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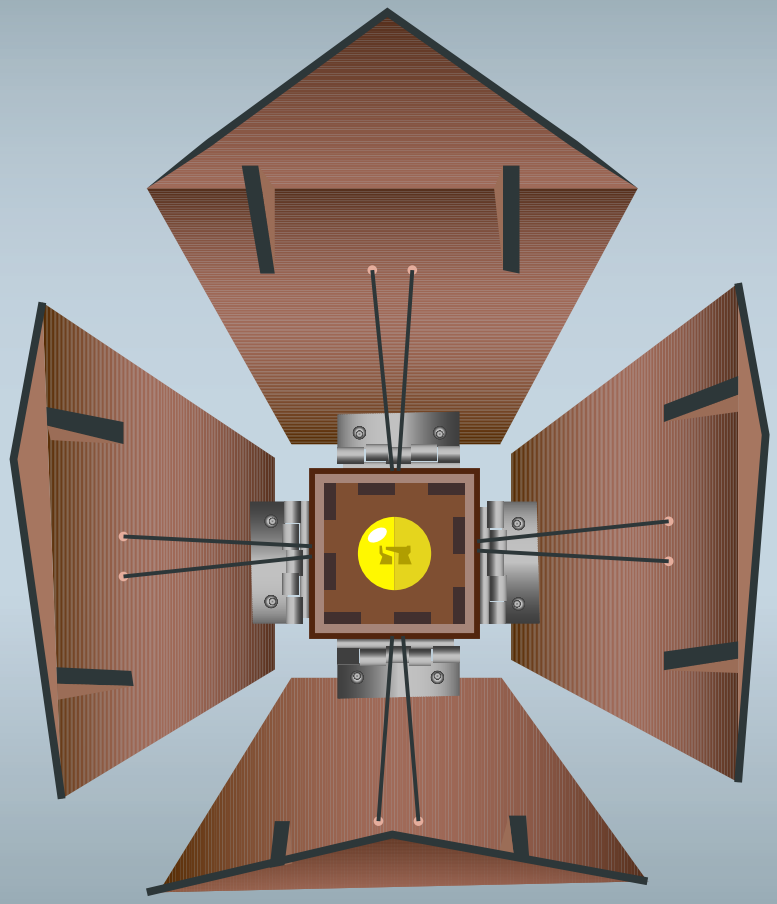

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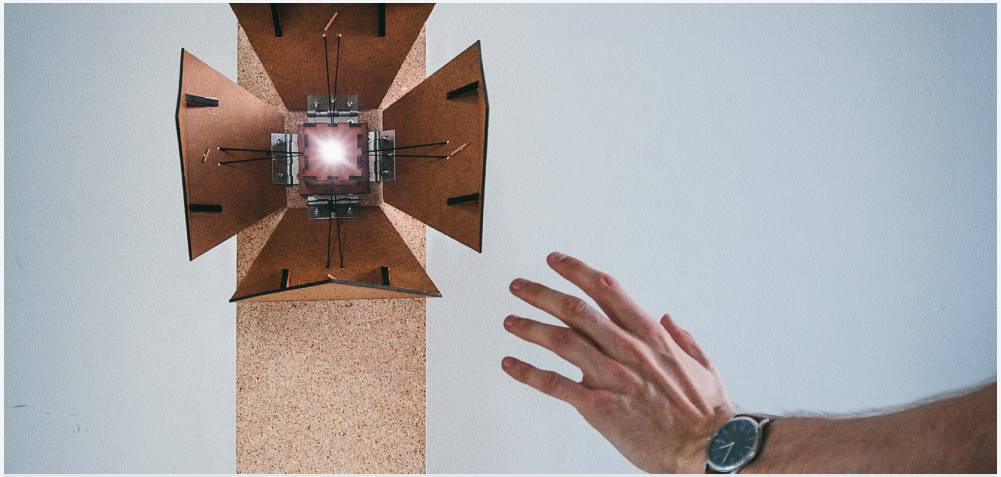
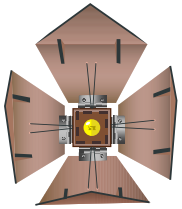
Abstract



In this paper we will explain how embodied interaction with a physical object can have an impact on Aesthetic Interaction. Starting with the design brief: “In this project we will explore how physical movement of people and everyday products, as well as the coupling between them, impact interaction aesthetics with respect to usability and expression.”, we explore different motions and emotions, and seek to find a way to combine the two with an everyday object. We explain this by describing how we created the interactive lamp: Blossom Bright. The lamp shows how a simple everyday object, in this case a lamp, can be expressive and interact with bodily movements to function. This paper explains the importance of a good brainstorming process, and how acting out different scenarios helps the designer create a prototype with a high level of fidelity. This paper describes the process of creating the Blossom Bright with its point of departure in a cootie catcher, to a finished prototype, with a much more organic approach in terms of both physical and temporal forms. We introduce some of the skills we applied to build the final prototype, and some of the struggles that we had to overcome in the process of creating an expressive artefact.



1. Introduction

Designing interactive artefacts deals with the experiences that arise in the meeting between interaction design, ubiquitous computing, and critical approaches to design. Working with design-oriented studies, we have been introduced to various approaches in the early stages of interaction design processes. In this field we are presented with a unique opportunity to design user experiences that communicate different types of expressions of a physical artefact, varying from emotional responses to the physical reactions of the audience. Our bodily movements and the perception of movement in our environment are essential to the interaction with the physical world and may contribute to the aesthetic experiences with interactive products.

During the conceptualization stage of the design process we discuss the motions and emotions of artefacts, and the way that they affect human interaction. Through research of everyday objects, we explored various design directions by combining ideas for emotions and motions with interactive artefacts. Examining different possibilities, we developed an interest towards movement that expresses an opening and closing motion. While interacting with digital products in everyday life we are only introduced to the final use of the products. Studying the work of interaction designers enable us to explore the developing stages before product launch. This helps us understand decisions made by interaction designers on how users engage with physical objects through their bodily movements.

