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MATERIAL TINKERING

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TFG REALIZADO EN PROGRAMA DE INTERCAMBIO

TÍTULO: Material Tinkering

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RESUMEN

Este proyecto pretende crear una herramienta física que ayude a los diseñadores a escoger un plástico para fabricar su producto, atendiendo a las propiedades intangibles y sensoriales de los materiales.

Tras realizar una profunda investigación, el proyecto se centra en la creación de un forma tridimensional que permite la evaluación de las propiedades sensoriales e intangibles del material sin influenciar la percepción de las mismas. Para ello se discute el concepto de neutralidad y su interacción con los individuos mediante la utilización de workshops y ejercicios con usuarios potenciales.

Las formas generadas han sido producidas en distintos plásticos por inyección. Las piezas resultantes, así como el packaging generado, invitan al usuario a interaccionar y a explorar la relación entre ellas. El resultado del proyecto continuará desarrollándose en investigaciones posteriores.

PALABRAS CLAVE

FORMA NEUTRAL – PROPIEDADES INTANGIBLES - INYECCIÓN - PLÁSTICOS - TOOLKIT

ABSTRACT

The aim of this project is to create a material library based on intangible characteristics. This toolkit will help designers with their interaction between their customers and will help them choose proper plastics for their design products.

Previous projects tended to focus on the technical properties of materials, rather than on intangible characteristics. After profound investigation/analysis of existing works we have summarised knowledge about material properties and started to create a neutral shape of plastic which will not influence the subjective feelings of the user.

The main part of the project discusses the definition of concept of neutrality and how the individuals subjectively perceive it. This was done throughout multiple workshops within varied groups of potential users which finally led to creating possibly neutral forms. Then we produced these forms using varied plastics with the injection machine.

The final shapes not only stress material properties, also induce the customer to discover plastic pieces throughout interaction between themselves and also between them and the packaging.

KEYWORDS

NEUTRAL SHAPE - INTANGIBLE PROPERTIES- INJECTION - PLASTIC -TOOLKIT

University of Antwerp

MATERIAL TINKERING
FINAL REPORT

European Project Semester - EPS 2018

Under Supervision of Lore Veelaert and Els Du Bois

Adria Fenollosa, Eduard Casadevall, Gloria Diaz, Tereza Vackova, Eva Wenborn

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ABSTRACT

The aim of this project, called material tinkering, is to create a material library based on intangible characteristics. This toolkit will help designers with their interaction between their customers and will help them choose proper plastics for their design products.

Our background research demonstrates that previous projects tended to focus on the technical properties of materials, rather than on intangible characteristics. Technical aspects concern the behaviour of materials under certain circumstances, whereas intangible properties refer more to sensorial and immeasurable attributes. After profound investigation/analysis of existing works we have summarised knowledge about material properties and started to create a neutral shape of plastic which will not influence the subjective feelings of the user.

The main part of the project discusses the definition of concept of neutrality and how the individuals subjectively perceive it. This was done throughout multiple workshops within varied groups of potential users which finally led to creating possibly neutral forms. Then we attempted to produce these forms using varied plastics with the injection machine, though the technical problems seriously complicated the manufacturing process. Therefore, the final forms are partly injected in desired plastics and partly printed with the 3D printer as the model of the shape.

The final shapes not only stress material properties but also induce the customer to discover plastic pieces throughout interaction between themselves and also between them and the packaging.

INTRODUCTION

Introduction.

This report concentrates on the project ‘Material Tinkering’. The goal of the project is to create a functional prototype of a material library for designers. This library contains four samples of common used plastics. Other materials can be continuously supplied in the future. The library, also known as a toolkit, aims to help designers and design studios with their understanding of the needs and feelings of their customers. In order to obtain this information, interaction between the toolkit, the customers and the designers is needed. During consultation their clients would interact with the plastics and the designers would thereby gain a more concrete concept of their costumers’ desired plastics.

This report discusses the shift of designers’ focus from technical aspects towards intangible aspects of materials and answers this shift by creating the mentioned toolkit. The prototype of the final toolkit is supposed to follow the mentioned trend; therefore, the emphasis is put on intangible feelings associated with different plastics. Whereas technical aspects are physically measurable, intangible aspects originate from personal association and are closely related to the human senses. This report also examines the effect of shape on the perception of intangible aspects.

Firstly, we provide background on the project. We consider the importance of the existence of this type of tool and we stress its exceptionality. This pa rt also refers to complex research and state of arts. We finish the background by pointing out the technical aspects of the machines and theoretical complication which proved to be real later.

Secondly, we discuss the project. We state our aim and how we have planned to reach it in time. We also discuss the team organisation and work delegation. Then the report presents a short summary of our stakeholders. The corporate identity is also part of the project, which will also be explained.

The last, most important part of the report is about the project process. The workshop process addresses the problematic concept of abstraction, neutrality and their analysis. The key results of these workshops are four defined forms. Afterwards, we needed to clarify some design requirements of the final shapes in order to proceed with production. All steps of the production with the injection machine and its complications are thoroughly explained. The last but one part focuses on the material and design of the packaging which are both related to our design requirements. Finally, the proposal of the booklet and its future lines are mentioned.

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BACKGROUND INFORMATION

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EPS Background.

The project is part of the EPS programme (European Project Semester). This programme is offered by 19 universities throughout 12 European countries to students with at least two finished years of study. The main aim of the program is interdisciplinary communication of students from different cultural backgrounds.

Mostly engineering students are the target group, though other students whose skills can help in concrete project themes are also welcome. After a semester of project work, students should gain enough skills for economic and technological expectation of companies on the market.

There are various differences between the EPS course and the EPS-providing universities. In general the project is divided into two parts: “project work” (evaluated with 20 ECTS) and a number of obligatory project supportive courses, a total of 10 ECTS. The focus is on the project work, which should not last less than 15 weeks and includes continuous work on a specific topic. Project supporting subjects mostly consist of teambuilding, different subjects related to marketing and product development and finally language courses.

Because of this project, students learn how to work in a team and take responsibility for their participation in the project. Every team consists of 3-6 members, ideally 4-5. Each project team is controlled by supervisors who assist the whole team to overcome barriers. These students must present the process of their work in regular assignments and reports.

Some core values of EPS

The general used language is **English**

It is a **group project** with 4-6 members

The project is under **constant supervision**

Introduction, importance and background of the toolkit.

Many designers know that designing is a process consisting of different kinds of aspects. Their preliminary studies are mostly composed of different intakes and perspectives on the design process. These studies provide would-be designers with a broad background about technical, social, environmental and economic aspects. Consequently, they realise that designing is not only about making money and making the product producible.

A product is used in a multi-environment, meaning that a product is used because it serves a purpose but is, for example, also used to fulfil a specific desire and taste. In order for a product to be desirable, it needs to achieve the requirements that are based on the needs and wants of its target group. Prior to the design and production of a product, an extended research about the target group has to be performed.

During the selection process of materials of the design, which is also an interdisciplinary effort (Hasling, K. , 2016) , designers currently use material libraries provided by either their own collection of samples and/or databases. Achilles Design, for example, have their own collection of already fabricated samples. These samples provide them insight into how plastics can serve a certain purpose and become a certain shape. These libraries are often only referring to technical properties. Technical properties are certainly important to decide on a material, although materials encompass more than only technical properties. Materials also carry a meaning with them.

Materials possess compositional properties, technical properties, sensorial properties and intangible properties. Compositional properties concern the microstructure of a material. These properties are not of direct importance to the designer because the properties are too far-fetched from their field of work, while technical properties provide the designer an understanding about the behaviour of materials under certain circumstances. These properties are important for deciding on the lifespan, endurance, strength, etc. of the product. Characteristics that are interpreted through the senses, like glossiness for example, are sensorial characteristics. These are also often translated into a technical description.

"Research and experience is thus necessary to decide on a form that is as neutral as possible, to minimise the influence of form on meaning. This report aims to develop such a neutral form."

Research reveals that designers have shifted their focus towards intangible aspects, whereas before they used to focus more on technical aspects. Therefore, the demand for a tool or material library focused on these intangible aspects increased. These intangible aspects concern attributed meanings like ”sexy” and ”masculine”. Much research has already been conducted on these ascribed meanings. Designers can use these meanings to add a specific intent to their developed product in order to cross a certain mood or message. Hence why it would be interesting to develop a toolkit for designers to interact with their target group and define which meanings or feelings they ascribe to a material. (Karana et al., 2007).

However, the ascribed meanings to materials are influenced by a grand amount of factors. These meanings are influenced by a person’s background, personal preference and culture (Rognoli, V. , 2010) . Besides these social factors, the form and setting in which the product is found also influences the final ascribed meaning. Many forms are associated with different kinds of meanings. Fortunately, plastics seem to diminish the influence of form on meaning. Sharp geometric groups were associated with wood mostly and hybrid or rounded geometric groups with plastics (Karana et al., 2007). We will focus on making a tool consisting of plastic samples only, because plastics offer a substantial range of application and because they are widely used. Nonetheless, meanings will not be ascribed without the influence of form in any case. Based on the form in which a material is embodied, people will ascribe slightly or even totally different meanings to the material. It is important to note that not one design method will guarantee an evocation of a specific meaning from a specific product. Meanings originate from interaction in a particular context, and theoretically any material can have any meaning ascribed. Although studies of this context have been carried out, none of them used a real 3D form. This is very contradictory because form is a mass given object that exists in a 3D world, thus it would be wise to use 3D models in further studies.

