PARA Controller

Squad
Crafting Everyday Soft Things
Type
M1.2 | Research Project
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Year
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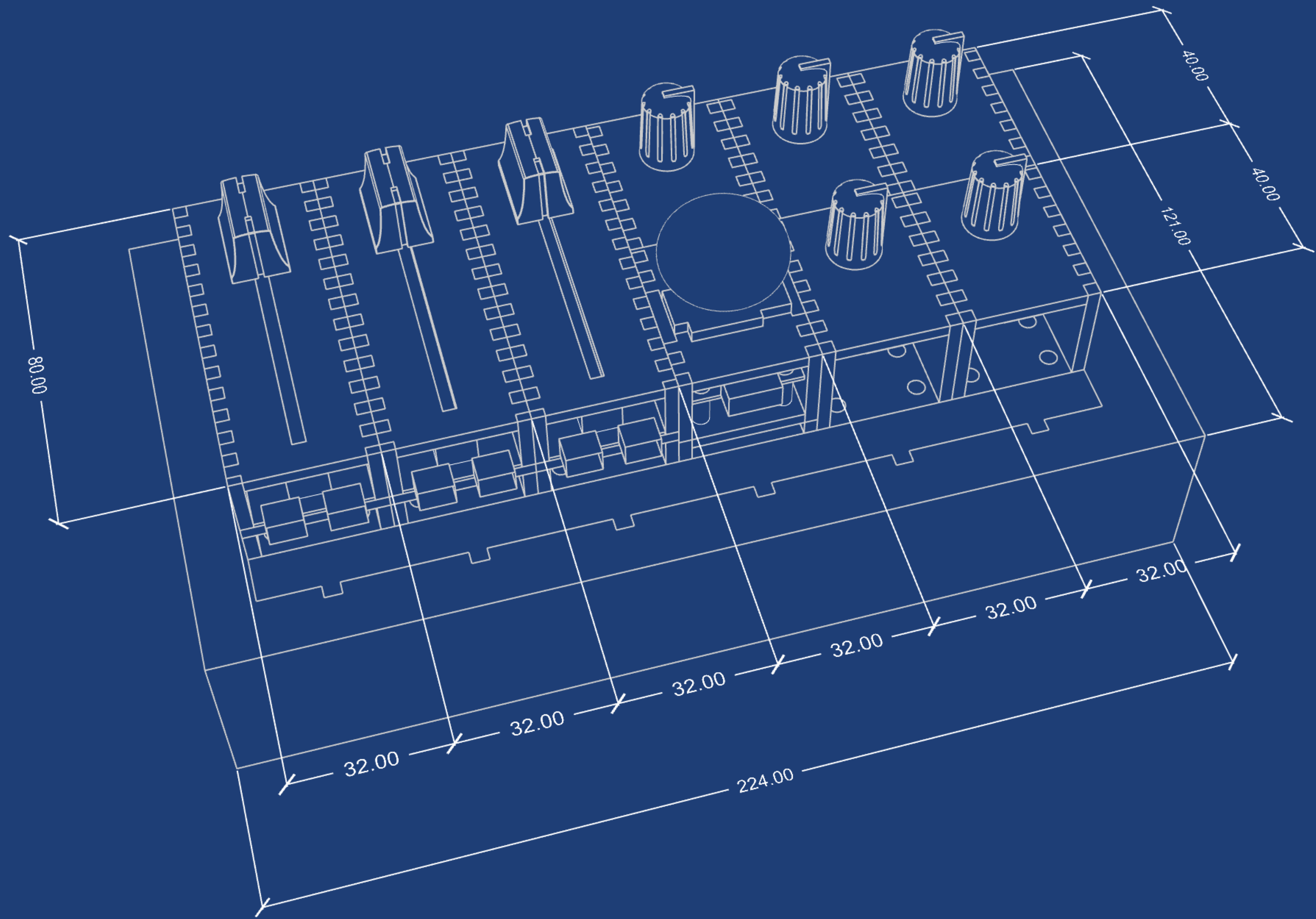
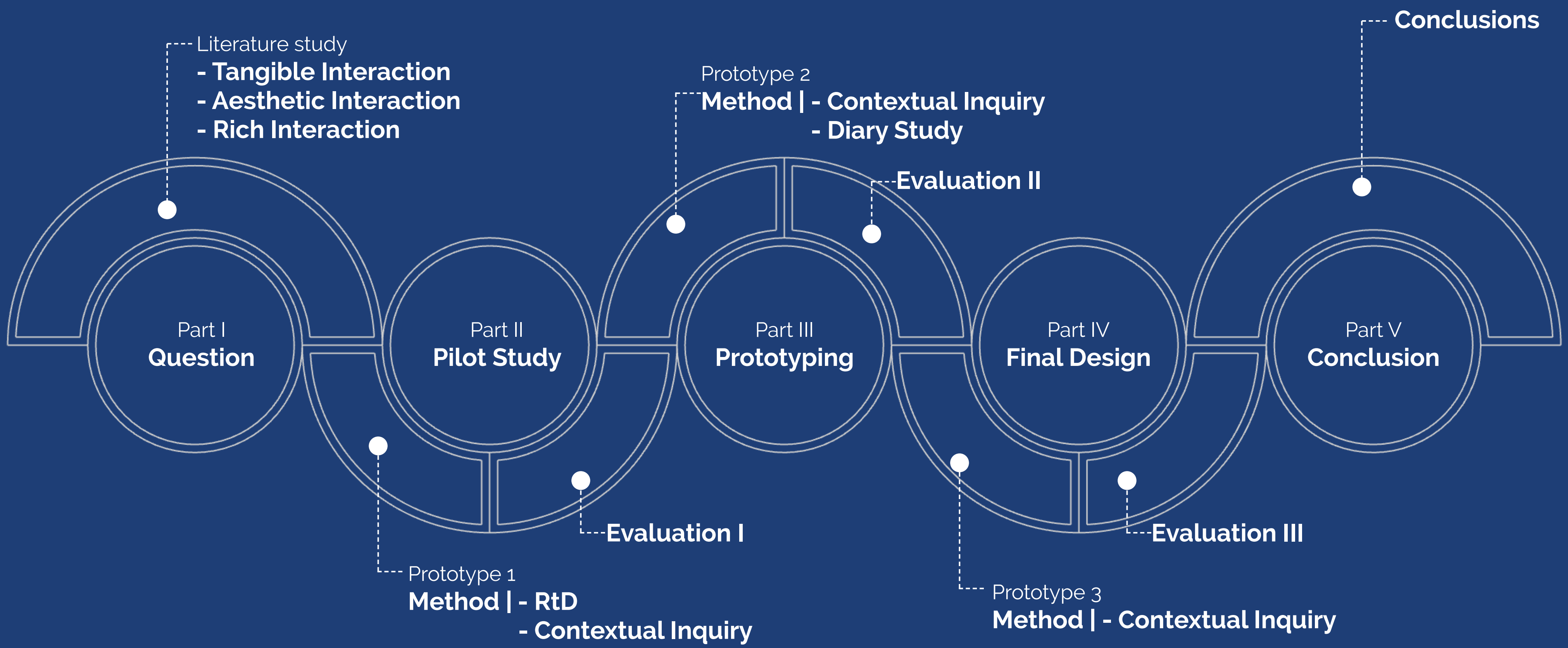
The **Para Controller** creates a physical medium with digital modelling. In addition, it provides a user-friendly approach for parametric designers to **control, inspect and directly manipulate algorithms in real time.** The Para Controller aims to develop tangible computational methods to extend the boundaries and capabilities of digital design and fabrication tools.

