PIP: Interactive Materiality through layering

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ABSTRACT

In the current development of Human Computer Interaction, the interface is swifting from graphical user interface to a shape-changing interface. This trend is driven by the integration of sensing and actuation technology. This paper describes the explorative development of a shape-changing interface for interactive materiality. A flexible, smooth, yet sturdy material is created through layering. The material exploration is described, the prototype explorations are evaluated by using the Frogger Framework, and is experienced by users. The prototype aims to convey the behavior transition of shyness to playfulness in a subtle interactive and tactile experience, which is done by programmable sensing and actuation. The final prototype contribute design implication for the future designers to create interactive materiality.

Authors Keywords

Interactive materiality; shape-change; interaction design; haptics; layered materials.

ACM Classification Keywords

H.5.2 User Interfaces: Haptic I/O, Interaction styles.

INTRODUCTION

The graphical user interface (GUI) has become a standard and predominant solution to connect users and computed artefacts. However, in the current development of human-computer interaction (HCI), this phenomenon is changing driven by advanced technological development such as programmable material in combination with smart sensing and actuation (Isabel P.S. Qamar, Rainer Groh, David Holman, and Anne Roudaut, 2018). As a matter of fact, this new trend yields a new type of interface design namely shape-changing interface that overcomes the limitations that a GUI cannot afford. For instance, tactile interaction.

Tactile interaction opens up more opportunities for users to take advantage of physical qualities of product. Because it builds on the premise of respecting people's skills (S. A. G. Wensveen, J. P. Djajadiningrat, and C. J. Overbeeke. 2004), which include perceptual motor and emotional skills. Designing a shape-changing interface challenges designers to not only consider material, interaction and function, but also to explore their correlation and integration in order to deliver a rich tactile interaction. Interactive materiality is suggested as an innovative solution that aims to bridge the gap between materials, function and interaction design.

On the other hand, materials afford different physical qualities and tactile experience. Regarding these different qualities that come with the materials, designers can apply them to different interaction design areas that afford certain functionality. For instance, Bosu is a design tool created by Ishii and Parkes (Amanda Parkes and Hiroshi Ishii. 2010) that combines several physical qualities of different materials and being used in soft mechanics.

Besides the qualities of material, In the current HCI design cases, designers have explored haptic interaction by studying materiality while applying computer technology (programming, sensing technology, etc.) into the design process, this allows materials to expand their original physical properties while becoming a medium for interaction.

In this project, we would like to explore materiality through combining different materials, along with a goal to design a shape-changing interface affords tactile interaction. In terms of aesthetic qualities, we aim to design this shape-changing interface that provides not only seduction for behavioural transformation (Jelle Stienstra, Miguel Bruns Alonso, Stephan Wensveen, and Stoffel Kuenen, 2012) but also create respectful and aesthetic interactions. The Interaction Frogger framework (S. A. G. Wensveen, J. P. Djajadiningrat, and C. J. Overbeeke, 2004.) is used to evaluate our prototype. We present our first attempt, namely PIP (Playful Interactive Pins), a shape-changing interface, which initially aims to inspire curiosity from the users and encourage them to interact with it through tactile experiences. The research question