Research and experience is thus necessary to decide on a form that is as neutral as possible, to minimise the influence of form on meaning. This report aims to develop such a neutral form. Besides this development, it will also design a correct guideline included with the tool for designers, so that they have a reference to the generally ascribed meanings to the provided materials. The final goal is to make it possible for designers to integrate these intangible characteristics of materials in their design.

Selecting materials is a complex process that takes up a considerable amount of time. It would be therefore interesting to also add sensorial and technical properties to the tool, so that designers do not need to switch between different tools whilst deciding.

State of Arts.

As explained in the first section of the background, several material libraries are focused on solely the technical properties of materials. These libraries are tools that are used in order to choose the proper material according to the characteristics of the product.

Currently, several different tools are available. Databases like CES EduPack, is such an example. By comparing several materials, the designer can choose the appropriate material. During this comparison, the designer can select technical parameters or requirements as a filter in order to have a more efficient research. The results of this research are trustworthy, but theoretical. It might be difficult for the designer to define meanings such as the tensile strength in a practical way.

Determinator Box, University of Antwerp

"The Determinator Box" (Fig. 1,2,3) is a project from the University of Antwerp and the University of Ghent. It supports the idea of Design from Recycling. Usually, technical properties are represented by numbers, consequently making it less tangible for the designer. The tool consists of different plastic samples, provided with hinges, thickness and parts that you can bend. These samples, manufactured by injection moulding, allow designers to experience the technical properties of plastics in a practical way. The Box provides 15 different materials, either virgin or recycled, each tagged with their material identity. The booklets included, offer technical information of the materials in order for the materials to be compared. To guide the user and inform him about the methods used while using the box, a guide can be found behind the booklets. (Du Bois et al., 2017).


Fig. 1

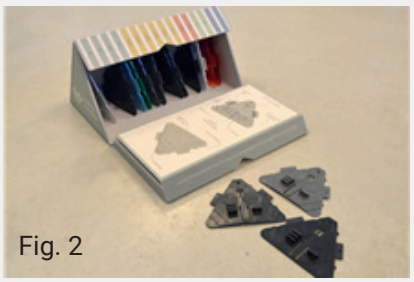


Fig. 2

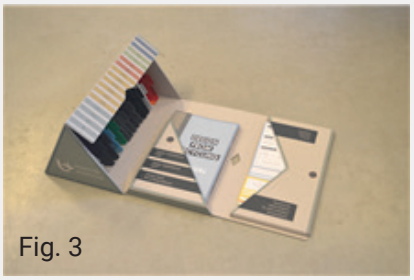


Fig. 3

Material Xperience Fair, Rotterdam 2018

Our personal experience of the material fair in Rotterdam, “Material Xperience” (March 2018), provides us with practical information about sensorial and intangible properties. The materials used in a product can elicit various emotions such as surprise. These surprising experiences are elicited by incongruent sensory information in products. A surprising conclusion of this fair was that even though the material was embedded in only a test sample, stimulations were provoked by the visual perception and tactile experience. However, these test samples were only based on rectangles and squares, fit to show the material itself but not the material exploration.

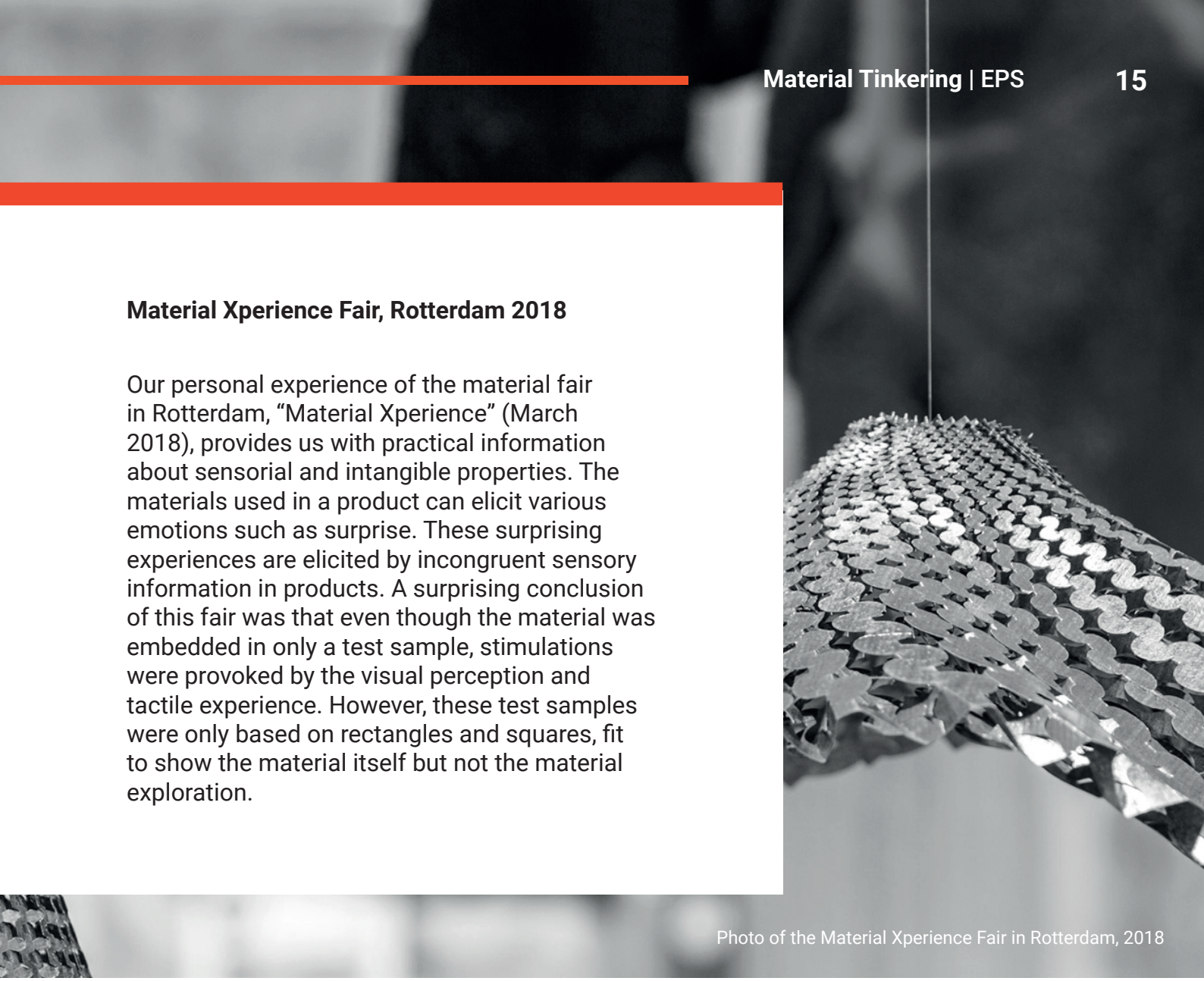


Photo of the Material Xperience Fair in Rotterdam, 2018

Besides the technical field, the user experience field is also a context where designers focus on. User experience explains and focuses on the interaction between the user, the product and environment. An aspect of this are the emotions and attitudes that are generated by such an interactive context. Thereby, materials have a great potential for providing a certain interaction to evoke emotions and create attitudes of the user. Even though this point is of importance in the designer world, currently, not much research has been conducted on this topic. As a reference for our project, we use the researches and work from authors such as Elvin Karana or Valentina Rognoli.

Reflecting on Material Xperience and on other approaches as mentioned in the background, material experience is dominated by visual, as seen during the acquisition, and tactual information (Karana et al., 2010). According to the research and state of arts, users should be able to touch the materials and carry these in their hands in order to get the full experience. They will be able to explore the materials and improve their interpretation of sensorial and intangible characteristics of the material.

Fig. 4

The project closest to ours was developed by The Material Experience Lab (Fig. 4), a project of Politecnico di Milano in collaboration with TU Delft. They assert the following:

"Material is a Medium. It communicates ideas, beliefs, approaches; compels us to think, feel and act in certain ways; enables and enhances functionality and utility. Materials Experience emphasises this role of materials as being simultaneously technical and experiential."

They are currently developing a toolkit, the Ma2E4, which contains samples of materials in four different levels: sensorial, meanings, emotions and actions. It also includes activities that stimulate the design process and help to find the interrelation between the experiences of materials. Their primary objective is to highlight the importance of the expressive-sensorial dimension in both design education and the design process (Karana et al., 2007).

The Machines.