Product Visualization

Perspective



PARA Controller



Research Process

Parametric Design

What is Parametric Design?
Parametric design is a general term that used to describe a computational design approach or algorithms - aided design that is aimed to automate the deign process.

Why Paramtetric Design?
Parametric design offers architects, industrial engineers and industrial designers with a powerful, logical and flexible medium to generate complex 3D geometry and simulations (Woodbury, 2010). It also enables designers to quickly alter certain design characteristics and interactively preview them in real-time (Tedeschi et al., 2016). Designers no longer need to create geometry or complex simulations in the traditional way, but instead, to create connective visual algorithms to automate the entire design process to replace the intensive labour work and repetitive interactions.

Problem Statement

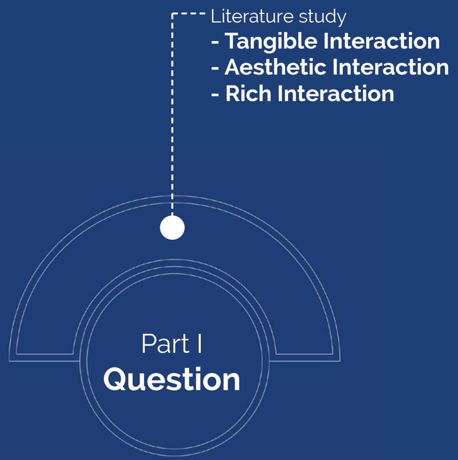
The creation of visual algorithms is difficult to master and very specific towards the different design requirements. Thus, the operation of the parametric design is limited only to specialists, which results in a linear process, where the evaluation is only executed after the design process for validation purposes, rather than for assisting in the process of design (Al-Qattan et al., 2016).