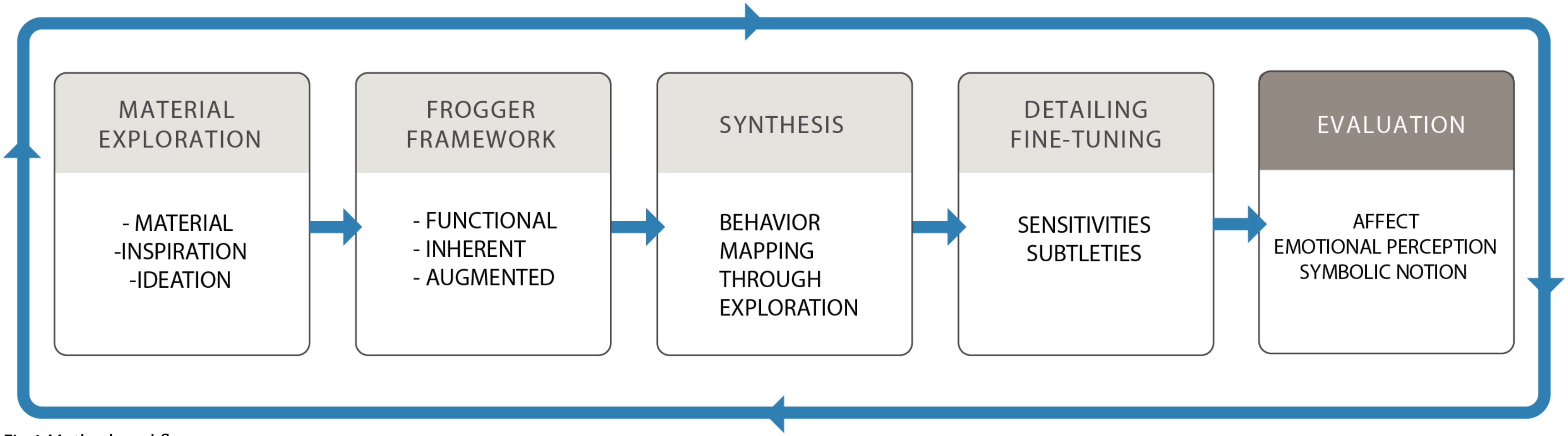

Fig.1 Method workflow

is proposed as following:

'How can we design a dynamic and flexible shape-changing interface that not only provokes behavioral transformation, but also deliver meaningful and respectful interaction?'

METHOD

First of all, inspiration and materials were collected. With these materials, an ideation workshop on a dynamic transition in the materials through exploration was performed, namely "sketching transitions in dynamic form from a materiality perspective." Designing for transformation of behavior requires a different design approach and process, because especially designing interactions have to be experienced. So, an exploratory approach was used with the Interaction Frogger framework as generative tool to guide through the iterations (Stienstra, Bruns Alonso, Wensveen, & Kuenen, 2012). The steps of this process have overlaps and occur interactively (see figure 1).

The first step of this approach is analysing the current behavior to be transformed through mapping the three types of feedback and feedforward; functional, inherent and augmented. Functional feedforward is the perceived function; inherent feedforward is the perceived interaction; augmented feedforward is the perceived extra sources of information; functional feedback is the output; inherent feedback is feedback on action through touch; and augmented feedback is extra information on whether it is functioning (Wensveen, Djajadiningrat, & Overbeeke, 2004). The feedback and feedforward are connected through the action the user performs.

The second step is the synthesis, which involves the mapping of the transformation behavior through exploration, such as trying out different materials and shapes, and adjustments in the coding. The desired result is then a continuous journey of action and perception, in which there is a change of behavior.

The final step towards the design is detailing, meaning fine-tuning sensitivities and subtly playing with input and output. And therefore also avoiding disruptive behavior, as in the interaction should not be too apparent or obtrusive.

A critique session with fellow students of the course acted as a user test to evaluate the prototype, since it is a very new topic that required a design perspective to be understood and this way more rich feedback was collected. So, the critique was given by the teachers and master students of the course Interactive Materiality. This took place at the Innovation Space from the University of Technology in Eindhoven. During this critique session, feedback was given on three aspects: affect, emotional perception, and symbolic notion.

Affect is about bodily reaction, so the user's initial reaction when looking at the object. Emotional perception is interpreting what is perceived and how. Lastly, symbolic notion concerns the overview of the previous two, so their overall expression and their perceived conceptual meaning behind the interaction.

After this the prototype could be interacted with and given extra critiques on, together with some potential points of attention through questions. Upon this critique, another iteration was done, which was shortly evaluated during the final presentation. Lastly, the final iteration was done.

DESIGN PROCESS

Fig. 2 BMW Vision Next 100

Fig. 3 Caress of the Gaze by Behnaz Farahi

Fig. 4 The 'stress bal' by Simone Schramm

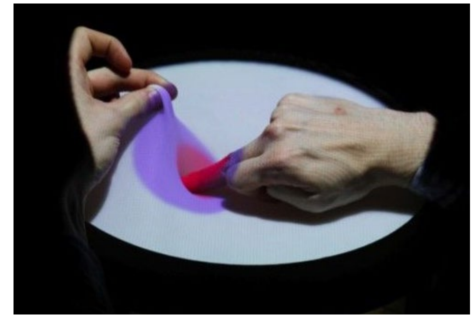

Fig. 5 Obake by Dhairya and Robert Hemsley

During the explorative journey, we found that layering materials can significantly change the properties, the tactile experience, but also the perception of the material. And through exploratory analysis and fine-tuning an interaction journey was made to provoke playfulness.

Our initial inspiration sources were pattern based shape-change, such as the BMW Vision Next 100 of which the dashboard is an analogue display system which alerts the driver to incidents and objects ahead (see figure 2; Habib, 2019; Karkafiris, 2016). Another example is the Caress of the Gaze by Behnaz Farahi, which is a 3D printed garment that responds with dynamic shape-change when someone is looking (see figure 3; Farahi, 2015). The 'stress bal' by Simone Schramm, which communicates the stress level in a haptic and visual way (see figure 4; Turner, 2016). Another interest was in flexible materials, such as Obake by Dhairya and Robert Hemsley, an elastic interface that explores gestures through 2.5D interaction (see figure 5; Obake, 2013).