2. Finding focus

We started the design process by looking deeply into the effect of motions and emotional responses within interaction design. On this stage of the project, we were actively exploring different design directions in which we wanted to work within. Exploring expressive potential of movements by observing a wide range of everyday objects such as an elevator going up and down, a piece of paper dancing in the wind, and water in constant movement, we analyzed potential emotions of the movements that we had seen. From this experience we learned that different emotions can be translated and identified in the way an object moves. But it was not enough to analyse motions and emotions. To drive design decisions, we had to make a link between the act of motion and a physical product. At this point there were no doubt that we wanted to develop a product in which a person experiences a particular emotion in relation to the object.

A significant amount of research had to be carried out, in order to find a focus for the project. We began our process by creating a huge map, that showed all kinds of everyday objects which we had previously been in touch with (Figure 1). During the idea generation phase, we used various brainstorming techniques to consider different physical forms,

Figure 1: A map of everyday objects that we get in touch with in our daily file

movements and emotions. Brainstorming is a group-oriented process that promotes innovation and let us map as many ideas as possible (Kelly, 2001). Until now, all we have done was to observe what was happening around us. According to Kelly some of the best ways to brainstorm is to be visual (ibid.). It includes sketching, mind mapping, and stick figures. We used mapping to picture diverse everyday objects on a piece of paper and assigned them a category in terms of the ability to move an object in a physical space and to use bodily interaction with the object. Figure 2 displays all of the everyday objects we came up with, and their placement on the movement axes (X-axis) and body usage (Y-axes). Also, Kelly has argued that another great way of brainstorming is to get physical (ibid.). Hence, to observe motions, we recorded videos of various objects in motion. Objects included the ones that are put into motion by a human activity as well as the motions that are provoked by the power of nature. The purpose behind the videos was to explore how movements can become meaningful by exploiting its expressive potential.

Video: Video of different types of motions that we observed

www.vimeo.com/mikhanosha/motions

Thus, we observed different emotions in movements using the Plutchik Wheel (Plutchik, 1980), which illustrates how emotions relate to each other. Each object was described in terms of its movement. We analysed what makes each object move, how it moves, and finally, which emotions each movement evokes. For instance, a microwave door opens due to human action. At first the door makes a rapid swing as giving a resistance and subsequently slows down as it opens more. According to our interpretation, this act corresponds to the feeling of surprise and shock as a result of an unusual or unexpected act. Hence, we were able to see the object not only as a whole, but explore the reasons behind functionality of the object (Figure 3). Brainstorming helped us specify which direction wanted to continue working in, towards the idea and interaction development.

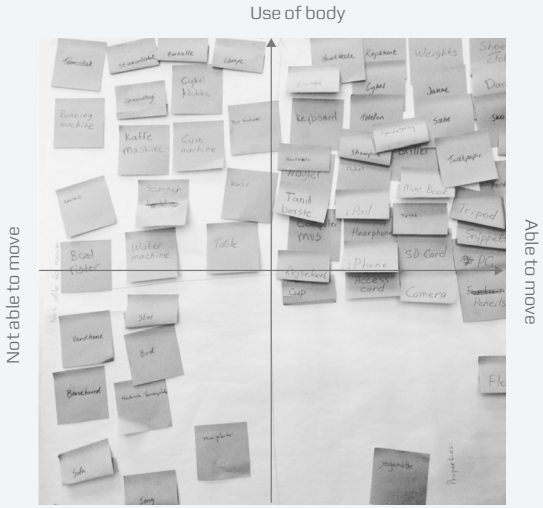


Figure 2: A map of everyday objects that we get in touch with in our daily file

	Football	Microwave
What moves?	· Ball is falling down · Player tries to hit it	· Door opens
Why does it move?	· Ball is falling due to gravity · Players are moving due to human action	· Door opens due to human action when pressing a button
How does it move?	· Ball is bouncing to the ground · Players are connected on a crossbar	· Door opens with swing/jump effect and slows down shortly after
Emotions	Anticipation > Anger Anticipation > Sadness Anticipation > Joy	Surprise

Figure 3: Table represents different objects and describes each of the object in terms of their movement.

3. Interaction development & idea development

Further in our process we created three triangles, each of them containing one artefact (tray, door and lamp), as well as movements and emotions connected to the artefact (Figure 4). We chose some of the movements from the videos we had filmed, and matched them with different emotions from the Plutchik wheel (Figure 5) (ibid.).
We brainstormed on different design proposals, and made sketches of all the ideas we had. Each of the triangles had about 6-9 design proposals. The three everyday objects we chose to work with, are all fairly unimaginative in its original form. The paper Unlocking the Expressivity of Point Lights (Harrison, 2012) works towards a rich set of expressive forms and an effective communication. To achieve this we used triangles as a method of analysing our chosen artefacts.

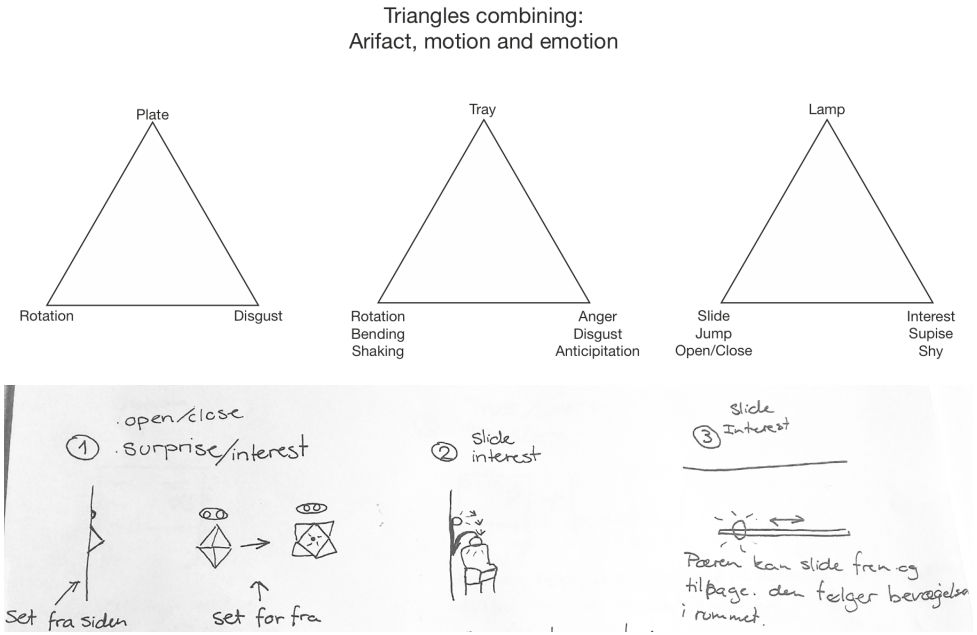


Figure 4: Connection between movements and emotions in a "lamp" as an artefact. For example, when lamp opens, it awakes surprise, and when lamp slides, it awakes interest.