On the other hand, parametric software such as Grasshopper or Solidworks is based on a graphical user interface (GUI), which does not provide designers with the interaction that occur naturally in the physical environment (Ishii et al., 2008). Additionally, parametric designers are also limited to existing tangible artefacts to interact with the digital environment (Plotnikov et al., 2016).

How to design a Tangible User Interface for Parametric Design?

"What determines whether the interactions provided by this TUI are considered to be rich interaction?"

"How can this TUI to designed to be able to add values to a parametric designer's workflow?"



- Tangible Interaction

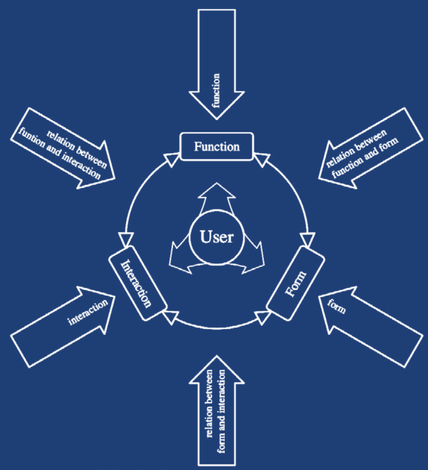
Interacting digital information by using windows, menus or icons has become a predominant approach in the design of HCI. Therefore, the term of tangible user interfaces was proposed by Ishii and Ullme (Ishii & Ullme, 2008) as an alternative for GUIs. Tangible Interaction is a interaction style that utilise physical objects as medium to interact with the digital products or systems. They argued that physical affordances offered by tangible or graspable objects allow users directly manipulate and control the digital information in a seamless manner (Ishii & Ullme, 2008).

- Aesthetic Interaction

Aesthetic interaction goes beyond only the aesthetic of form (Frens 2006). Joep argued that aesthetic interaction is the aesthetic experience that only can be gained while interacting, additionally, it has also to do with how functionality is reached.

- Rich Interaction

Joep Frens took the theory of affordances and tangible interaction to a further step. Which he described as Rich Interaction. He argued that any interactive product can be seen as an integration of the three following properties: form, interaction and function (Frens 2006). Additionally, he also argued that rich interaction is build on respecting people's skills, and it aims for aesthetic interactions (Overbeeke et al., 1999).



Rich Interaction Framework (Frens 2006)

Method | Research Through Design

Three Themes

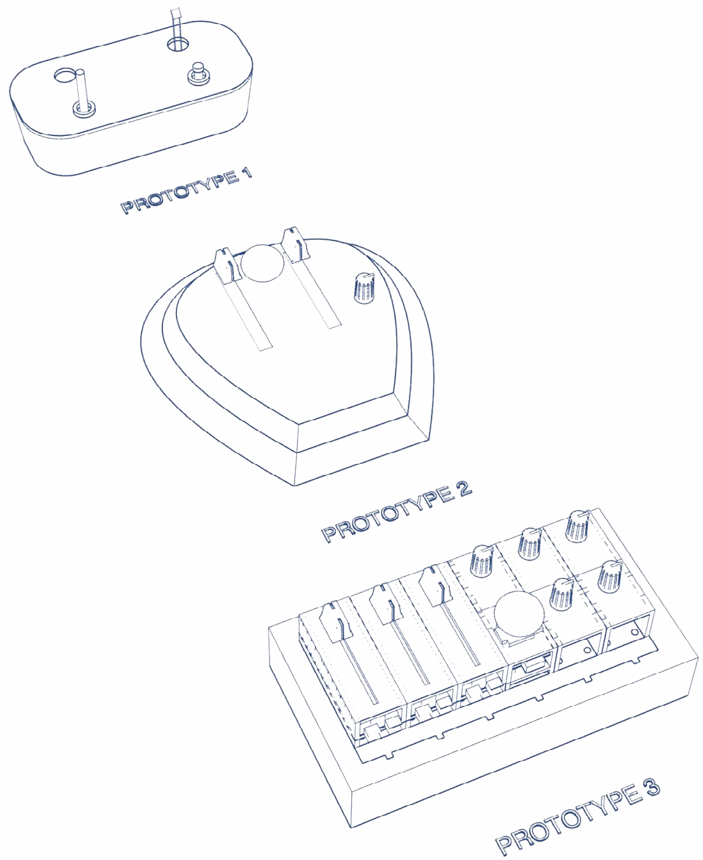
This research project is conducted by using research through design method, which can be described as generation knowledge through the iterative process of designing, building and ***testing experiential prototypes***. Each iteration was designed that differ in ***shape, interaction and function***. In order to find out what elements offered by this TUIs will be perceived enjoyable, hence providing good user experience, ***3 themes were defined***. Each theme was defined to cover a specific area of the potential solution domain. When designing this TUI, we interviewed different specialists, which ranging from architects, industrial designers and even fashion designers. This serves the researcher to find a balance between different grasshopper users.