Fig. 6 Lycra with hexagon shaped plastic net on top connected with paperclip

Fig. 7 Utility foam covered with lycra

Fig. 8 Push pin toy with squared patterned foam underneath

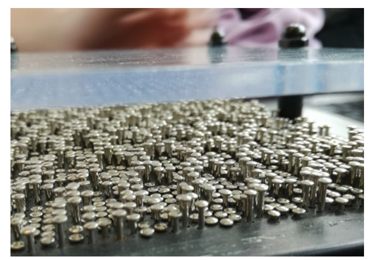

Fig. 9 Push pin toy with sleeve foam with an incision pattern that is stretched underneath

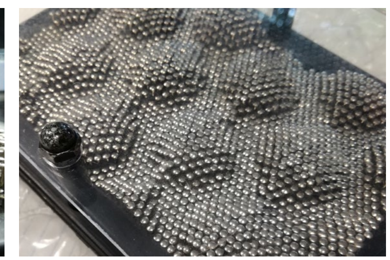

Fig.10 Push pin toy with plastic protection bubble wrap underneath

From the workshop "sketching transitions in dynamic form from a materiality perspective", it was decided to focus on a transition through shape-changing.

Initially, a lot of stretching with different materials was explored, together with their shape- and pattern-change (see Appendix 1). Then some materials were combined. One sample was a shiny lycra and a plastic net with a hexagonal pattern, connected through a paperclip, affording to pull it (see figure 6). When pulled, a slight shape-changing of the net was visible, and it also casted a shadow on the lycra, resulting in an interesting dynamic visual effect. A second sample combined lycra and underneath a low density utility foam with a wave relief (see figure 7). This gave a very interesting experience; it triggered a positive surprise since the user is guided through the bumps and the combination was extra soft and smooth.

Then, the utility foam of the second combination sample was combined with another 'material', namely a push pin toy to add to the desired dynamic shape-changing property. From that, explorations were done by putting different materials underneath, such as the squared foam, the sleeve foam, and the plastic protection bubble wrap (see figure 8, 9, 10). It gave interesting patterns, but no added value concerning the tactile experience, in particular pressure, since it was not as spongy as the utility foam. So, the utility foam was eventually chosen, which made for a nice smooth tactile experience with a very pleasant resistance when applying pressure.


Fig. 11 Push pin toy with utility foam

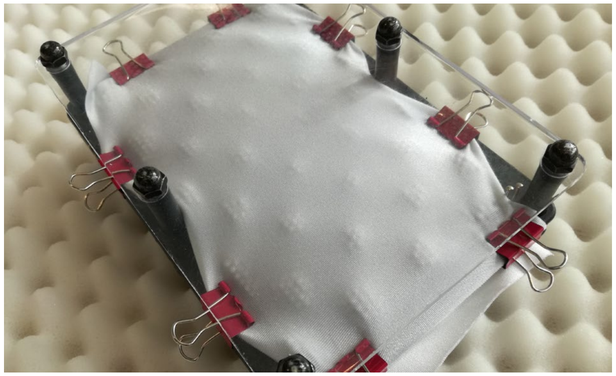
Fig. 12 Push pin toy with lycra, and utility foam

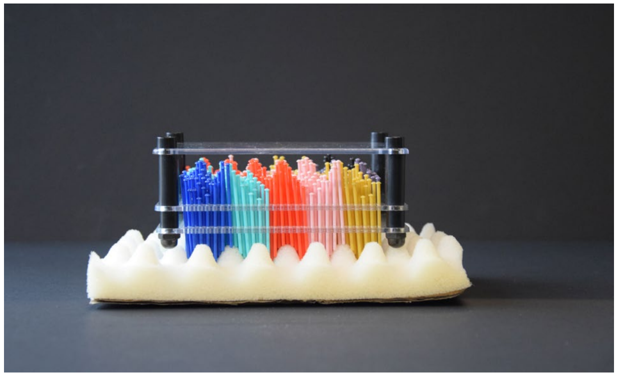
Fig. 13 Plastic pin toy

- Analysing

Then the lycra was added (see figure 12) to the utility foam and push pin toy, not only keep the pins in place, but also to add a softness and smoothness to it, which complimented the soft foam. This smoothness made interacting easier and more appealing, and thus added to the seduction, so to attract the user for interaction. Moreover, the easy stroking allowed for a more playful interaction.