To produce our prototypes and final prototype, we will use 3D printing and injection moulding. The toolkit will consist of different material samples, embedded in a specific form. During the first steps of this form creation, we will use 3D printing. These prototypes will be 3D printed and verified, where after the moulds will be manufactured. These moulds will also be 3D printed in order for them to be used for the injection moulding machine.

To successfully manufacture these forms and prototypes, and eventually our toolkit, we must understand how these machines work and which parameters we will most likely have to pay attention to.

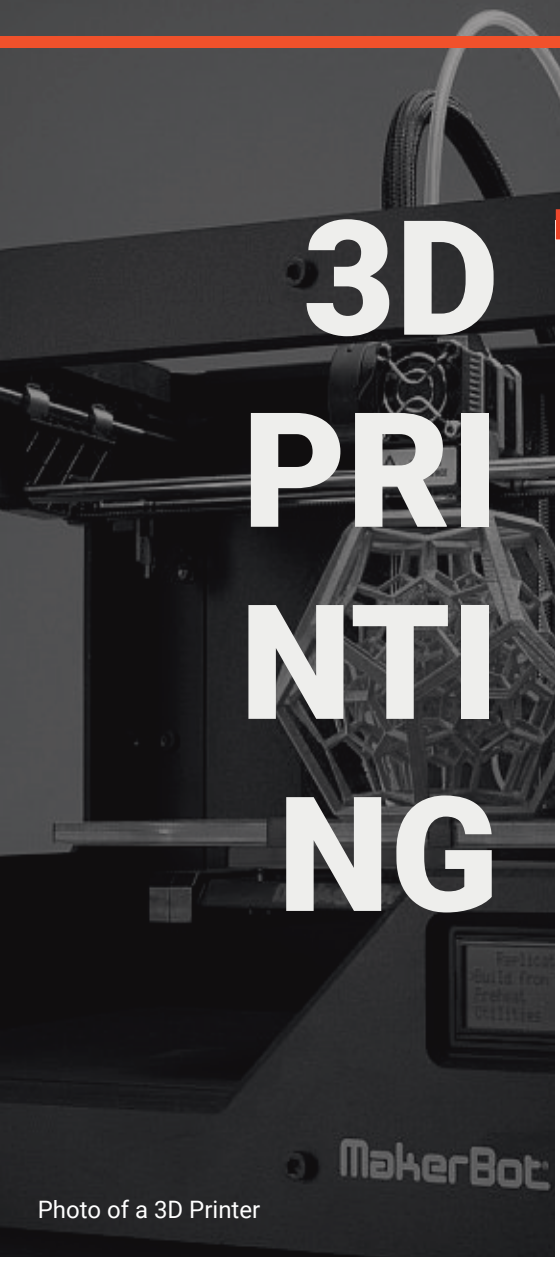


Photo of a 3D Printer

3D PRINTING

Case Study

The last decade, interest for 3D printing has grown dramatically. The first 3D printer was built in 1980 and over the years, it developed to be the best way to make an idea become something real. Companies are designing and making better 3D printers every year, making it more accessible for the common people besides designers. It is a low-cost and error evasive process that is easily learned.

The 3D printing process is as easy as creating a 3D model. 3D models can be created in various programmes like SolidWorks, but also in more accessible software. Afterwards, the created 3D model will be sent to the 3D printer and finally be printed. Nevertheless, depending on the brand of the 3D printer, the quality can vary as well as the time span of printing.

We chose this type of manufacturing for this project is because of the low production cost and quality of the printed parts. There is little to no loss of material during printing, moreover it is possible to create a sophisticated shape with high precision.

If this project were to unfold further and if the demand of toolkits increased, 3D printing would be a less desirable method to use. In order to offer a substantial range of toolkits, we will need to address a new manufacturing method (e.g. injection moulding). 3D printing takes up a considerable amount of time. Moreover, only a restricted number of materials are able to be 3D printed, which is less interesting for the project. Though, as we mentioned before, this method will only be used during the prototyping phase of the project. It is a suitable method to check possible designs and evaluating product ideas.

Exploration of Possible 3D-Printers

The university of Antwerp provided us with some machines so as to design, create and build our product. Evidently, we studied all the possible 3D printing machines in order for us to use the most fitting machine for our project.

1

Dimension SST 1200es

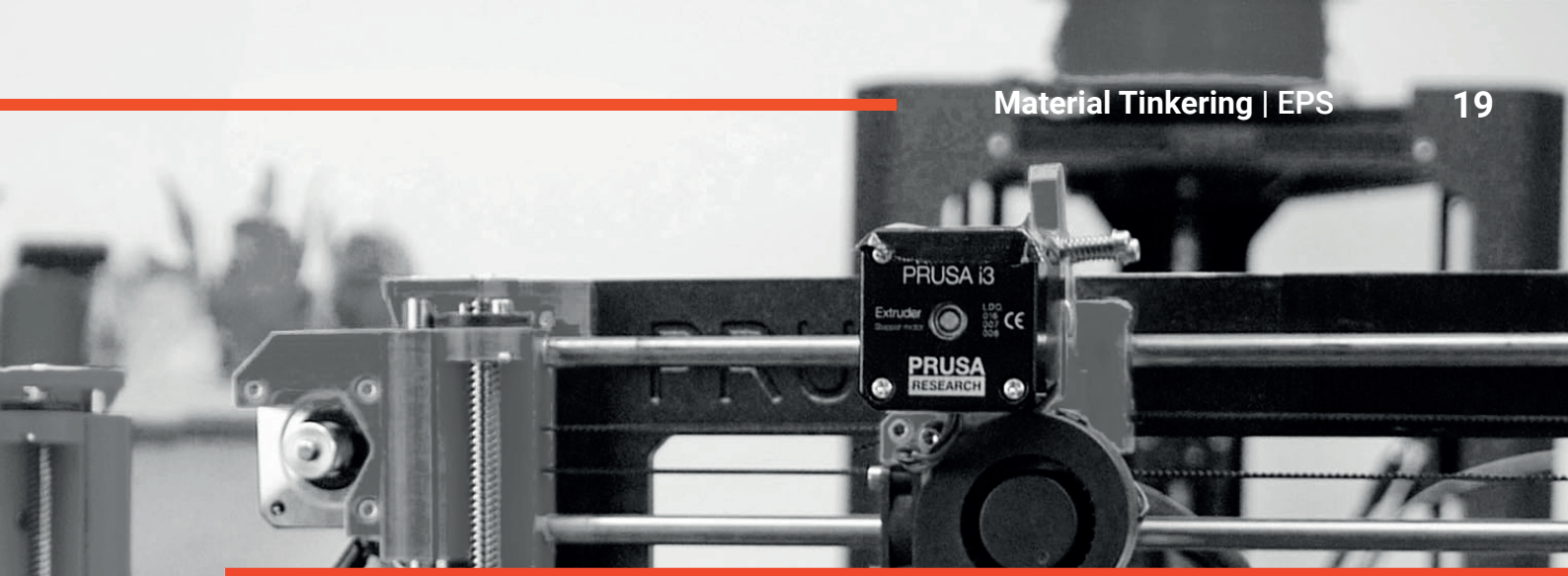
A possible machine that we could use for the first forms and eventually the mould is called “Dimension sst 1200es” (Fig. 5). This machine is provided by the University of Antwerp. In contrast to the stringed 3D printers, which are more common and less expensive, this machine allows us to manufacture moulds of high detail with strict conditions. This is necessary to acquire an accurate result after injecting plastic with the injection moulding machine. Moreover, it is possible to use an acceptable range of materials with a high melting temperature in the 3D printer, which is a requirement for the injection moulding machine.

Fig. 5

Build Size	254x254x305 mm
Printable Materials	nine colours available in ABS and a comparable polymer to ABS with a higher resistance to high temperatures
Layer Thickness	0.254/0.333 mm

Table 1

Although this machine has some great features, the material that is used has a melting point below 200°C. Consequently, the machine is not fit for use since the mould requires a higher temperature resistance. This machine could have been used for other purposes like prototyping the shapes, but there are other 3D printers that are more fit to fulfil this purpose. The machine is expensive in comparison to the Prusa 3D printing machines.



2

PRUSA

It is fairly certain that Prusa i3 MK2 became one of the most popular 3D printers. Most of the design studios and design freelancers have their own Prusa. Being one of the most common 3D printers, this machine is intuitive and understandable, with great features and possibilities in ways of usage. Moreover, there are plenty of materials that can be used for printing. However, the machine is not equipped with sophisticated technology – though we don't necessarily need this feature for every purpose in our project.

Build Size	250 x 210 x 200 mm
Printable Materials	PLA, ABS, PET, HIPS, Flex PP, Ninjaflex, Laywood, Laybrick, Nylon, Bamboofill, Bronzefill, ASA, T-Glase, Carbon-fibers enhanced filaments, Polycarbonates...
Layer Thickness	From 0,05 mm

Table 2

The 3D printer Prusa was chosen for several of reasons. One of them was that the machine was ideal to provide our first prototype samples. In contrast to the 3D printer "Dimension", this machine combines simplicity and great features - such as using widely available materials and being able to print quite sophisticated shapes. Despite some imperfections that may have and the low-temperature resistance of the materials, talking about prototyping, this machine is the most requested during projects.