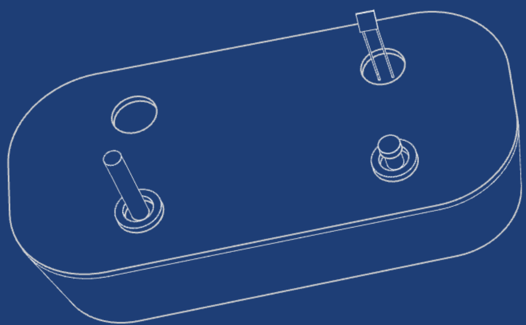
Three themes are:

1. (Pilot) Prototype: A symmetric interface that offers both handed interaction

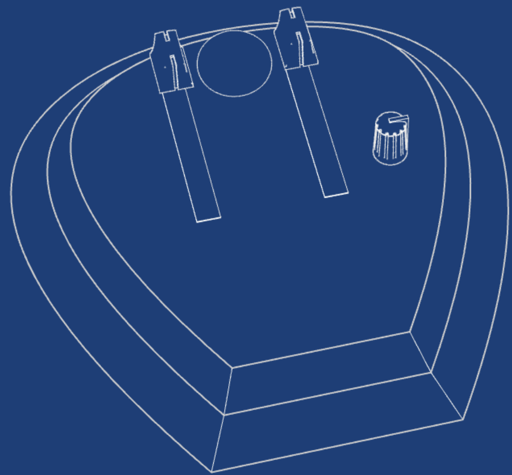
2. Ergonomic Prototype: A textile interface, offers one-hand interaction