With the combination of all three materials, movements were explored, such as tilting the push pin toy in linear and rotary manners and doing manual shape-changing by manually pushing against the cardboard behind the foam. Through these exploratory movements, the behavior, curiosity, was recognized, and with that the more dynamic and dense pattern foam was chosen (see figure 11, 12), over the more calm and less bumpy relief. This kind of 'up and down' motion was inspired on a variety of phenomena from nature and bodily movement and behavior, ranging from a happily jumping child to a curious dolphin riding the bow waves and an excited dog that wants to greet his human friend."

Then, the feedforward and feedback were mapped of this behavior. The functional feedforward is the shape-changing of the attention grabbing pattern that is moving up and down, inviting to be interacted with. The inherent feedforward is the pattern and material that seemingly allows for being pushed. The half emerged pattern in motion would make the user curious and invites the user to interact. The functional feedback is also shape-changing, though now through a locally emerged part, revealing the pattern, that follows the user as they hover or touch, which conveys the message of being curious. And the feeling of this change from a flat surface to an emerging pattern that can also be pressed, is inherently experienced. The six aspects of the Frogger Framework were also mapped (see Appendix 2).

- Synthesis

A squared interface affords a static interaction with right, left, up and down motion, therefore a circled interface was chosen to avoid this limitation. By having a circular interface, this will allow the user to experience a more fluent and friendly way of interaction rather than using a squared interface, which we experienced to allow for a more static and robotic movement. The behaviors are shy and playful, and this circular interface would more likely to be a suitable shape to afford such transformation of behavior.

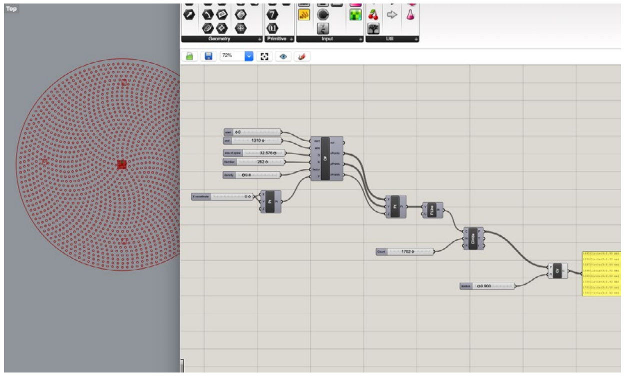

Fig. 14 Grasshopper code

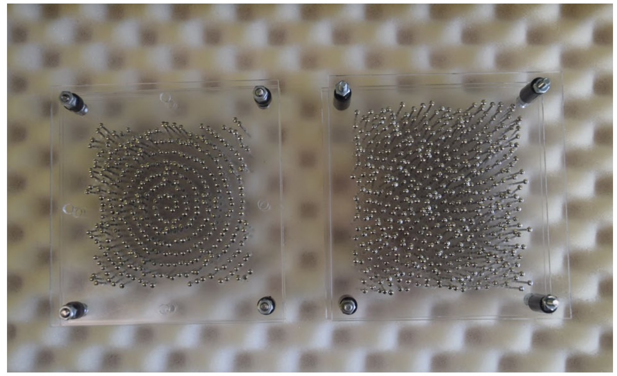

Fig. 15 Pin toy 1 & 2 top view

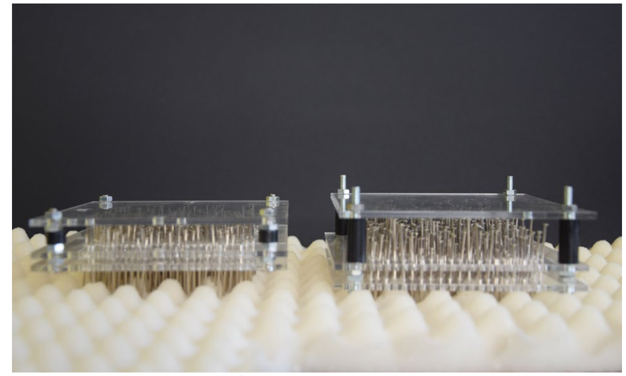

Fig. 16 Pin toy 1 & 2 side view

- Exploration of shape-changing pattern

The interface of the push pin toy is structured with pins in a dense manner. When placing it on any object, the shape of that object will be transformed to the surface of the pin toy (see figure 13). Different materials of pins were tried out, namely plastic and metal, but it was discovered that the plastic pins caused too much friction. Therefore, the metal ones were chosen for their low friction.

Grasshopper (see figure 14) was utilized to generate the pattern which is used as the interface. The Grasshopper code has three input parameters: density, position and number to control density of patterns, position of holes and amount of them.