Photo of a Prusa 3D Printer

3

ProJet 660Pro

It appears that the 3D powder machine ProJet 660Pro is one of the best on its market because of its simplicity and efficiency. This American brand is famous because of the differentiation between the most common 3D printers and itself. This machine uses powder instead of using plastic strings as a resource. Furthermore, the final result can be in different colours because of its 4 channel CMYK full-colour 3D printing. This feature enables the designer to produce accurate and detailed colour models of the design. This 3D printer is more used in academic and industrial environments because of the high cost of resources and the machine itself.

Build Size	254 x 381 x 203 mm
Printable Materials	VisiJet PXL (CJP)
Layer Thickness	No Layers (Powder)

Table 3

We chose this machine to print our moulds for the injection machine. Although this machine only provides one material, it also provides a material which is highly resistant to hot temperatures. This feature is ideal for the injection moulding machine and thus our choice of mould printer.

A doll made with the ProJet 660Pro

INJE TION MOUL DING

Photo of a manual injection moulder

Case Study

Since 1872 this manufacturing process increased to become more popular because it is an efficient solution to obtain more accurate products. Due to this process being relatively fast, a wide range of products can be produced in a short amount of time.

As the name points out, the technique uses an injection method to bring melted material into a mould. This mould can be removed after injection, to obtain the final, solidified shape. To acquire the desired shape, the mould, the material and the machine have to be taken into account. All three aspects have certain parameters that will influence the shape. Consequently, these parameters need to be known and handled correctly.

The most important characteristic of injection moulding is the possibility to create a wide range of products, all having the same shapes without any significant differences.

Besides the ability to copy (nearly) identical shapes, it is also a low-cost manufacturing method. The initial cost will be high, but because the substantial amount of parts produced, the cost will be divided over a wide range. Plastic and energy used for every sample will also be accounted to the individual cost per sample, which will compose most of the individual cost.

In contrast, this asset can also turn into a drawback. Injection moulding is not recommended to be applied when dealing with a low volume of product samples because of the high cost of starting equipment and moulds. We mentioned that we will use 3D printing when prototyping because the injection moulding process would take up too much time and money. If we were to prototype using injection moulding, then we would have to produce moulds for every testing sample. This requires more time, money and energy than a 3D printing machine.

Material loss is limited, especially compared to a manufacturing process such as CNC. CNC starts with a block of material and cuts the excess material. Injection moulding is also efficient in this aspect because only the excessive injected parts have to be cut off - which is also limited.

Besides these positive and negative aspects, there are also common, known difficulties during the injection moulding process. It will take a considerable amount of time to create a new mould if the mould is designed wrongly. This implies losing money and time. Below is a summary of the most frequent complications and solutions.

1

Warping

Complication

During the solidification process, the material shrinks. This means that the final sample will be smaller than the negative of the mould. In other words; the final dimensions of the solidified sample are smaller than the expected dimensions. Furthermore, if the cooling is performed unequally along the sample, uneven shrinkage will be the result. This will result in internal stress, subsequently causing twisted or bent shapes.

Solution

We will use a shrinkage factor to calculate the modified dimensions. We also have to guarantee that the cooling is performed slowly enough to avoid the emergence of internal stress.

Photo of a CNC machine

2

Radius

Complication

Sharp edges in a sample causes internal tensions and deformation.

Solution

We must apply radii in all the surfaces of the sample that are in contact with the faces of the mould. Otherwise, internal tensions and deformations could appear. If we make a metal mould, we should take into account that these moulds are mechanised by radial milling machines. This procedure causes radial edges in the mould, instead of sharp edges.

3

Extraction of the sample

Complication

The liquid plastic fills the mould, until it is entirely filled. When it cools down, and thus solidifies, it shrinks to such an extent that it is difficult to extract the sample out of the mould.

Solution

We must apply a draft angle (Fig. 6) in all the faces perpendicular to the opening line. A well designed mould has a draft angle of 0,5°, but it is recommended to use one between 2° and 3°. We will start with the minimal requirement, and adjust where needed.

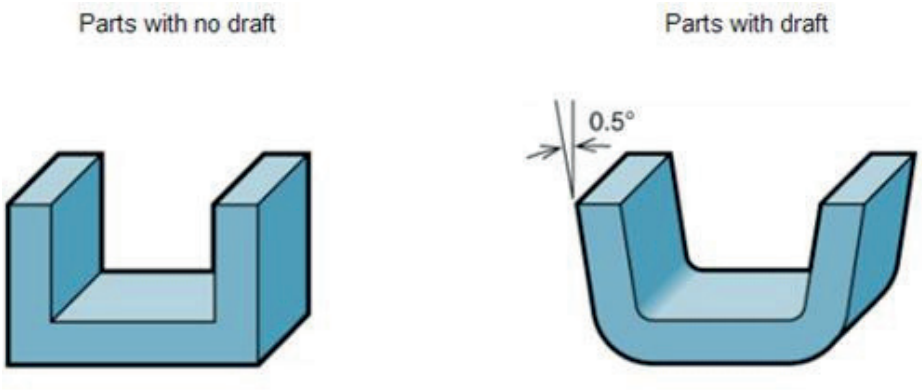


Fig. 6

4

Vacuum Voids

Complication

Vacuum voids are internal air pockets. These are situated in the material itself. It is caused by uneven cooling, insufficient pressure or misalignment of the moulding parts.

Solution

We should increase the holding pressure and ensure that the parts of the mould are aligned correctly. We can also try to use plastics with a lower viscosity, because this will enable the air to escape more easily.

5

Jetting

Complication

This occurs when the molten plastic cannot stick to the surface of the mould due to a high injection speed and thus velocity. As a result, jet streams will be formed. These snake-like streams cool independently from the surrounding material and are visible on the moulded surface of the sample.

Solution

To solve this complication, we could increase the mould and melt temperatures and also reduce the injection speed. This will allow the plastic flow front to stay together in order to avoid creation of individual streams.

6

Flow Lines (Fig. 7)

Complication

When the molten plastic flows and cools along the sample, streaks, patterns or lines are formed. The fluid changes direction all the time due to the different contours and bends of the mould. When the velocity also varies, there are different moments of solidification. This will cause the flow lines. In addition, surfaces with a different thickness or a process with a very slow injection speed can cause the same complication.

Solution

We should increase the injection pressure and speed. The temperature of the molten plastic can also be heightened in order for it to not cool before finishing the injection.

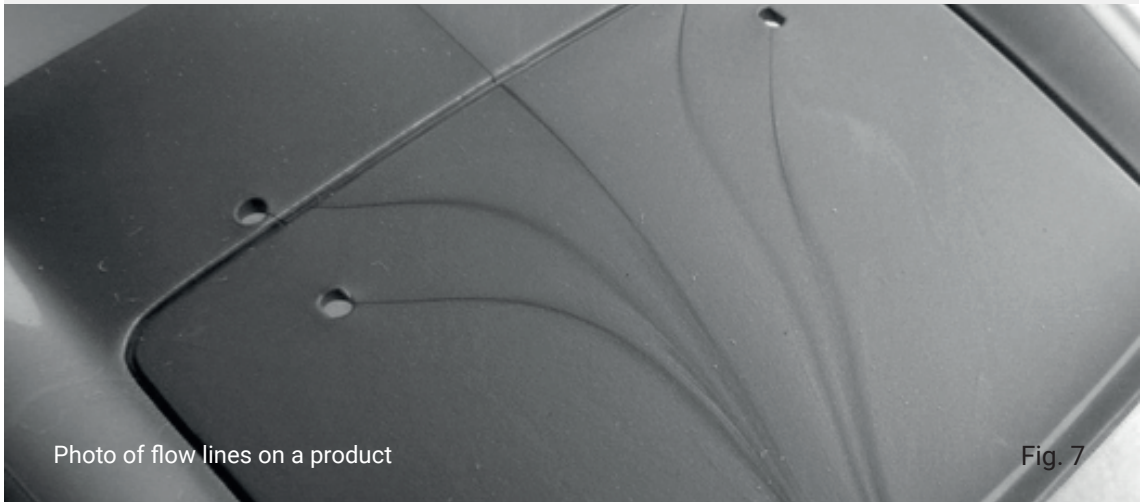


Photo of flow lines on a product Fig. 7

7

Short Shot

Complication

Short shot means that the plastic did not fill the entire mould. Thus, parts of the final sample are missing.

Solution

In most cases, this happens if the mould temperature is not high enough. It could also be because the viscosity of the material. If there's bad ventilation, air could be trapped inside the mould, thus causing parts to not be filled properly.