3. Modular Prototype: A modular sandbox.

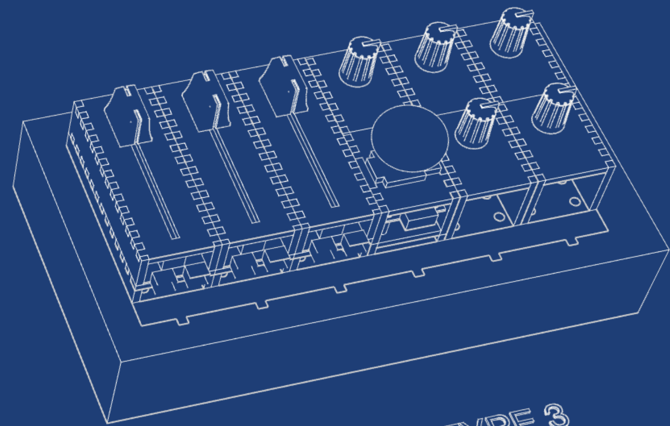




PROTOTYPE 1

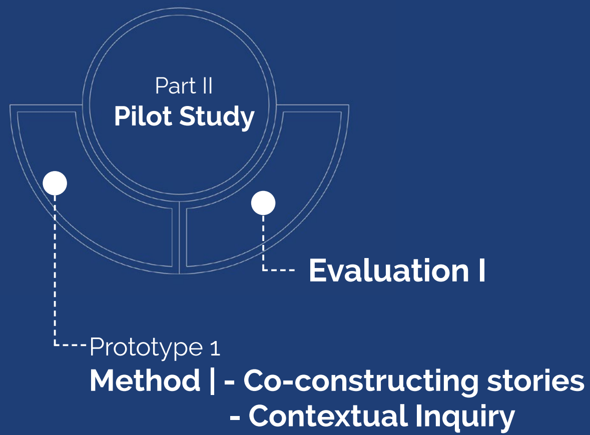


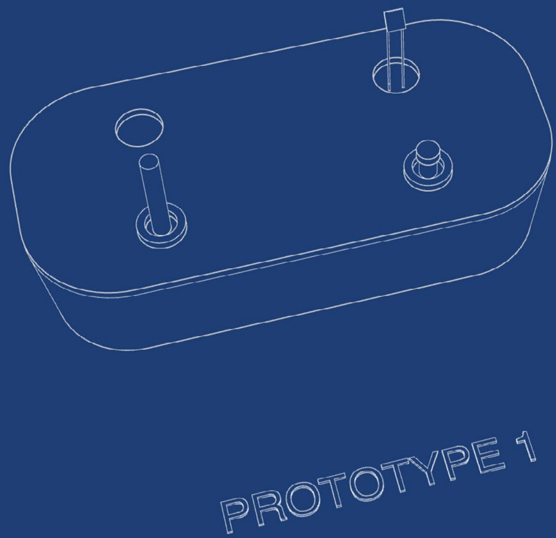
PROTOTYPE 2



PROTOTYPE 3

DESIGN EVOLUTION





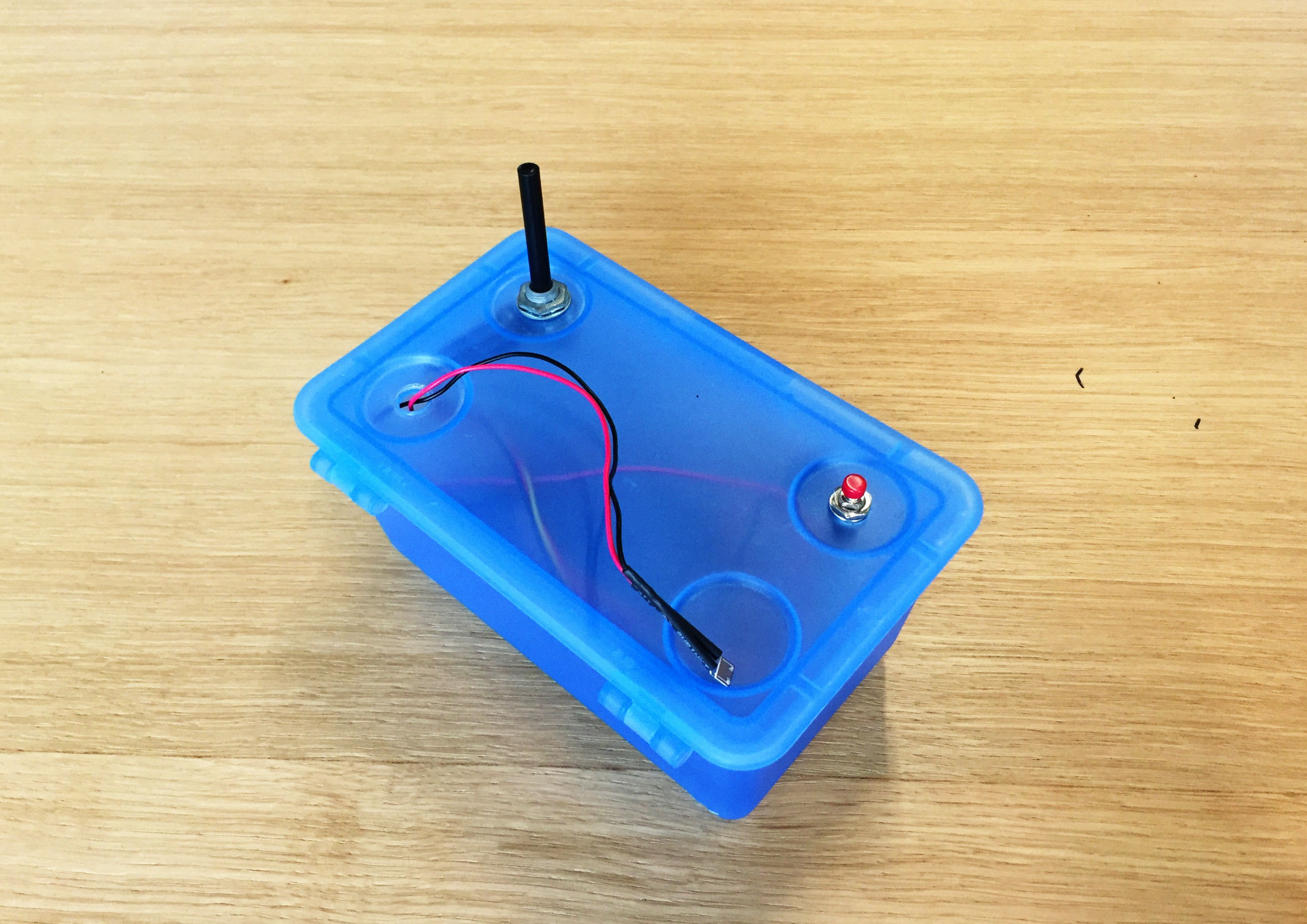
Pilot Study

- Design

The pilot study was executed before the midterm demo, as the starting point, it aimed to elicit user experience and define design criteria. The pilot prototype is originated from a lunch box that has a symmetric from. It has also a proper size which allows two-handed interactions for the users. Three electric devices are installed on this TUI: light sensor, potmeter and bush button. Three grasshopper examples were provided for user to interact.