Parameters fine-tuning was performed in the Grasshopper code, this served to find the ideal pattern with suitable density, position and amount that is able to transform the shape of the supporting material. In this experiment phase, two types of utility foams were tested (see figure 15, 16)

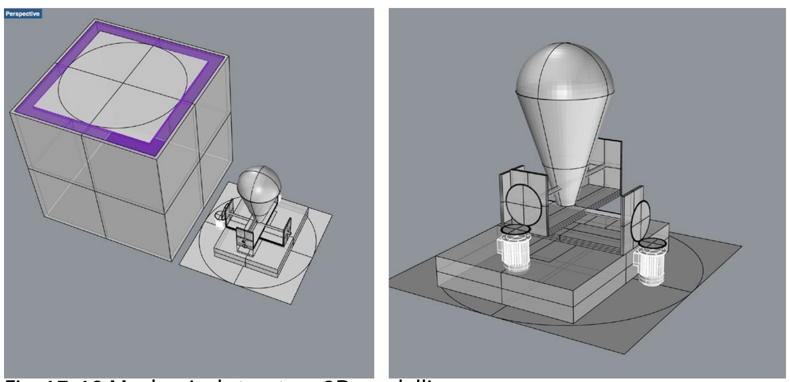

Fig. 17, 18 Mechanical structure 3D modelling

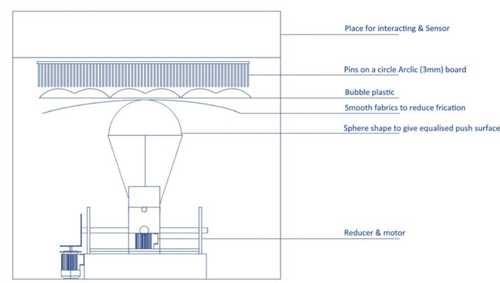

Fig. 19 Layering of the structure

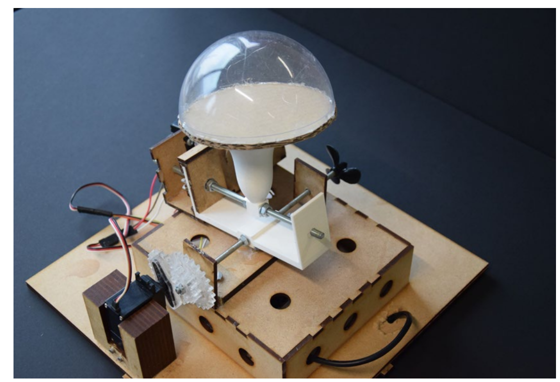

Fig. 20 Mechanical prototype

A mechanical structure that allows the sphere to move in four different directions requires at least two motors. The sphere that is placed in the central area will be moved according to the positions of two motors (see figure 17,18). The total structure is placed under the pin interface, the supporting foam is placed in between with the smooth fabric face to the sphere to reduce the friction (see figure 19). Two light sensors were used to track the amount of light indicated as input to check whether someone is in front of it, and the motors are the output to execute the interaction (see figure 20).

After having built the prototype on the right scale, some more exploration was done on the behavior. However, this time we noticed that following the sphere was a much more satisfying experience. This changed the behavior 'curious' to 'playfulness.' With this, the feedback changes a bit, the functional feedback because it is now being followed and the inherent feedback because the user can now less easily or at least for a shorter period push the pattern, since it playfully avoids the user. The six aspects of the Frogger Framework were also mapped (see Appendix 2).

Critique was then received (see Appendix 3). It was mentioned by two out of seven students that the material experience is incongruent, in this case indeed softer than expected through the layering with the smooth lycra fabric, the spongy foam and the semi visible sturdy pins: " (…) pins almost feel soft- like the foam, but its not."

Three out of seven recognized that the user would follow the pattern: " (...) you might want to follow the movement instead of it following you". Though one thought it would be the other way around: "As the spikes are very local, it seems to me that it will follow me. (...) I think it will be fast, sold movements.

- Detailing

During the last exploration, however, the behavior journey was enriched through a shy behavior. So, when the user approached the object, the static emerged pattern retracted, instead of playfully showing up on the opposite side. The one that experienced, did indeed recognize the shy behavior. Someone already suggested something similar to the shy behavior: "Invite to touch, wants to play with the hand? (push-pull away?), playful." This was also explored the other way around by changing the position of the sphere. In other words, the pattern would be revealed when approached. Which was experienced by one person, who thought it was inviting.

The behavior shy is very different from playfulness, and with that the mapping was changed. The functional and inherent feedforward is the static emerged pattern that seemingly invites to be pressed. Moreover, the pattern is retracted when the user comes closer and the pattern can not be tactilely experienced. the functional feedback is therefore lacking and nothing happens when touched, so there is no inherent feedback.

For the last iteration, these two interesting behaviors were combined to the final design through a behavior transformation, so from shy to playful. Eventually, the pattern exploration came back in the shape-changing emerging pattern, which then closed the cycle of exploration.