8

Sink Marks

Complication

Walls of greater thickness also causes stress in the sample. The changing direction of the fluid will cause different solidification moments in the cooling process. Contrary to metals, plastics are not good at conducting heat. The exterior faces will cool faster than the internal ones. This difference in cooling will cause the thick section to draw inward and create a sink mark on the outside surface of the part. In worst cases, the part will be completely warped. This makes the sample unattractive and even unpractical. Besides this aesthetic downside, it can also lead to serious damage if it suffers from dynamic stress. The life span will be shortened because of the internal stress that caused the strain.

Solution

We should avoid very thick surfaces and use additional structures such as ribs instead. These will increase the general strength and avoid sink marks. It is recommended to use half of the value of the wall thickness for the ribs. We can also lower the moulding temperature, while increasing the pressure. This will allow a more accurate cooling process that avoids possible defects.

9

Flash (Fig. 8)

Complication

If the mould is not properly closed, or the injection pressure is higher than the force keeping the mould closed, flashes will appear. Flashes are thin layers of plastic that originate from the partition line between the two parts of the mould. These layers cool down and solidify and remain in contact with the final sample.

Solution

If this occurs, we should reduce the injection pressure and the quantity of injected plastic. We also should ensure that the moulds are cleaned and correctly closed.

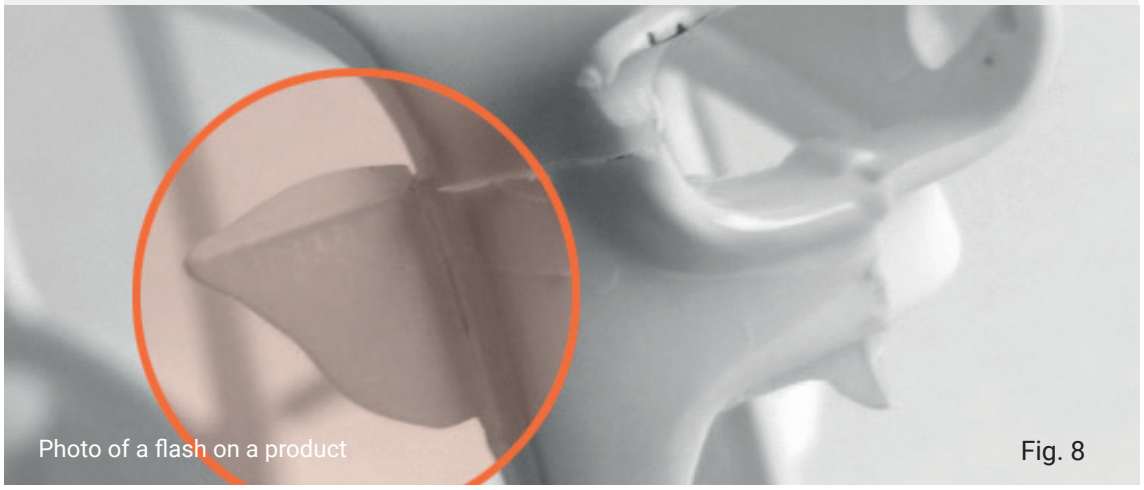


Photo of a flash on a product

Fig. 8

10

Diesel Effect/Burn Marks

Complication

There will be degradation of plastics if very high injection speed is used or when it is exposed to excessive heating. Another factor that influences the heating is ventilation. The air trapped inside the sample cannot escape, thus compressing and overheating the sample and finally degrading the surface.

Solution

Reduce the injection speed and guarantee good ventilation for the critical areas.

Exploration of The Injection Moulder

CR Clarke

The machine that we will use for injection is called “Injection Moulder 25-CR Clarke”. This is also provided by the University of Antwerp. The machine does not have the best characteristics of its competitors albeit it is a simple way to learn how the process works. This machine enables us to design shapes using plastic granules and a cast. It is manually operated.

Max. Mould Weight	25 grams
Used Voltage and Ampere	230V and 2A
Average Injection Time	45s
Average Cycles/Hour	30-40
Max. Heat Level	200C
Materials	(melting temperature below 200°) PE, PS and PP e.g.
Mould Diameter	75mm
Max. Mould Thickness	95mm
Machine Dimensions	483x300x694

Table 4

The reason for using an injection molding machine is the necessity of having the same shape several times. We used this manufacturing process for this reason and also for the short time and money wastage.

Available Materials.

The University of Antwerp provides us with a collection of plastic pellets. These plastics are:

Mixture of PP and PE
Grey virgin PLA
Transparent virgin LDPE
Blue recycled PP
KANEKA
Polypropylene (PP)

There is also a shredder(*) available to offer the possibility to recycle plastics and create our own collection of plastic ‘pellets’. Possibly, companies could provide us with more plastics.

The four materials mentioned above are sufficient to start designing the tool and to have a first experience with the machine and shape design. Albeit, it would be necessary to obtain different plastics in order to provide enough samples to experience and compare.

** Halfway through the project process we were told that we would not be able to use the shredder.*

4

PROJECT

PRACTICAL INFORMATION

PROJECT CONTENT

WORKSHOPS

DESIGN REQUIREMENTS

PRODUCTION

PACKAGING

BOOKLET

Practical information.

Before we start explaining the content and process of our project, we will provide you with some practical information about the project. We will explain you the aim, goals and approach in order for you to have a better understanding of the project.

The aim

Choosing a material is one of the most important phases during the design process. The material will define the essence of the product. Besides the technical properties that the material should have in order to fulfil the requirements of the product, there are other aspects to take into account. The way the user perceives the product and the sensations or emotions generated by the sensorial experience can determine the user experience.

Therefore, a balance between the technical and user centered characteristics is strongly required. The touch, the firmness and the shape, for example, are factors that may seem unimportant, but actually influence the decision making process of an individual.

The long term aim of the project is to develop a tool for designers to help them choose materials based on intangible characteristics. We intend to raise awareness of how intangible and sensorial properties affect user experience and we also want to give designers the opportunity to increase their resources and skills.

"Materials are like words. The more materials you get in touch with, the more solutions you can see and express." (Van Bezooyen, 2014).

Though, we have to concentrate our effort on creating a neutral shape if we want to achieve the final aim. The plastic samples of the toolkit need to be neutral because it allows the designers and users to evaluate and experiment the sensorial and intangible characteristics of solely the material without being influenced by the the meaning of the shape itself.

Therefore we will focus our research on the development of a neutral shape. This aim guides us to set the goals for the project.

Goals

According to the aim of the project we decided to establish following goals:

Develop a coherent kit of material samples that enables designers to experience and evaluate sensorial characteristics of different plastics.

Design a specific shape for the samples that enables designers to explore without being influenced by the shape itself.

Raise the importance of intangible and sensorial characteristics.

Encourage students to take sensorial and intangible characteristics into account during the design process.

Improve our technical skills by working with an injection moulding machine for our sample prototypes.

Photo of product design sketches

Phases of the project

1

The approach

The objective during the first few weeks was to **understand our project** and establish a **good relationship** between the team members. Subjects such as Team Building and Intercultural Communication helped us to get to know each other and understand the different backgrounds and perceptions of the team members. We also had the opportunity and time to prepare all the questions about the project. By the end of this phase we had a general idea about the subject of the project, and its main aims and goals.

2

The research

We performed an **extensive research on sensorial and user centered characteristics**. Valentina Roginoli and Elvin Karana were our primary references for our project. Acquiring general and focused knowledge about the field of the project was indispensable in order to increase our resources and open our minds.

3

The exploration

Exploring the possibilities of the shapes in relation with the **parameters of the machine** determines the final samples. These parameters have a strong link with the design requirements. By **exploring** these **forms** we are also attempting to understand how people interpret certain materials, without being influenced by form and thus production technique. After having developed the first few shapes, we organise several **workshops**. The objective of these workshops is to test how people comprehend a 'neutral shape'. We will explore further by making 3D printed forms and organising more workshop in order to determine the neutral and final shape. This phase is the longest and most important for the project.

4

Design requirements

After deciding on a shape, we will need to decide how we will produce the sample, which materials we will use and which requirements there are for manufacturing.

5

Detailed design

We **define the final measurements** and surfaces of the samples, according to the requirements previously fixed. We will also **design the packaging** and other necessary provisions. We will also develop technical drawings in order to create the mould and testers.