- Participants

6 participants take place in this study. All participants were chosen based on the fact that they have some experience with parametric design. Besides, participants with different educational background and use context may result differently. Two of the participants studying architecture and three students are majoring industrial design.



Evauation I

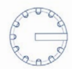
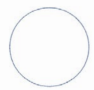
The pilot study confirmed the hypothesis put forward before the research project that the use of TUI can effectively increase the likelihood of using grasshopper, thus providing good experience. However, this TUI concept provides the user with a limited range of action possibilities: rotating the potentiometer, pressing the button and covering the light sensor with one hand. We found that only the potentiometer and light sensor can be seamlessly integrated during operation base on the fact that only analog inputs are taken in grasshopper code to manipulate digital numeric data.

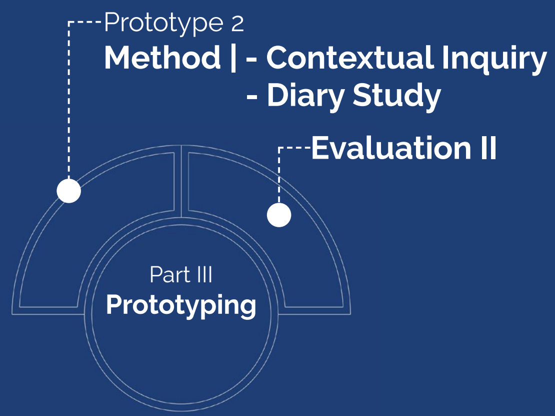
This form of TUI failed to provide aesthetic interaction because we discovered that user also needs to be able to use the mouse. In addition, the shape of the potentiometer is considered to be a joystick; we believe this was because of the inappropriate affordance was percived by the users. In the given example, the predefined functions are the rotation, translation, scaling patterns. Based on the observation we also found out that only when the rotation that operated by rotating potentiometer was perceived enjoyable. Changing density of the light sensor and pressing button also failed to provide user aesthetic interaction.

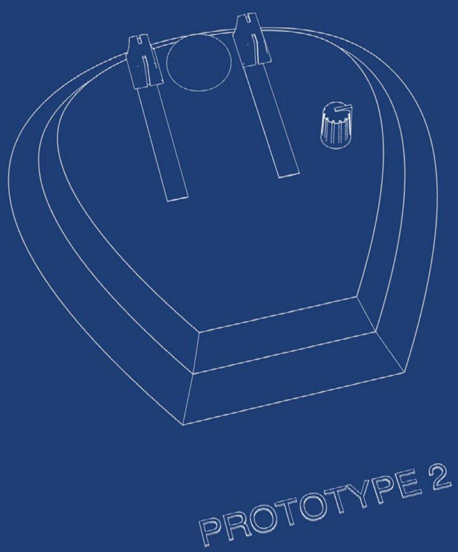
Implication

We found that appropriate design metaphors created aesthetic interactions in TUI design. Ishii developed a set of physical instantiation to replace GUI elements during his TUI design study. This provided inspiration for our research and laid a solid foundation for the development of our physical instantiation.

In grasshopper, movement, rotation and scaling are achieved by using the digital slider component and its corresponding components. We plan to design the interaction of these three functions by using the following set of physical instantiation:

Potentiometer slider 	Number slider (Extrude, scaling)
Potentiometer 	Number slider (Rotation)
Joystick 	Number slider (Translation)





Prototype II

- Design

Based on the design implication and physical instantiation that was developed in the pilot study, In this TUI concept, two potentiometers sliders, a joystick and potentiometer are added. Slider potentiometer serves to mimic the 'number slider' component in the grasshopper. Joystick serves to provide users with multidirectional control ability. The reason to use slider and joysticks was they offer a higher kinesthetically sense and flexibility, it was also perceived more intuitive to operate the software.

- Participants

The similar research was conducted as the pilot study. The findings provide a lot of insights into the design or improvements of the interactions, however, it did not directly contribute something significant to the research questions. The findings are perceived a bit "on the surface". In order to capture and understand the user behaviours and intentions in situ, a diary study is hereby conducted.