DESIGN

PIP, an abbreviation for Playful Interactive Pins, draws the user's attention through a shy behavior, emerging slowly with rather quick retracting. Upon touching, PIP retracts even faster, almost scaredy. The user might first startle a bit, and then carefully stroke to kind of ease PIP. Accustoming to the user, it slowly emerges more and more near the user, then it will be stationary for the user to explore the material. Then PIP, who is accustomed now and somewhat confident, playfully goes to the opposite side of the user and invites the user to follow and play. PIP will retract upon touch and keep on appearing somewhere else. When the user eventually goes away, it will keep on emerging quite fast, asking for attention. But after a while it will become a bit shy again.

This transformation journey from shy to playful was mapped. The functional feedforward is the shape-changing of the attention grabbing pattern, that is moving up and down, though in a shy manner. The inherent feedforward is the pattern and material that seemingly allows for being pushed. The functional feedback is also shape-changing, but then through the transformation of behavior. And the feeling of this change from a flat surface to an emerging pattern that can also be pressed, is inherently experienced. The six aspects of the Frogger Framework were also mapped (see Appendix 2).

Fig. 21 Exhibition setup

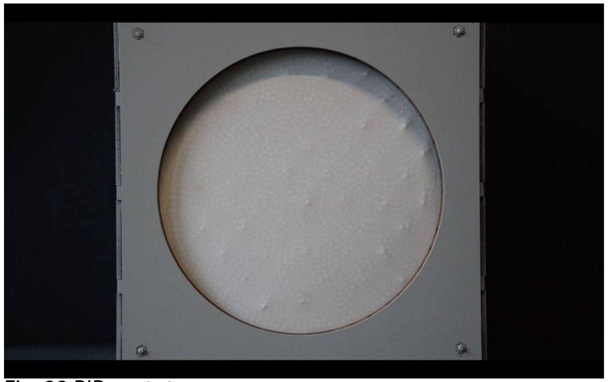

Fig. 22 PIP prototype

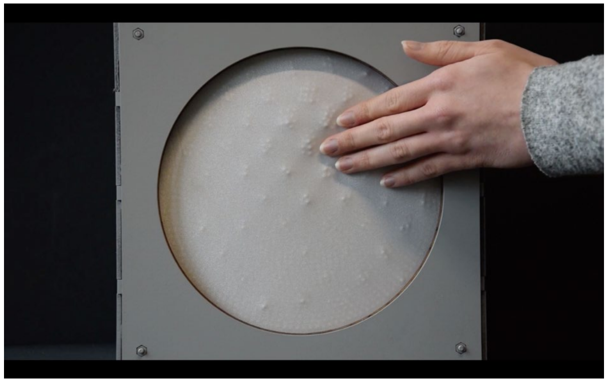

Fig. 23 Interacting with PIP

DISCUSSION

The framework used in this project guide us through the entire design process. The material exploration was performed by laying different materials instead of solely one type. This method enriches as well as expands the properties that come with the materials. For instance, the interface is required to be placed in the front direction, thus the gravity has become a minor affecting matter for the pins, however, with the original property that lycra fabric affords, the pins were able to be pushed back to create a flat surface.

The usage of pins was perceived in various ways. Some user perceived them in a negative way, they mentioned: "(...) there is a bit of disgust, I don't want to touch it. it is too good to be true, and it looks like a cell in the view of microscope (...)". The reason for this phenomenon may be caused by some people with special phobia, namely trypophobia, which is an aversion to the sight of irregular patterns or small holes or bumps. It can also be a design problem that the pins were covered with one layer of lycra fabric, the obviousness of interface could affect the emotional perception of user.

In contrast, the interface was perceived to be a blind dots interface that is able to create a method of communication, she stated: "(..)looks like a blind person is writing, feel like the fabric is going to send me a message through the dots under the fabric (...)" This interpretation brings the design implication that the mechanism of this interface can be implemented for creating a shape-changing interface to display blinddots language for disabled people. On the other hand, the supporting foam under pins can only transform one type of pattern in this prototype, however, this input foam can be replaced easily, therefore, the potential of changing different shape on this interface is unlimited. For the future work, more patterns can be experimented.

One of findings during the pattern exploration is that the density of the pattern influences the transformation of the supporting foam. However, this was only concluded by visual observation by few participants, which can also be perceived differently per individual. Besides that, there were only two types of patterns that were experimented with, and the scope of the experiment was rather small, therefore we cannot draw any significant conclusions.

There are overlaps between synthesis phase and detailed phase, the major difference is the scope of behavior subtleties. Designing the behavior subtleties was experienced to be a difficult aspect when designing this shape-changing interface. This is because people perceive subtlety differently in their individual context. Some feedback was given on the transformation of the behaviors. The behaviors that were intended to be demonstrated on this interface seem capable of transforming current behavior (shy) to an alternative behavior (playfulness).