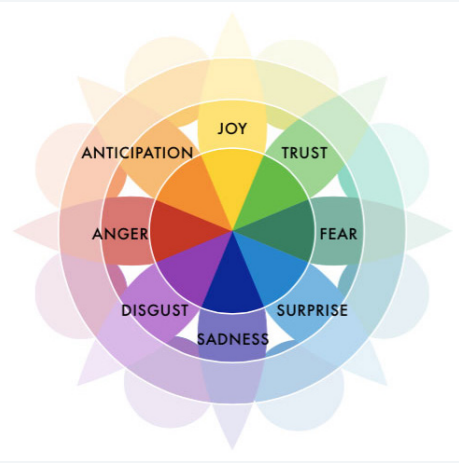


Figure 5: A wheel of emotions by Robert Plutchik

Among several design proposals that can be seen in figure 4, we selected what we believed to be the three most fascinating ideas from each triangle. According to Kelly, the third physical approach to brainstorming is "bodystorming", where designers act out current behavior patterns and see how they might be modified (Kelly, 2001). Thus, we made three storyboards and used a body storming technique to act them out in real life as can be seen on the video.

Video: Video of the storyboards - "Bodystorming"

www.vimeo.com/mikhanosha/motions-emotions

By combining the three elements of interaction design: physical form, temporal form and interaction gestalt (Vallgårda, 2013), we are able to create a successful design that communicates the intended message those who interact with the artefact. According to Vallgårda in

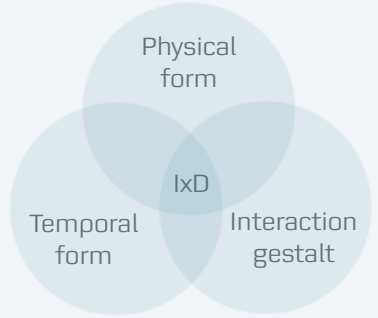


Figure 6: The three elements of Interaction Design (Vallgårda, 2013)

moves, temporal form is a composition of actions, the physical form is the three-dimensional shape of the object, and the interaction gestalt is the performance of movements that a human actor does in relation to the object (ibid.). Another great way of physical brainstorming according to Kelly is to have materials on hand to build raw models of an idea (ibid.). We decided to work with the cootie catcher, that was inspired by our childhood (Figure 7). We saw opportunities to express a wide range of emotions based on the act of interaction with the cooties catcher. The artefact which is made of paper is easy to work and quick to play with both its physical and temporal forms. Acting out helped us to play and explore different ways in which the artefact can react when interacting with humans. According to Harrison, small point lights can be expressive, and even though their output is very simple, their design space can be quite rich (Harrison, 2012). It helped us realise that we don't have to use a high complexity in movements to achieve an expressive form. This applies to the idea of a cootie catcher that consists of very simple movements; opening and closing. The storyboard we made for the cootie catcher shows the interaction with the artefact. We drew the storyboard