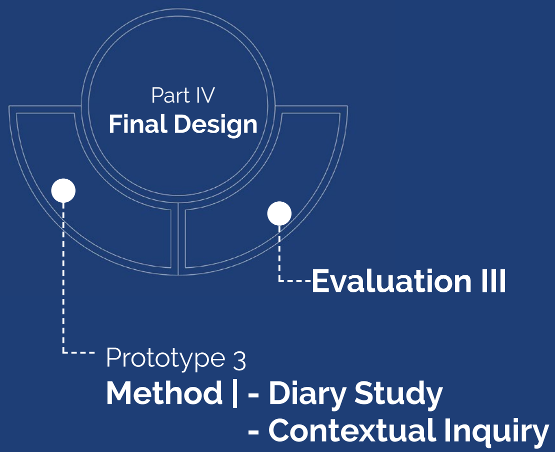
Evauation II

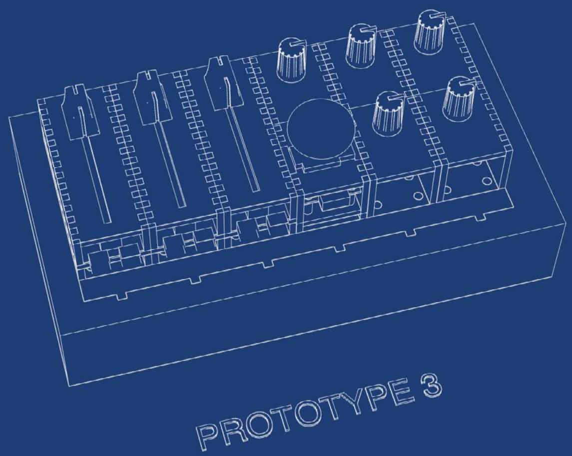
This form of TUI provides aesthetic interaction. We also found that the use of soft materials can enhance the user's experience. On the other hand, the one-handed interaction provided by this TUI allows the parametric designer to interact more comfortably. The physical instantiation we developed in previous pilot study has succeeded in creating good design metaphors, especially the use of slider potentiometers. It vividly mimics the sense of control provided by the digital slider in the grasshopper. The joystick provides a flexible way to manipulate geometry vertically and horizontally in the Rhino workspace, giving users more real-time operation. Rotary potentiometers provide aesthetic interaction only when rotating geometry.

However, this TUI concept failed to provide ergonomic interaction because the size of this TUI failed to satisfied someone with a smaller hand. Besides, thumb is capable of performing 2 dimensional control, but we have not created this possibility in this design concept.

Implication

The design metaphor derived from previous research has effectively promoted aesthetic interaction. We intend to inherit this principle into our final prototype. On the other hand, we find that there is still plenty of room for improvement. We found that our participants like to integrate the "growth" feature into the design of the TUI. They mentioned that the amount of interaction available is limited, which may be due to the different educational background of each participant.