CONCLUSION

The properties of materials can be inherited and expanded by layering them in a different order. In this project, three types of different materials with their own property were combined, the usage of pins on this interface create opportunities to transform any shape of supporting material, this indicates this interface has great level of flexibility and adaptivity.

This project explored the integration of material and technology to create a shape-changing interface. The design method which was applied in this design practice brings design implications for designers who want to create their interactive material.

REFLECTION

In my previous research project, I have some experience with rich interaction and designing tangible user interfaces, so I thought that shape-changing interface would be an alternative for tangible interaction. However, working on this project brought me different experience. First of all, the focus of this elective is to create transformation of behavior through interactive materiality. Which seems to be a mysterious term to me. I expected this elective will be an exploration of soft and hard materials, and then use electronics to create a sort of interactive behavior.

However, the material exploration workshop brought me different expectations. it is important to explore the physical qualities of materials and try to discover their potential by experimenting and sensing them in different contexts. My personal interests lie in different pattern creation, but it was difficult to connect behavior transformation with pattern creation. Luckily we discovered that push pin toy has potential to transform basically any type of patterns, therefore, I could also create a nice opportunity to improve my grasshopper skills to generate a code that allows quick pattern modification. However, only two types of patterns experimented before making the final prototype, I would like to invest more time to create different patterns for the future works. Besides that, it was also the first time I did sort of mechanical 3D modelling, a lot of thoughts were implemented during the modeling of the inner structure of the prototype.

- Learning curve

Conceptualization was relatively easier for me and my teammate, because we both have research experience with fabrics and 3D skills to create prototype. The most difficult part for us to solve was the electronics and programming. Since both of these areas were not our expertise areas, we encountered a lot of struggles in finding the proper solutions to map our intended behavior. Initially, the conductive yarn was chosen to be the input device to activate the motors, however, the sensitive of conductive yarn failed to provide fast feedback, thus, they were being replaced by light sensors which give quick and direct feedback.

Designing a transformation of behavior was also challenging during the design process. Initially we intended to create behavior of curiosity that pushed pins will follow the movement of the user, thus we chose to design a circular interface that allows users to move freely, however, to realize this interaction was very difficult for us. Especially working with two motors, it was difficult to map the behaviour of curiosity , after the critique session we change to different behavior.

The entire project was experienced very intensive in my own experience, I spent a lot of time on making the prototype and helping Fabienne with programing, I enjoyed working with her because have same passion on patterns, 3D printing and materials.

- Conclusion

This elective brought me a lot of insights on interactive materiality and transformation of behavior, I gained my skills on prototyping and programming, my perspective on materials has also changed, I see more design qualities and potential on materials. The method I learned for designing interactive materiality provide me useful guidelines, it also raises awareness of how difficult it is to design a behavior that can be perceived as it is supposed to be.

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Appendices

Link to final video: https://vimeo.com/371664845

Appendix 1: Workshop Interactive Materiality exploration

Transition through shape-changing

Fig.1 All explorations from the workshop from Interactive Materiality, on transition through shape-changing. Roughly explored chronologically from 6 to 12 and from 2 to 5 and lastly 1.

First, we explored stretchy fabrics, see samples 6 up to and including 12 in the photo above. 6 was interesting in terms of density and gradient in color. Foam sample 7 and lycra fabric 8 were not such interesting results, since there is no evident shape or color changing. As for 9 and 10, which are in fact the same plastic material but are stretched in opposite directions, they are very interesting both in terms of shape and texture changing. 9 has a rough texture when one performs a lateral movement up and down, 10 is less rough in the middle and is even smooth at the more dense white edges. The original shape of this material's pattern is hexagons, but in sample 9 a brick pattern is visible, which you can also see in 10, but then diagonally. 11 is made with vertical folds and horizontal incisions, which resulted in a rather unpleasant texture and experience. As for sample 12, which was a squared pattern foam, it was overlapped and stretched and gave a subtle gradient in density. We continued with incisions, but then in a fake leather with cotton backing; 3 is horizontal and simple stretched some more as the incisions opened up a bit, 4 are slanted and when stretched a shape much like cubes appeared, which was most visible in the shorter sample.