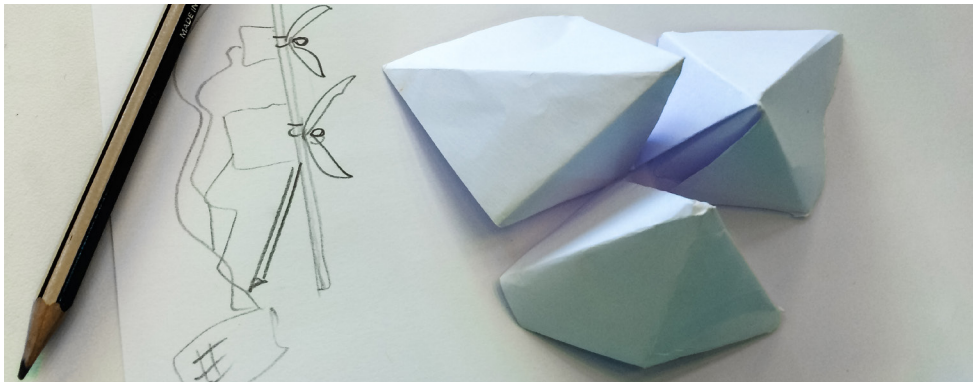


Figure 7: A picture of a cootie catcher

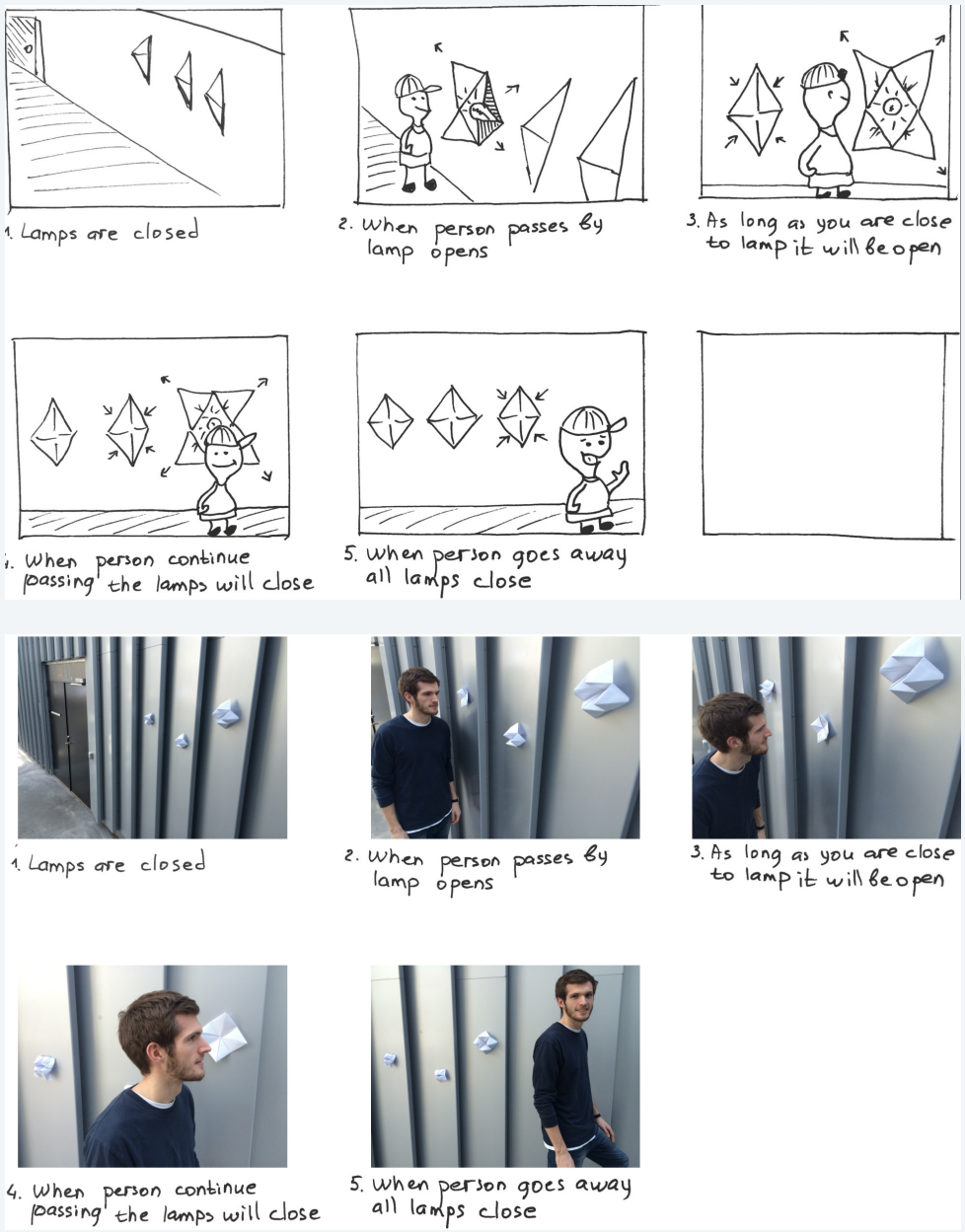


Figure 8: Storyboard and the enactment of a storyboard both on paper and in real life

on paper, and acted it out. As it can bee seen on (Figure 8) the storyboard, both on paper and in pictures, shows functions as scenarios on how we expected the cooties catcher to react when it is interacting with humans. At this point, we had an idea of how we would use embodied interaction to reach an expressive interaction aesthetic, but we still needed to explore both physical- and temporal form.
At this design stage, we were particularly focused on the theories proposed by Buxton regarding sketching. Buxton suggests that sketching should be: evocative, suggestive, explorative, provocative, tentative and propose questions (Buxton, 2007). Meaning that the process of sketching is an explorative practice, which is meant to give a rise to reflection and discussion, rather than just an aim towards a final design solution. In this stage of the development process, we focused just as much on sketching the wrong solutions, as we focused on sketching all the right ones. In doing this, we forced ourselves to both articulate and consciously consider why we chose to move in one direction instead of the other.

Finally, we proposed answers to some of the questions that arose in the process of sketching. Next, we began to move from low fidelity to a higher fidelity. We ended the sketching process and began prototyping.

4. Prototype development

Initially, we applied the theories of Buxton to define what the learning outcome from our prototyping process should be. Prototyping is a didactic process, and contrary to the process of sketching, it is meant to be descriptive, refining, testing, resolving. As such, prototyping forced us to further consider and detail our previous choices, narrowing down the ideas made towards the artefact and its interaction.
Prototypes are widely recognized to be a core means of exploring and expressing designs for interactive computer artefacts (Houde et. al, 1997:1). To develop the concept of our artefact we built different prototypes, both physical and electronic, in order to represent different stages of our design and to explore new possible options.

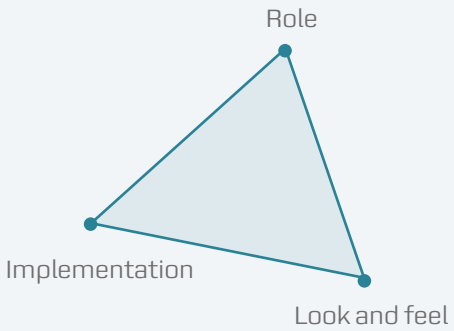


Figure 9: Design aspects of an interactive prototype (Houde et. al, 1997)

Our process of working with prototypes can be reflected in Houde and Hill's model of what prototypes prototype (Houde et. al, 1997:3). This model consists of a three dimensional space, including; role, look and feel, and implementation, which are important aspects of the design of an interactive artefact (ibid.) (Figure 9).

"The first dimension "Role" refers to questions about the function that an artefact serves in a user's life - the way in which it is useful to them" (ibid.). At first, our concept was centered around the user trying to attract attention from the Blossom Bright lamp which blooms on the wall as a piece of art. If there were multiple artefacts hanging side by side on the wall they would react on each other depending on the user's interactions and bodily movements towards it. Due to constructive feedback from the class and further experiments with our prototype,

we decided to reverse the overall concept. After exploring different options on defining the core function of the artefact we developed a concept of encouraging the user to move away from the artefact itself. Essentially, the function depends on the distance towards the artefact. E.g. it invites you to come closer if you are far away from the artefact or it will encourage you to move away if you are close to the artefact. Thus the artefact aims to move people away from itself, rewarding a person with the full view of the blooming artefact, and the revealing of the light in the center, which is the core function of the artefact.

