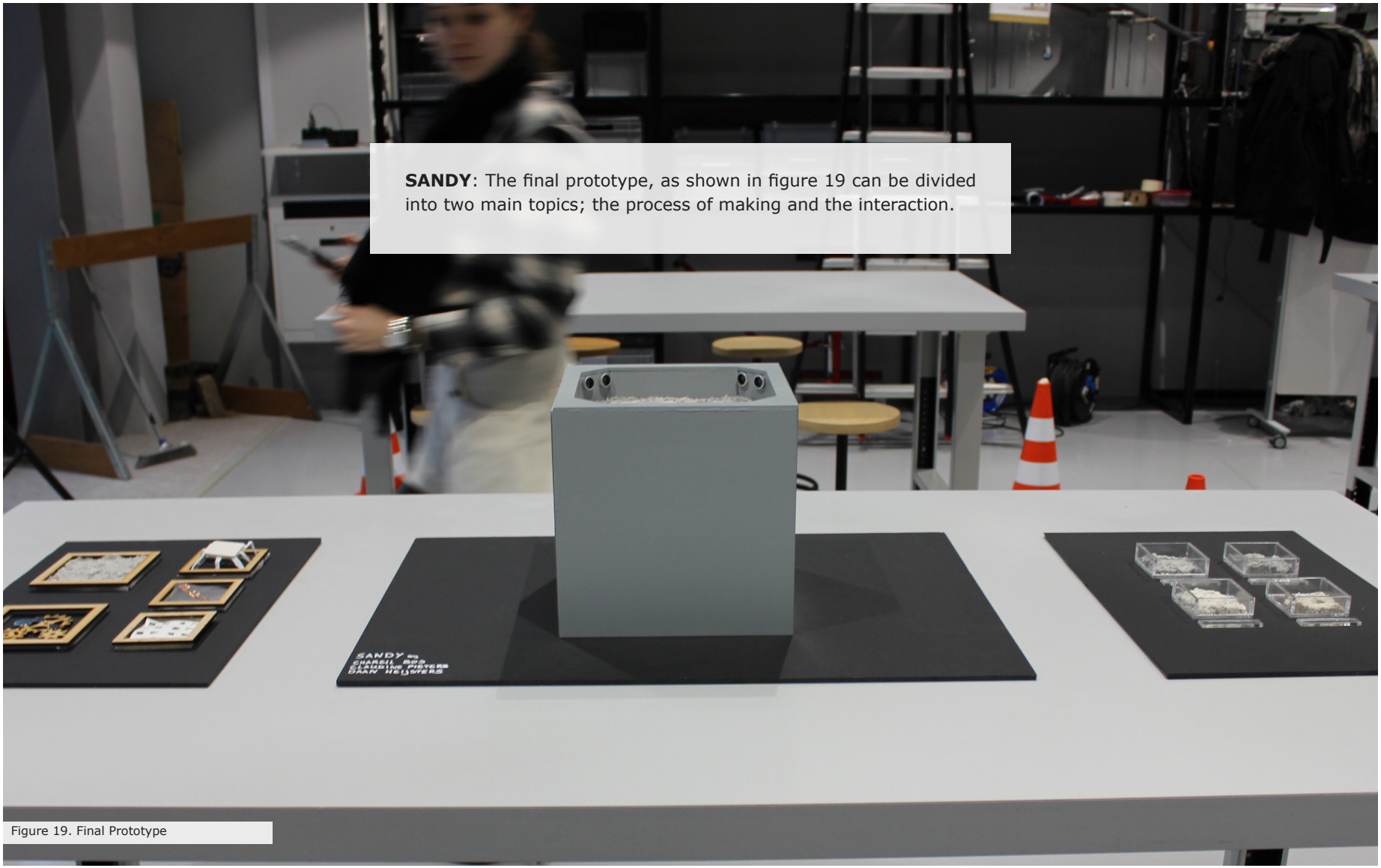


Figure 18. Sampels for Sandy

Final prototype



SANDY: The final prototype, as shown in figure 19 can be divided into two main topics; the process of making and the interaction.