Next to sample 5, we also explored pulling and pushing with lycra in a different setting (see figure 2)

Fig. 2 Lycra pulled over circular object with paperclip

Appendix 2: The six aspects of the Frogger Framework

6 aspects of the Frogger Framework	Curious	Playful	Shy to playful
Time	When the user touches the fabric; as long as the user touches and hovers the fabric	When the user touches the fabric; as long as the user touches and hovers the fabric	When the user touches the fabric; as long as the behavior transformation takes, plus the user touches and hovers the fabric
Location	Macro	Micro	Micro
Direction	XY direction tilting	XY direction movement; rotating	XY direction movement; rotating
Modality	See; touch; (hear)	See; touch; (hear)	See; touch; (hear)
Dynamics	The speed stays the same	The speed stays the same	Generally, the movement is accelerated in time
Expression	Open; flowing; young	Open; flowing; young	First close, then open; flowing; young; tempo is increased

Tab. 1 the six aspects of the Frogger Framework

Appendix 3: Peer feedback

neg/pos, remark/suggestion, interaction, tactile,

Participant 1:

1. There is a bit of **disgust**, I need to take a step back, **do not want to touch**.
2. **Disgust**, too round, too good to be true, it is a zoom of an expansion (experiment?).
3. It looks like a **cell in the view of microscope**, it will move and crumble, like living ceas (creature?).

Participant 2:

1. Question; the **boundaries** of the interactive area, this makes me wonder of the behavior
2. The pins fade out towards the **edges**, this makes it hard to see the boundaries of the pins. This invites to explore this boundary.
3. Highlight the contrast between the sharp spikes, and the **vague interaction area**. this also enables the object to surprise as spikes can appear out of nowhere. This (might) cause(s) **careful** behavior of the viewer

Participant 3:

1. Intrigued of what it might do increased my **attention**
2. At first I only saw a few dots but the more/longer I watched the more **dots appeared**, this increased the attention.
3. It reminds me of a **night sky**, There is more there than what you can see.

Participant 4:

1. First impression is that it only has interaction in the **middle** as the shape is round. The spikes are immediately visible, and show that **there is more behind it**.
2. The fabrics is so **smooth and shiny**, I **don't really feel like touching it now it is not moving**. It does give the impression that it will react on my behavior.
3. As the **spikes are very local**, it seems to me that it will **follow me.** Because of the spikes, i think it will be **fast, sold movements**.

Participant 5:

1. Respect to the artifact. **Respect**, **carefulness**.
2. It looks really good and well crafted, **close to perfection** with the circle area the tension in the fabric. **Respect** to what they have done and afraid to destroy it.
3. Looks like how a **blind person** is writing, I feel like the fabric is going to send me a **message through the dots** under the fabric.

Participant 6:

1. **Intrigued**, see the **small textures under fabric**

2. curious, seems like it can take the **shape of different patterns?**, kinda **disgusted by the sound (metallic)**
3. Invite **to touch**, wants to play with the hand? (**push-pull** away?), **playful**

Participant 7:

1. It look **shiny, tidy**, dotty. I feel a sense of creepy
2. The dotty surface makes feel slightly creepy, **scary**
3. I feel like to **push the dotty things** down to have an **even surface** invite people to push.

Participant 1

- Do you want to engage the **finger or the whole hand**? what is the reason for the **round shape?** Will it push your hand away?
- it feels like a push game or a collaboration result. maybe try different forms. this **pattern of the foam feels really expected**. therefore it can go two ways, be a **'perfect' pattern** that is beautiful to look at, **or expected this boring**

Participant 2

- -
- the hand/finger following is interesting but **it might be to[o] repetitive**. maybe think about some **variety**

Participant 3

- **how does it get your attention** to begin with? can the **pattern itself** trigger an interaction?
- **satisfying to touch**, so much that you might want to **follow the movement instead of it following you**. the pattern of the pins increases the that you want move your fingers (feel a bigger surface)

Participant 4

- what is the **ending behavior?**
- Do you want to keep the egg foam? it adds extra **spikes, but I think it is distracting**
- nice thingy. I really **like the round shape** and i think it adds

Participant 5

- Are the material/materials on the side of the pin maybe feel better if it was a bit soft? Is the movement of the pins supposed to stop directly after the interaction or **can it leave "footprints"**?
- Satisfying

→ the movement is so smooth thanks to a lot of pins **it is a soft feeling to interact with it, even tho many of the materials are hard.** the pins **follow** your hand and that makes it **satisfying**

Participant 6
- have you considered an **idle state to initiate the interaction**? what will determine your choice of foam/pin configuration?
- **Smooth movement** and the **pins almost feel soft-like the foam but its not**. it feels nice against your fingers with the many touch points

Participant 7
- can the stick move in **different speeds?** How are you going to leave(?) the hand with a **high enough resolution** to really **follow** the users actions

Fig.3 Feedback

Final presentation notes:
I like the pattern + fabric emerging
follow behavior redefine
I like the sound
sound is cute
also the ringing
visual → invite
it is intriguing
very subtle
little dots are inviting