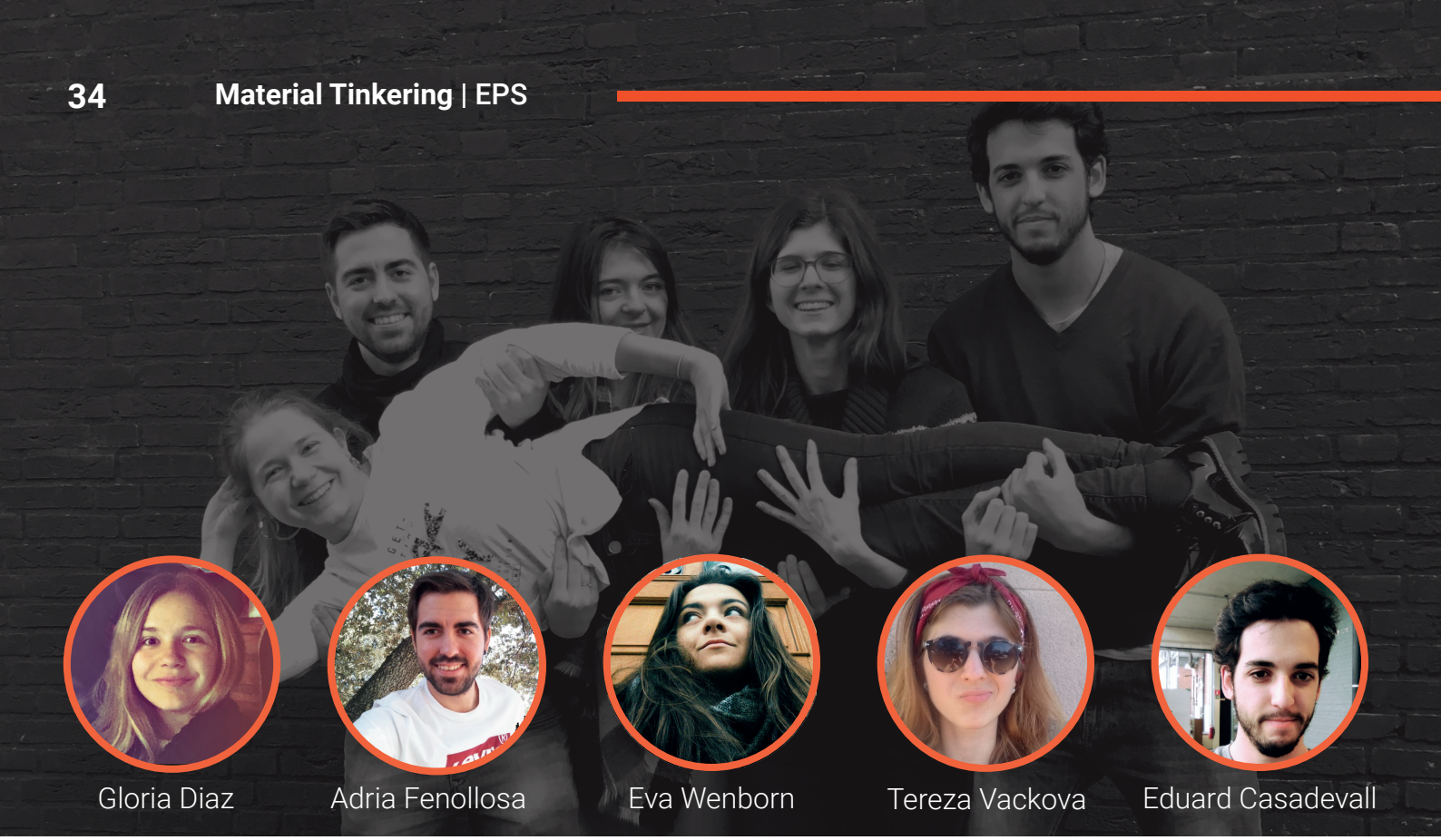
6

The production

We **create the final prototypes** using the injection moulding machine. We will include reflections and corrections needed for further research and projects. Finally, we will be able to **draw conclusions** on the whole project.

To illustrate these phases further, a Gantt Chart is included in the first appendix (Appendix 1: Gantt Chart). This chart shows the different phases of the project and the general tasks of each phase (main column). The specific tasks are set week by week, keeping the assignments and personal workflow in mind.

The main, first row shows the weeks of the project. The coloured cells of row of tasks show the time needed in order for us to carry them out. Some weeks or tasks include comments to refer to deadlines or exams.



Team Organisation

Team organisation is essential to succesfully end a project. We performed several workshops and filled in some questionnaires during our lectures Team Building to create a general idea of our team flow. These lectures made it easier for us to divide tasks and responsibilities in our project.

The Belbin Theory involves a behavioural questionnaire to determine one's preference in team roles. Due to the Team Building classes, we were able to evaluate everyone's team role and analyse the results.

There are 8 natural team roles, but not all of them are represented in our team. The following image illustrates the natural roles from each team member (Fig. 9):

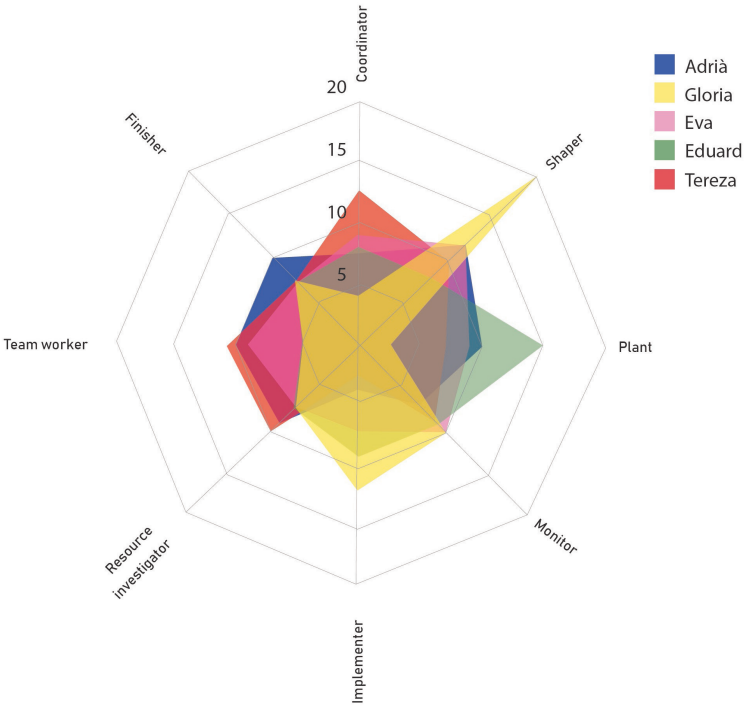


Fig. 9

To summarise the result we can conclude that the team is composed by many shapers. This fact could lead to some arguments between the shapers themselves and between the shapers and 'non-shapers'.

In case of dispute, each person will explain his or her opinion. It is important to respect others' opinions and to let them express their arguments and visions. In case of disagreement, a vote will be carried out instead. By using these methods, every team member will have the same level of authority.

Apart from the amount of shapers, we can also conclude that we do not have any clear finisher, so we should be careful and decide who is going to be the person who warrants us that we will not work excessively and imprecisely due to procrastination. By recent experiences, we noticed that Gloria is someone who prefers to focus on tasks and who keeps up with the pace. Nevertheless, we will still need to take this fact into account.

Our team has not got a clear leader. According to results of the Belbin test and our own experiences, we have decided that the best option is to let the leadership float through the group. After comparing our portfolios and preferences we have set up different fields and set "captains" for each of them. For tasks focusing on the machines, we decided that Adrià, as a mechanical engineer, and Eduard will be the captains. Tereza and Eva are the captains of the blog and general graphic design. Finally, Gloria is going to take care of task delegation and organisation of the project. In addition, every member of the team will support the others with his/her experience and knowledge.

Other roles such as the secretary or project manager have not been appointed. From our point of view, every opinion is important. Every team member should be involved in the project by taking care of every task, appointments and deadlines.

In order to retain a continuous communication flow, we have decided to use different platforms:

- We will use **Trello to set up tasks and to do lists.** All the members can modify, add or remove tasks. We also have to check it regularly and update it as soon as possible for keeping the workflow in pace.
- We will use **Google Drive as a platform for uploading and sharing documents, assignments and relevant information to the project.** We should respect the ordination of the files to preserve an overview.
- Apart from the Gantt Chart, that gives a global view of the workflow, we can see all the **deadlines and events on a common Google Calendar.**
- **WhatsApp will be used to keep in touch on a continuous level.** We check this application on a daily basis.

We decided to divide reports or general writing work into multiple parts, so that every member of the team is obliged to write his or her part. By applying this method, no one will collapse under pressure. In order to attain a uniform writing style, we set up some rules beforehand.

Every Friday we will have a meeting with our supervisors to check the process of the project. We communicate with them by email, which is usually sent by Eva. All of the members are included in the cc-box so that all can follow the conversation.

Besides emailing the supervisors, we also attempt to contact plastic companies in order to do workshops and collaborate with them in the future. After mailing fails, we will call them by phone for a more personal approach.

We spend time on the project during the designated class hours and individually at home. Due to a large number of classes, we do not have had much time to work on the project, which is why we also spend time on the project individually. After Easter break, the amount of classes should diminish whereby we will gain more time to spend on the project.

One of the rules of the team is that it is ok to be human. That means that we should be able to work during the fixed dates, be on time and do the work that we have assigned to do. But we are also humans. We think that taking care of the members of the group is necessary and easy to do if we trust each other and communicate. If someone is sick, too tired to work or has any issues he or she should tell this to the group. We will all support the member. If someone needs to leave earlier or needs to work, he or she should also communicate this in order for the team to adjust the plan.

Apart from the facts that we explained, the project plan is in continuous evolution and change in order to include new deadlines and tackle new obstacles.