The second dimension "Look and feel" denotes questions about the concrete sensory experience of using an artefact - what the user looks at, feels and hears while using it (ibid.). This comes to light in prototyping with the physical form. Here, we were introduced to laser cutting as a tool to cut materials in a specific pattern leaving an edge with a high quality surface. The laser cutting technology works with vector designs and turns the design into real products by laser cutting and engraving the design on materials with a millimeter laser precision. At first, we started working with cardboard as a material to build our prototype. Cardboard is often used for folding cartons, boxes and carded packaging, which enabled us to explore

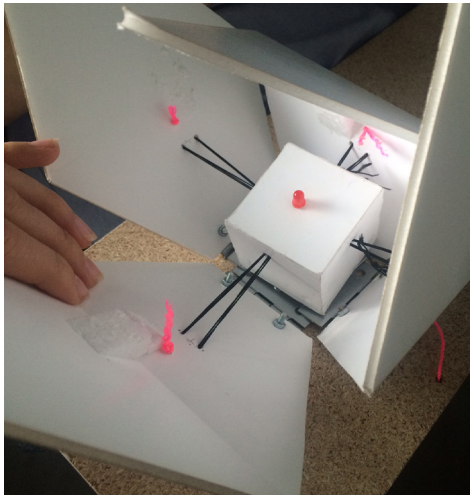


Figure 10: Cardboard prototype

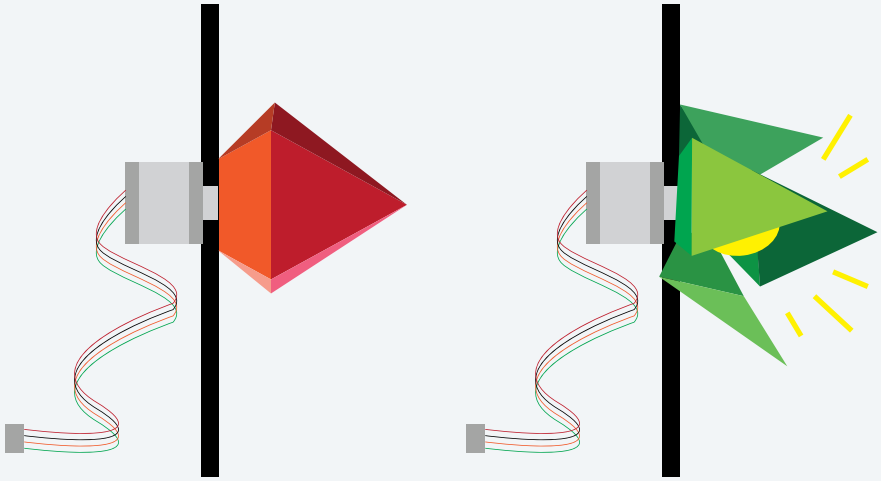


Figure 11: The shape of the artefact is inspired by the natural shape of the flower

different options on creating physical shapes for our prototype in folded cardboard material (Figure 10). By taking the physical form of a cootie catcher and separating each of the four corner tabs, we came up with an idea of making each tab into four leaves. The natural shape of a flower inspired us to focus on the organic motion of flourishing leaves. Working with cardboard enabled us to imitate the shape of a leaf by bending each leaf in a 165 degree angle. By doing so, we were able to control the angle specific distance of bending the artefact (Figure 11). Thus, the reason of bending the leaves of the artefact is related to aesthetic reflections on how the artefact should communicate the core functions to it's audience.

Another physical element that was needed in order to make the prototype work properly were the strings. The strings were connected to each of the four leaves which enabled a pull motion for opening or closing

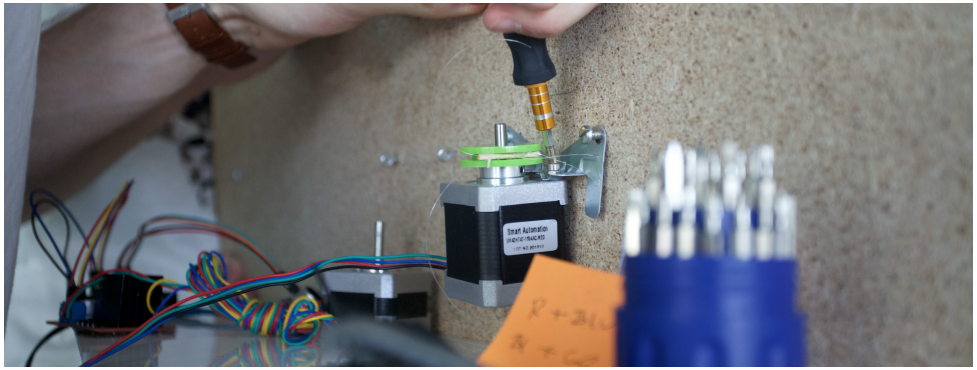


Figure 12: Setting up the electronic stepper motor and gears

the artefact. A lot of different aspects such as gravity, pull strengths, minimal resistance effects etc. were discussed during the process in order to build an effective way of implementing the strings. We created a system that could combine the strings by using a wooden board as a placeholder for the artefact, with accurate tiny holes in it. In this way the strings were wired up with each leaf and then combined into a single string in order to enhance the pulling strength. At first, we were using cord as strings but then discovered that the cord was causing too many problems due to resistance issues. Then we decided to go with fishing wire as strings due to its advantages as a strong material and its transparent look which makes it almost impossible to see from a distance.

A third physical element that was used in the prototype development was the gears. They played an important role for the user experience by connecting the electronic components with physical elements. The challenge here was to build a gear setup that were able to maintain all of the strings from each leaf and combine them into a single string, which could be pulled from the electronic stepper motor used in the prototype (Figure 12). First we created the gears by drawing the different pieces in a vector design. Next we turned the digital gears into real objects by laser cutting the design on materials made of plastic that were ideal for using glue to build the setup. This process was part of our initial prototype development on material explorations and formed our physical prototype into a diamond shaped flower artefact.

The third dimension “Implementation” is about electronic prototyping and refers to questions about the techniques and components through which an artefact performs its function - the “nuts and bolts” of how it actually works (ibid.). The basics of electronic prototyping is about getting computer to do what we want them to do (Haverbeke, 2014:1). During the course we were introduced to the basic principles of Javascript programming. With our physical object in mind we did a brainstorm on what the code should do and how we could apply some of the fundamental rules of Javascript to the prototype. The prototype consists of different electronic components, which enables various functions to the artefact. These components consists of an Espruino board, jumper wires, distance sensor HC-SR04, stepper motor including mounting hub, H-Bridge L298N and a power supply.