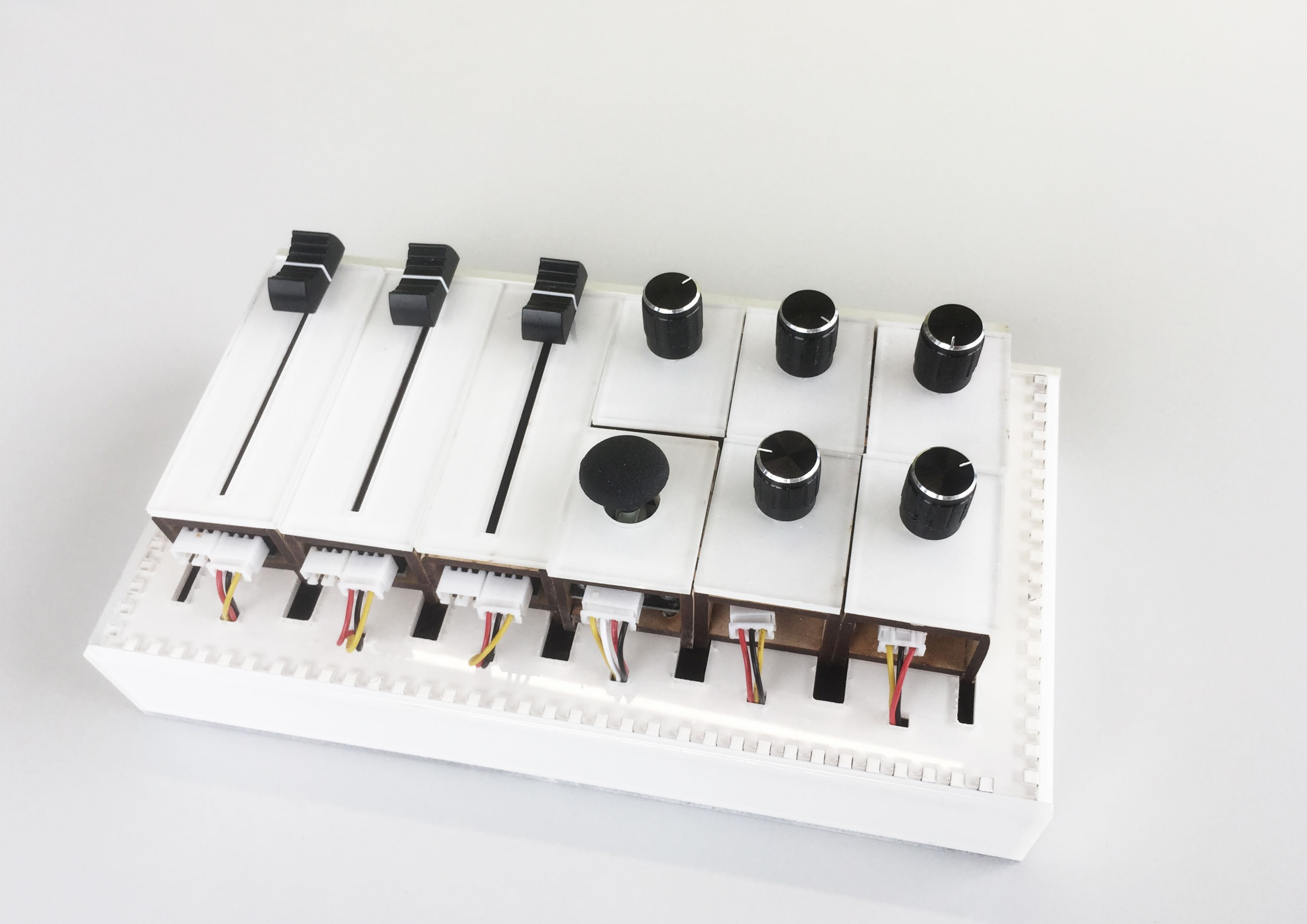
Prototype III

- Design

This TUI concept comprises a modular tray in which tile modules can be placed. The left is a set of three tile modules aims to provide users with function of increasing or decreasing input numeric values. They are also the physical instantiation of number slider in grasshopper. The joystick is placed in the second row of tray which offers participants a multidirectional manipulation. The rest of tray is mounted with rotary potentiometer, they are considered to be the default modules, of course there will be more module with different function will be developed in the future.

- Participants

The participants will be recruited during the demo day, people who has experience with TUI design or parametric design can articulate their opinion or perspective on the design of thsi TUI.



Evauation III

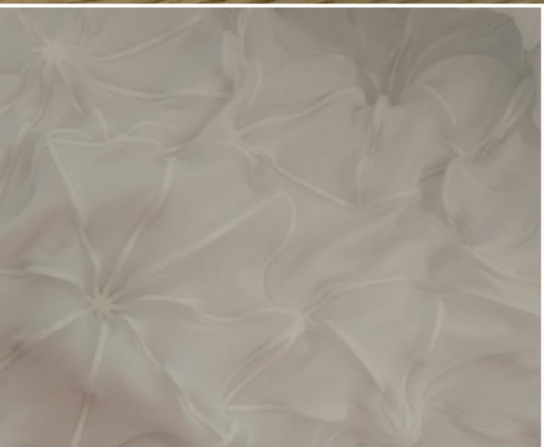
We performed the exact same grasshopper examples throughout the research project, and the final prototype concept, the Modular Sandbox, brought form, interaction and functionality in a straightforward manner. When interacting with this form of TUI, aesthetic interactions can be found in the new TUI concept. In addition, we also solved the problem existed the previous prototype. Now we can provide users with a customizable interface. The default module tile is a rotary potentiometer, but we have also received some suggestions that in different usage scenarios, this TUI should be able to embed other types of analog devices, such as light sensors, in order to simulate change of light density in a facade design. Or a bending sensor that simulate force analysis in architectural design.

Discussion

Interacting grasshopper with a tangible user interface create engaging experience for parametric designers that what could not be achieved on a graphic user interface. Through the entire research process, we found out by applying proper design metaphors is the key to lead aesthetic interaction. Prototype 1 used a simple setup for the TUI that allows participants to establish a connection between digital and physical analog input. Additionally, we also developed a set of physical instantiations as design criteria. This design criteria was further explored in the development of prototype 2 and 3. The ergonomic prototype (prototype 2) was tested with professional fashion designers, both of them have a limited working experience with grasshopper, but they were able to design patterns simply by using this this TUI. This expands the boundaries of current design tools and pipelines to achieve a novel approach for engaging parametric design and co-design by using a tangible user interface. The research opens up the possibilities of establishing a tangible artefact that is capable to bridge the gap between the physical and digital environment and provide designers with an intuitive, real-time visual feedback and collaborative solution.











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