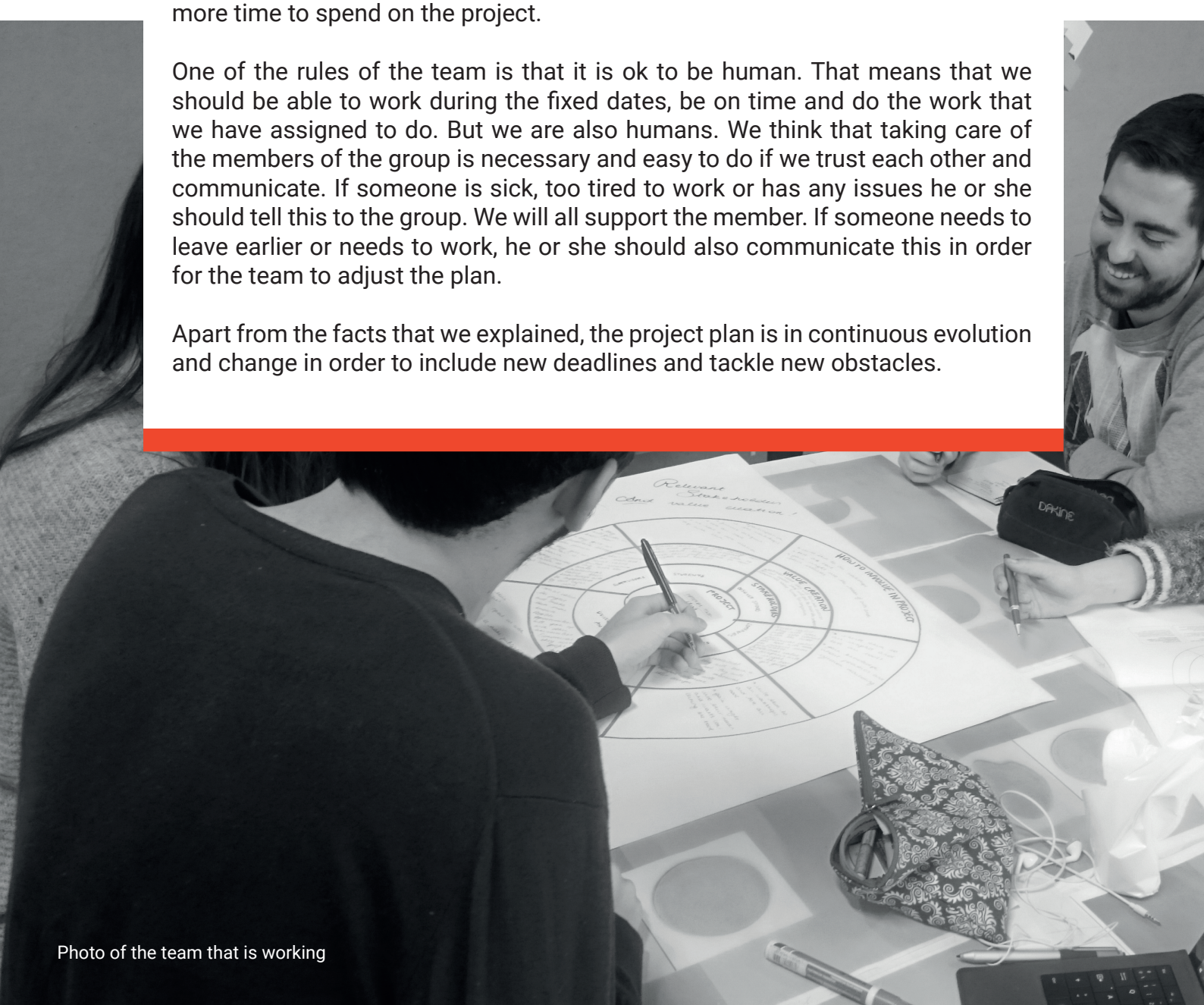


Photo of the team that is working

Project content.

To support and give context to our project, we provide some useful project information to support our toolkit for designers. To start putting our project onto the market, we should have a corporate identity that fits with our views and customers. Besides these marketing driven basics, we should also be aware of who our stakeholders are and what they can provide.

Persona (Appendix 2: Persona)

In order to understand our customers better, we decided to create a persona. Our customers are designers, either being a freelancer or working in a design studio.

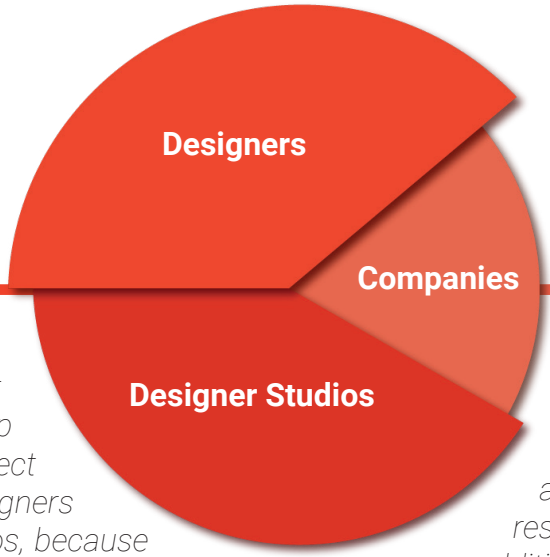
A persona is a definition of a fictive person with concrete characteristics such as name, age, hobbies and habits. The concept was determined by Alan Cooper, a software engineer who came with a new approach to effectively demonstrate ways of using software by a user.

James Lauren is 32 years old and he works for a design studio in a big city (more than 400 000 inhabitants). He is creative, open-minded with strong visions (Appendix 2: Persona Word Cloud). He has completed a university degree, although his skills cross the barriers of his field of study. Following trends is part of his job but it is also something he enjoys in his daily life. He likes vintage cars and likes design items. He wears a designer Fossil watch. He is an example of a designer who would be interested in our toolkit.

Stakeholders (Appendix 3: Stakeholders)

Our customers, designers and their final customers are in fact involved in a wide range of par ties. It appears that this range can be divided into an academic and commercial sector.

COMMERCIAL SECTOR



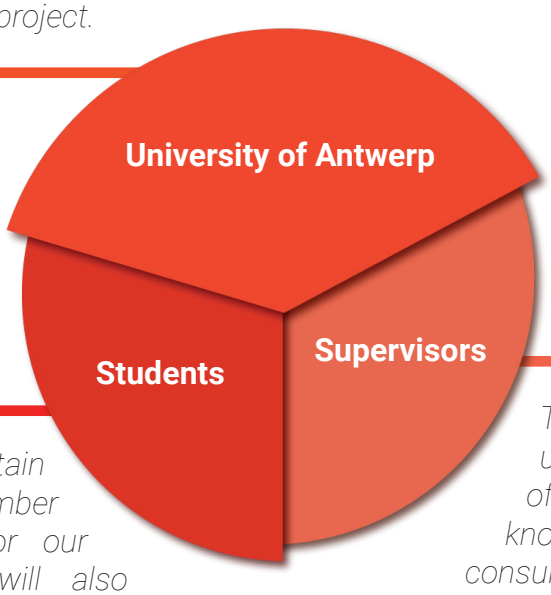
The most important stakeholder group for the project consists of designers and design studios, because they will most likely buy our product. This group will also be included in our workshops for valuable input.

Plastic companies, primarily those seated around Antwerp, could provide us with a significant scope of resources, e.g. plastics. In addition, we would appreciate eventual collaboration for gaining more know-how and providing them with a possible new customer.

Fig. 10

ACADEMIC SECTOR

Our research stems from surveys which our supervisors conducted during the past years at the University of Antwerp. Although there is no concrete financial budget for the project, the university provides us basic plastics for prototyping, machines and class rooms. Besides these practical provisions, supportive courses organised by the university help us to gain more skills to complete the project.



In order to obtain our desired number of participants for our workshops, we will also address (designer) students of the university. The students of product development will also become the users of our toolkit, thus being a great resource of input. Apart from the determinator box, designed by the University of Antwerp, we also use the research from Politecnico di Milano and TU Delft as a baseline. In exchange for knowledge after releasing the final prototype, these universities can extend their teaching aids with this toolkit.

The supervisors, being university employees, offer our team their know-how through regular consultations. Furthermore, received feedback and support also helps us to proceed with the project.

Fig. 11

Corporate Identity

Creating a corporate identity proved to be an important step in our project process, even though we had doubts. The main aim of our corporate identity is to define our product and its recognition in general. This decision led primarily to easier presentation in public, improved communication with possible partners and finally (visual) unification of all our work.

Based on brainstorming during the lectures of cross media communication, we came up with the logo (Fig. 12, Page 41).