5. Design vision and constructed prototype

5.1: Design vision

To understand the design vision, and the constructed prototype as a result, it is important to understand the underlying narrative of the artefact. A

narrative that plays an all-important role in the process of designing and ultimately creating the prototype of the artefact.
We took our point of departure in the physical form of the cootie catcher, and the accompanying question: How do we make a diminutive artefact communicate shyness and spark interest? We set out to create an object that would not only capture the imagination of the user, but also create a sense of coherence between technology and nature. An interesting dichotomy, which seems ever so relevant in our day and age.
In creating the design vision and final prototype, some of the following questions had to be proposed:

- Why does the artefact sit on the wall, and not on the floor?
- Why is the artefact one shape and not the other?
- Why is the artefact the size that it is?

The answers to the above questions were found through the process of both creating the design vision and designing the actual artefact. A process that is covered in the section below.

Entering the final stage of the design process prior to the exhibition, a more organic approach was taken towards the design of the artefact (Figure 13). Drawing inspiration from the shape and movement of a blossoming flower, the artefact looks

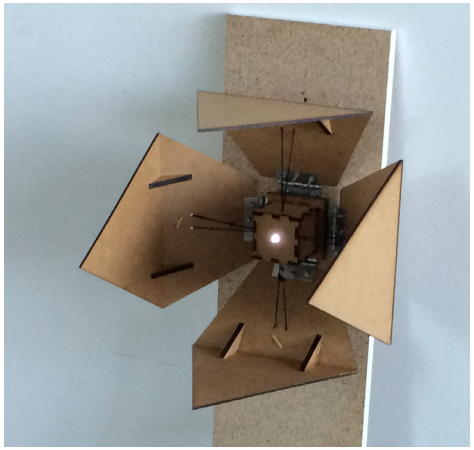


Figure 13: The final stage of the design process

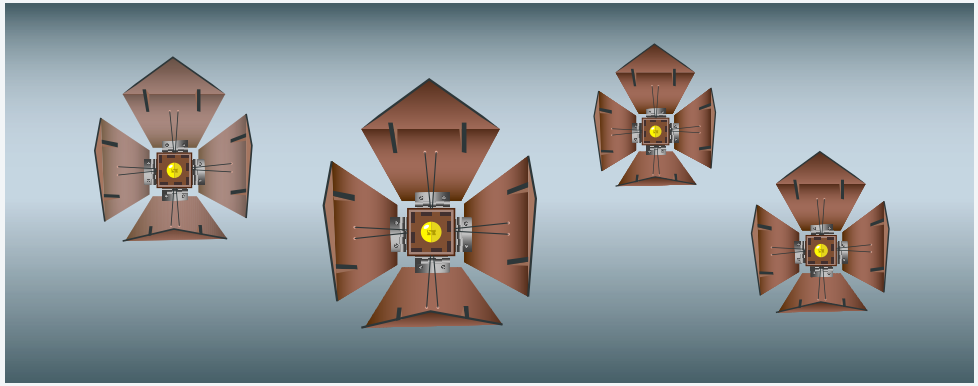


Figure 13: The original idea of Blossom Bright with many artefacts in different sizes

as if it's almost growing out of the wall, approximately eye level with the user. The idea is that the artefact sits on the wall in large numbers and in many different sizes, imitating flowers on a field (Figure 14). It is built to actively encourage real-life interaction between people. Like flowers in spring, the shape and movement of the artefact takes its point of departure in nature itself and the blooming of a flower; a universal concept spanning cultures and language barriers. Reminiscent of leaves, each individual Blossom Bright consists of four concave leaves that open and close, depending on the distance and movement of the individual. These are the two temporal aspects that the artefact will respond to. Reversing the process of a blooming flower, the wings of the artefact close as you move towards it - and open as you distance yourself from it, revealing a soothing light in the center of the artefact. In this way, the artefact aims not to draw much attention, but rather encourage the individual to move away from the walls and further into the room, rewarding you for spending time on what really matters - other people.

As a whole, the idea is that the artefact creates an element of surprise in its blooming motion, draws people away from the walls and into the room, sparks conversation and lights up the space.

As a result of the above process and design vision, the sketch of the final design for the prototype looks as follows: (Figure 14)

5.2: The name

We decided on the name Blossom Bright for numerous reasons. The artefact itself draws direct inspiration from the flower; not only in its shape, but also in its temporal form - the opening and closing of the concave leaves, as described earlier. The word bright stems from the fact that the artefact is a lamp; we've placed a small LED light in the center of the artefact. In this way, the name represents both the form and the function of the artefact.