Figure 19. Final Prototype

Process of making

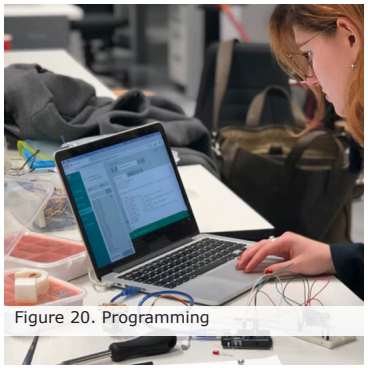


Figure 20. Programming

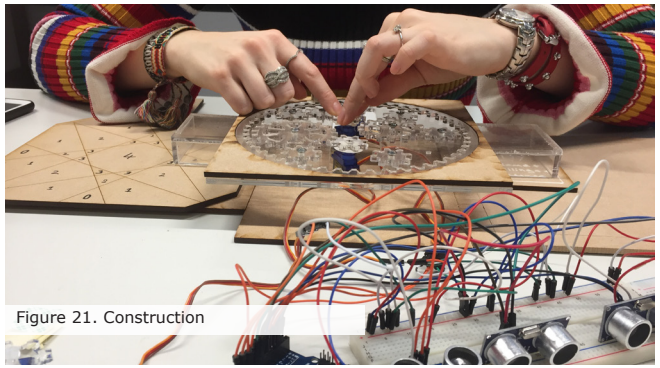


Figure 21. Construction

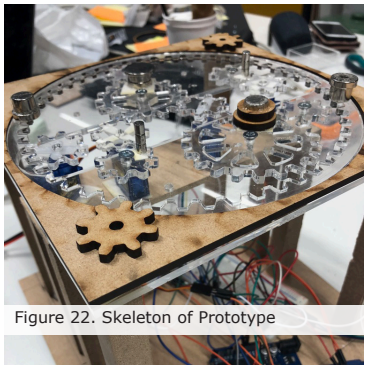


Figure 22. Skeleton of Prototype

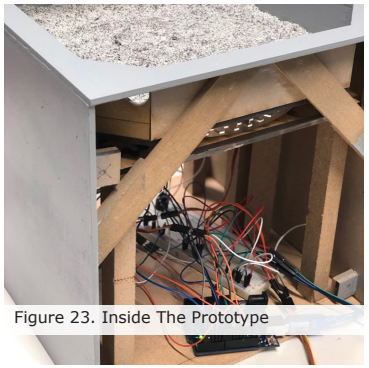


Figure 23. Inside The Prototype

SANDY consists of four Ultrasonic Distance Sensors (HC-SR04) in every corner of the box. These sensors measure the position of the user's hand and using this information, a particular gear starts to rotate as a reaction to the user's presence. The four gears are powered by Servo motors (SG90). The process of making is presented in figure 20, 21, 22 and 23. In total, SANDY has four different groups of gears. Two small groups, one huge gear and a smaller group of 2 gears as shown in figure 21. The force of the magnets ensures the effect of the patterns. The stronger the magnet, the more clearly a pattern reveals. SANDY uses 4 different types of magnets, from a strength of 100 gram till 8 kilos.


Figure 24. Mixing SANDY 1.


Figure 25. Mixing SANDY 2.


Figure 26. Mixing SANDY 3.

SANDY

The haptic visuality of the interactive material, SANDY, will invite the user to interact with the interface. The pleasant surface texture of SANDY consists of 30 percent Sagic Sand, 40 percent small stones and 30 percent iron filings. Figure 24, 25, 26 and 27 display a detailed photo the process of making of SANDY.

As described in the design process, the gesture of rotating/turning was chosen to enhance randomness and in extension the playfulness of the experience. SANDY is part of a shape-changing interface that shifts from an inherent feedforward toward functional feedforward. This means that the communication of what kind of action is a possible shift to the transition of the revelation of the object itself. When a user is close and/or interacting with the material SANDY it will reveal a certain pattern as shown in figure 28, 29 and 30, on the other hand by interacting with SANDY the user is actually slowing this process of revealing the pattern. Just by playing with the material, the user can interrupt the pattern and add a personal touch to it.

Figure 27. Close Up SANDY

Figure 28. Interaction With SANDY

Figure 29. Concealed SANDY

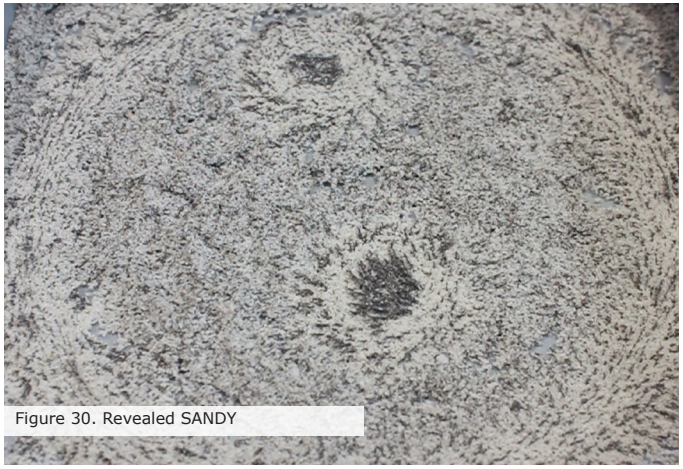


Figure 30. Revealed SANDY

Discussion & Conclusion

The work presented in this annotated portfolio contributes to a relaxing and playful experience, through the 'new' material SANDY. SANDY is controlled as well by the underlying system as by the input from the user. Through the research through design approach that is described, a variety of different samples were made before the final SANDY. However, there are still numerous aspects of SANDY that could be further explored. Not only the mixture of SANDY could be further developed, but also the underlying mechanism. Different shapes could give different interaction, as well as different strengths of magnets might give a completely different experience.

In the current design, SANDY has a begin state where nothing has happened yet, but as soon as the user starts interacting with it the state changes. It won't go back to the previous state unless the user does it manually. This is specifically chosen because the traces of use were a big part of the experience that the authors wanted to create. However, what if SANDY would go back to her previous state after use? What would this mean for the experience, if everytime the user starts with a clean slate? This is an interesting aspect that could be explored within further explorations.

Also, currently there are not really specific applications for SANDY. It might be useful for elderly people with dementia to play around with to maintain their motor skills. As well for people that are mentally disabled. Their motor skills could be enhanced when the interaction becomes more of a game. When the underlying system could react to music it could also become some sort of form of relaxation.

All things considered, SANDY is a material that is fun to play around with. The feedback we got was that almost everybody wanted to keep playing with it. That said, there is still a lot more that could be explored to make SANDY ready for application.

Acknowledgements

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