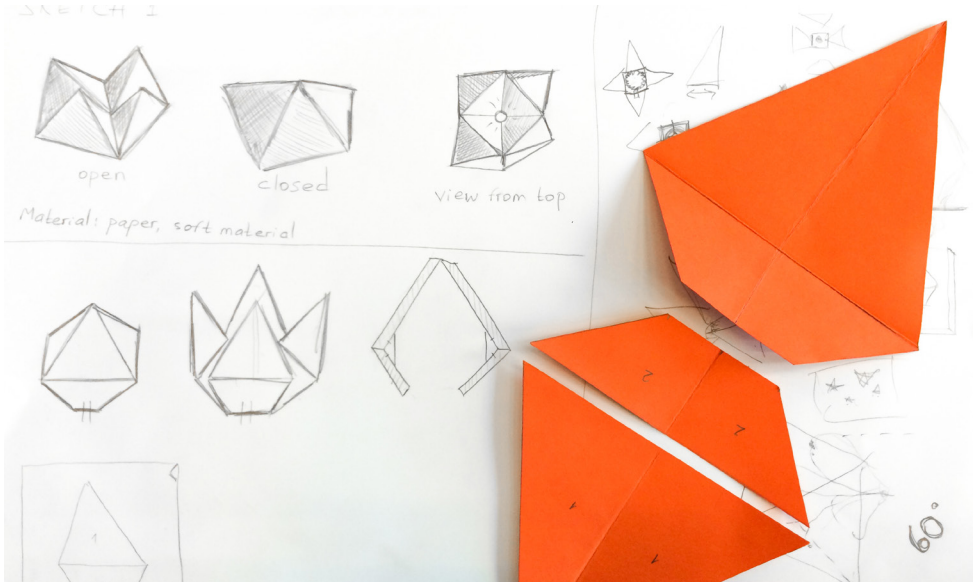


Figure 14: Sketch of the prototype

5.3: Video

In filming and creating the video of the final prototype, it was important to clearly communicate the interaction between the user and the artefact. As a result, the artefact was filmed on a simple, neutral background, so as to not distract the viewer. The video expresses how distance as the temporal aspect of the user relates to the function of the artefact. To give the user a sense of overview of the artefact and its workings, several different camera angles have been utilized inspired by the Fonckel One demo video. To keep the video simple and not distract the viewer, on-screen text and voice-over has not been applied. We created the film on the philosophy that the pictures should speak for themselves and the belief that if on-screen text and voice-over is needed, then the communication in the video itself isn't clear enough.

5.4: Hardware

The final prototype is constructed in wood. The original idea was to fix the leaves directly onto the wall, and hide all electronics behind the wall. However, for the sake of the exhibition, we fixed the leaves on a wooden board. This allowed us to move the artefact around, as well as showcase the inner workings of the artefact. All of the leaves are connected to the same stepper motor placed on the back of the board. A fish wire is connected to each leaf, going through holes in the board and finally connected to a gear on the back of the board. The gear is placed on top of the stepper motor. This way we can control the rotation of the stepper motor that pulls the string. The stepper motor receives a command on

Video: Video of the final prototype "Blossom Bright"

www.vimeo.com/mikhanosha/blossom-bright

how far to step from the JavaScript code, while the ping sensor is used to measure the distance between the person and the artefact (Figure 15).

5.5: Software

Figure 16 is a snippet of the code we create in JavaScript for this project. We made three "if" statements using intervals to control the opening and closing of the leaves.
State 1 works if the distance is 25 cm or less. When a ping sensor registers an input by someone being within this state, the leaves should close - stepper motor should be at step 0. The same goes for state 2 and 3. The states react to different length and gives different inputs to the stepper motor. The higher steps, the more the lamp will open. We reversed the stepper motor, with step 0 as the starting point. This way we control the leaves, and have the same starting point every time the ping sensor registered an input (Figure 16).

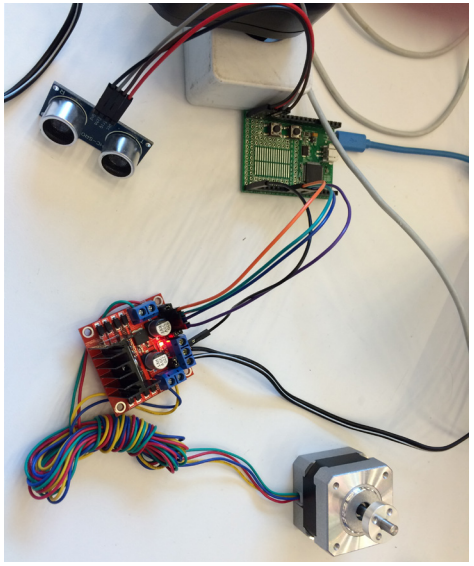


Figure 15: Hardware

This is how we imagined the hardware would react, but in reality we still did not have a well functioning code. We faced two major problems with the code. First of all there was no function telling the stepper motor how fast it should step between the three states, which is why we missed the organic feeling we wanted to achieve. Second of all we wanted the ping sensor to give the stepper motor an input every time the person in front of the sensor moves closer. That would have required the stepper motor to take a step every time the value changes.

```
var sensor = require("HC-SR04").connect(A0,A1,function(dist) {
  distance=dist; /*console.log(distance+"cm away");*/

    if(dist<25) // If the person is less than 25 cm away
    {
        tilstand=1;
        stepTo(0);// step to 0 - close
    }

    if(dist>26 && dist<200) // If the person is between 26 and 200 cm away, then do 300 steps
    {
        tilstand=2;
        stepTo(300); // step to 300
    }

    if(dist>200) // If more than 200 cm away
    {
        tilstand=3;
        stepTo(1000); // step to a 1000 speps - open up
    }
  console.log(tilstand);
});
```

Figure 16: A part from our JavaScript code

5. The exhibition

The prototype of the Blossom Bright was presented at an exhibition at ITU. This was both to see how people interact and react to the artefact, but also to gather feedback and suggestions for improvement.
In this paragraph, these testimonials and comments about the artefact from the visitors of the exhibition will be covered. Based on the feedback that we received, we will comment on the aspects of the artefact that succeeded, and the aspects that did not. It is important to note that the artefact presented on the exhibition was not the final prototype. Rather, it was a prototype with a number of flaws and mistakes

Figure 17:Visitor reactions and feedback at the exhibition of Blossom Bright

that we were well aware of. These mistakes are a result of both time and material constraints. However, we chose to use these flaws to our advantage, and see them as an opportunity to examine aspects of the design that had not previously been considered. One of the unintended mistakes that worked out to our advantage was the opening and closing of the leaves at higher speeds than we had intended. The feedback, presented below, will be used to discuss how our design intentions align with the actual prototype and the people interacting with it. Furthermore, the feedback will be used to discuss and reflect on the artefact as a whole, and how it could be improved and revamped in future designs (Figure 17).

We have chosen four different testimonials to how visitors experience the aesthetic interaction, using their own body (Please see appendix 1). The four approaches are just some of

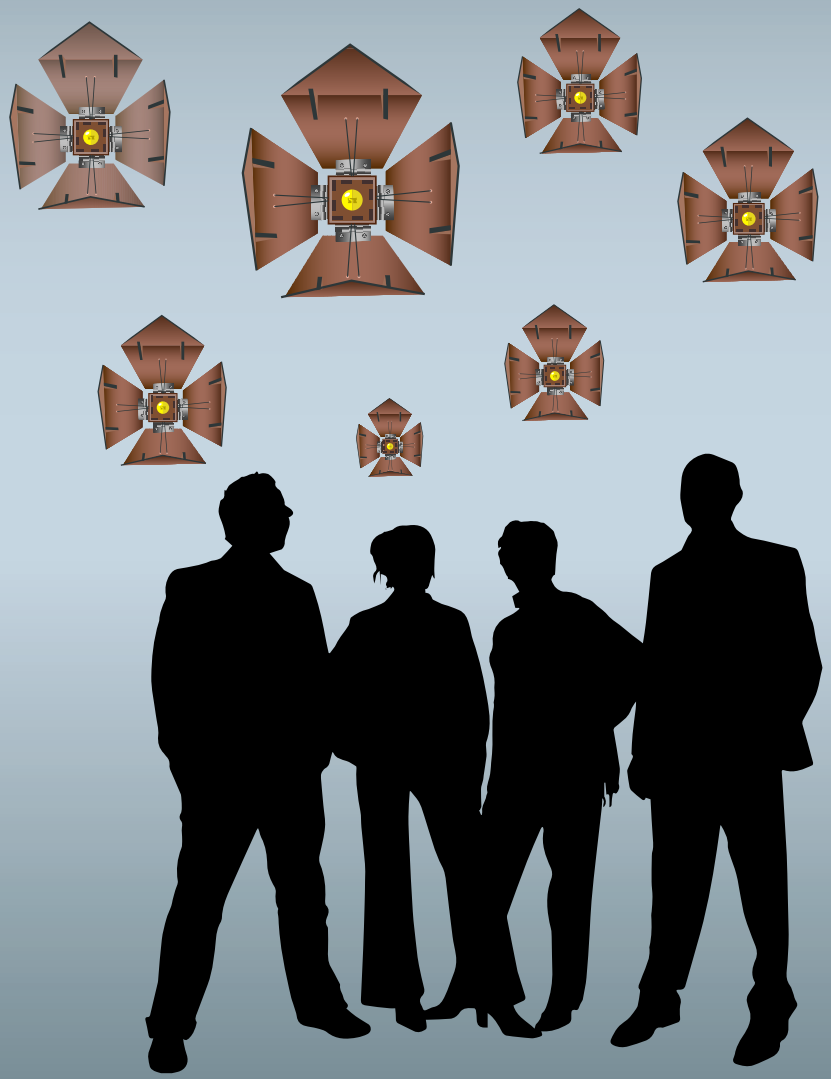
the responses we received from the exhibition. We chose the following four testimonials because of their useful and interesting thoughts that they provided.

The responses that can be read in appendix 1 shed light on the aspects of the prototype that work well - but more importantly, the responses shed light on the aspects that don't align with the design intentions. The fact that the leaves of the artefact open and close quickly generates a feeling of surprise, but also a feeling of fear and aggressiveness, contrary to shyness. This motion also counteracts the intention of creating a feeling that the form is organic. Because of the fact that organic material is known to both grow and move slowly, it would be natural to apply this to the artefact as well. However, it's probable that if the leaves close slowly, the artefact would become too predictable and wouldn't spark interest nor surprise, as a result. Thus, the feedback provided the realization that perhaps the element of surprise and interest weighs higher than evoking a sense of shyness. Another important realization was the one that although the rapid movement of the leaves counteract the metaphor of the flower, it also helps underline the dichotomy of nature

and technology. A contrastive theme that we thought to be important to incorporate in the design of the artefact.

7. Conclusion

The Blossom Bright is a result of a number of applied practices and theories within the field of interaction design. Throughout the course we explored how movement can be a meaningful element in interaction in terms of interaction aesthetics. From the initial process of brainstorming, to the final process of prototyping in hardware, each step has yielded important lessons in our understanding of designing for people.
Going through all the stages of the design process we explored various design directions by combining ideas for motions and emotions with interactive artefacts. We designed a user experience in the form of an interactive prototype that imitates the shape and movement of a flower. Blossom Bright provokes emotional responses from the audience through the bodily movements by the means of the temporal form of the artefact. The movement of the artefact expresses an opening and closing motion.
In this paper we explored how human interaction impacts interaction aesthetics in regards to expression, through the development of the Blossom Bright. Essentially, exploring movement refers to exploring bodily action. Examining the expressiveness of the artefact with a point of departure in bodily skill in interaction - as well as exploring the motions of the interactive artefact - was crucial in the development process.
Our bodily movements and the perception of movement in our environment is essential to the interaction with the physical world, and contributes to the aesthetic experiences with interactive products.



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Web 1: https://www.youtube.com/watch?v=D7kvXDhbRUM

Appendix 1

Feedback from exhibition visitors

Visitor 1:
Visitor 1 showed interest in regard of how the artefact worked. He would've liked to see the artefact opening slower and more smoothly - as he would've expected it to. Doing this might have removed the surprise factor though. The feeling of surprise seems to have been the common denominator amongst visitor responses. When we asked him what his reaction was to the sudden movements, he described the lamp as being "angry".

Visitor 2:
Two men from the ITU were interested in the lamps movements. They did not think as much about the physical form of the object, but they were attracted to the lamp by the way it moved. They both tried to lean over the object, put their hands inside the lamp and stepped very close to the ping sensor, all to see how the artefact responded to bodily movements. They knew that at some point it would close down, but never when - this they described as both interesting and surprising, both the feelings we were looking to achieve. It did though bother them, that they did not find a pattern in how, and when the lamp would open and close.

Visitor 3:
Visitor 3 felt the lamp wasn't as organic as she would've liked - but rather more geometrical. The artefact sparked interest, but did not react in the way she had expected. She expected the artefact to close slowly as she approached it, but as a result of the random behavior she felt confused and did not see the purpose of the lamp.

Visitor 4:
The next visitor felt attracted to the big poster at the exhibition. She did not know what to expect from the lamp, or what it would do. As she approached it she was surprised by how random it moved. She tried to approach it both slowly and quickly. She wanted it to stay open so that she could have a closer look at the inside of the lamp. And when she realized the sensor did not react to how fast or slow she approached it, she began to move away from it, until it opened up to her.

Code ordering within the HTML code (left) and how each code block is arranged by the style sheet