During sketching (Appendix 4: Logo Sketches), we attempted to create a shape that would be as neutral as possible. Naturally, we did not know which shape would be neutral at that time, but we concluded that basic forms were the best starting point. We agreed that we did not want to create a shape that represents the final prototype. The pentagon noticed in this logo, symbolises the five human senses. The orange triangle represents the customer of the designer and the grey area the designer itself. Through interaction between both parties, and by using the five senses, meanings are ascribed to the materials. This concept makes the attributing process more tangible for the designer, thus explaining the company name ‘tangee’.

Besides symbolising the core concept of our project, the orange triangle also represents our manufacturing method: injection moulding. The orange part is the resulting output of this production technique.

We agreed on using orange and grey as a colour because this symbolises energy and vibrancy (orange) and classicism, matureness and seriousness (grey). In short, the brand acts with a strong, young drive, while being responsible.

Typography

Rubik Regular	*Logo name*
Roboto Regular	*Full text*
Roboto Bold	*Main titles and Emphasis throughout text*
Roboto Light	*Subtitles and Citations*
Roboto Thin Italic	*Descriptions*

Logo

Orange

Playful
Energetic
Vibrant

Grey

Classic
Mature
Serious

tangee

Fig. 12

Colours

c: 0% m: 83% y: 93% k: 0%	Primary Accent Distinctive Presence Primary Colour
c: 66% m: 59% y: 58% k: 40%	Prominent Accents Dominant Presence Secondary Colour
c: 8% m: 93% y: 100% k: 1%	Small Accents Subtle Presence Tertiairy Colour For Details Only
c: 5% m: 73% y: 71% k: 0%	Small Accents Subtle Presence Tertiary Colour For Details Only

Workshops.

Before we started off with the workshop structure mentioned in the latter part of this part, we worked with a different approach. This approach, however, was eventually declined by our supervisors due to misunderstandings and different point of views.

At first, we tried to gain some inspiration for samples to include in the final toolkit. We planned to evaluate the neutrality after the creation of the shapes, instead of defining neutrality firstly – as we will do in the following structure.

All members sought some inspiration online, by going to material fairs and looking for similar toolkits where they used plastic samples. We have been in extensive discussion during this phase of the project, constantly bouncing arguments and opinions back to each other. Eventually we came up with following forms that we proposed to our supervisors:

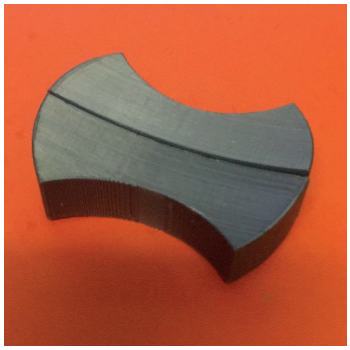


Fig. 13

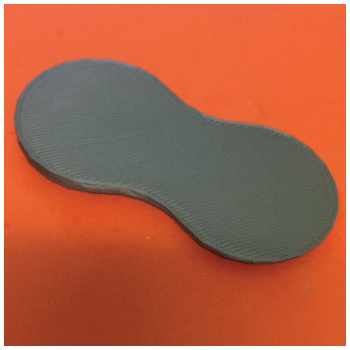


Fig. 14

Fig. 15

Variants of Fig. 13:

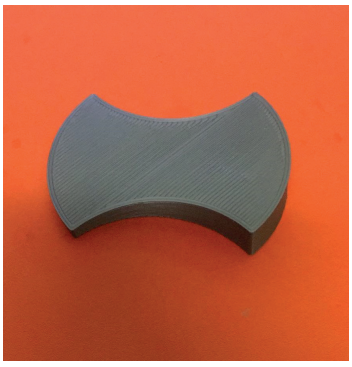


Fig. 16

Fig. 17

These forms were meant to be used during our planned workshop (which is the workshop that we mention in step 8) , but, as we mentioned before, our supervisors wanted us to follow a different path. Whereas we thought that the emphasis lied on the toolkit, they explained to us that in fact, we had to focus on finding the neutrality of the forms. Due to this change in our project plan, we had to adjust the work structure for the following weeks.

Instead of focusing intensely on the design process, we will work through the neutrality of the samples. So we proposed a workshop structure (Fig. 18, Page 45), which was accepted by our supervisors. The structure is not difficult to follow:

1

Workshop 1

We asked designer students what they think neutrality is. They had to formulate a definition.

2

Workshop 2

We asked designer students to create neutral shapes as fast as possible using plasticine.

3

Workshop 3

We defined which pairs of characteristics are typically associated with forms – and not with the material or colour – by asking participants their associations.

4

Workshop 4

We asked students, both designers and non designers, to create shapes that represent a characteristic of a pair. In total they had to create 12 shapes using plasticine.

5

Workshop 5

Our team created the averages of all the shapes of workshop four for all characteristics, meaning that we end up with 1-3 averages per characteristic.

6

Workshop 6

After having created the averages of workshop four, we had to create a form that inherited both characteristics at the same time. This means that the shape shall have either both meanings or none of them.

7

Workshop 7

The but last final step is to create “neutral’ shapes that are based on the shapes of workshop 6. In other words, we had to create an average of all the averages of workshop 6. In total we created over 12 forms, forcing us to contemplate which form we were going to use further.

8

Workshop 8

The final and last workshop is to choose 4 final shapes for our workshop and validate them through questionnaires. These four shapes were in fact derived from workshop 7 because multiple forms were similar – thus enabling us to merge them together to one form.

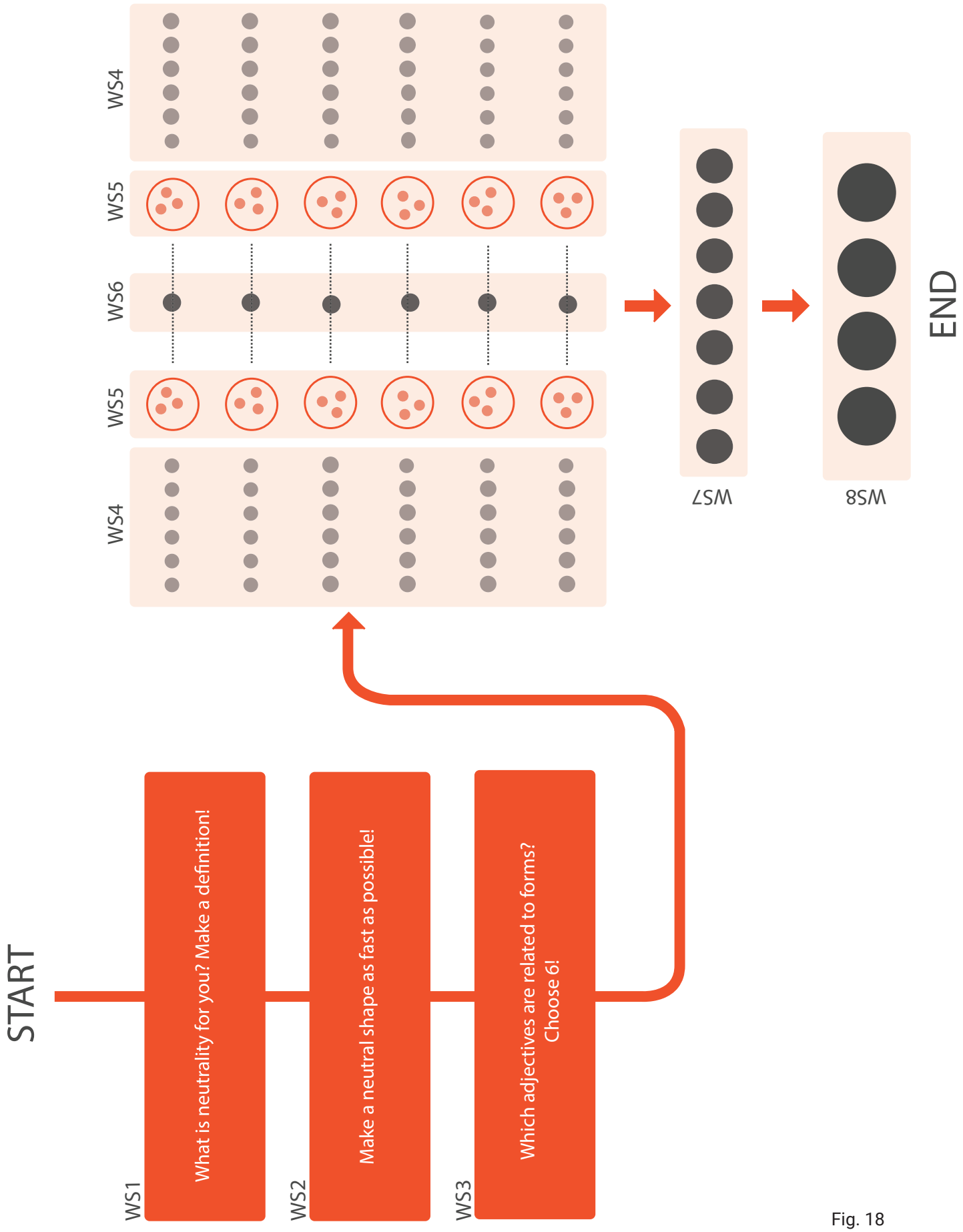
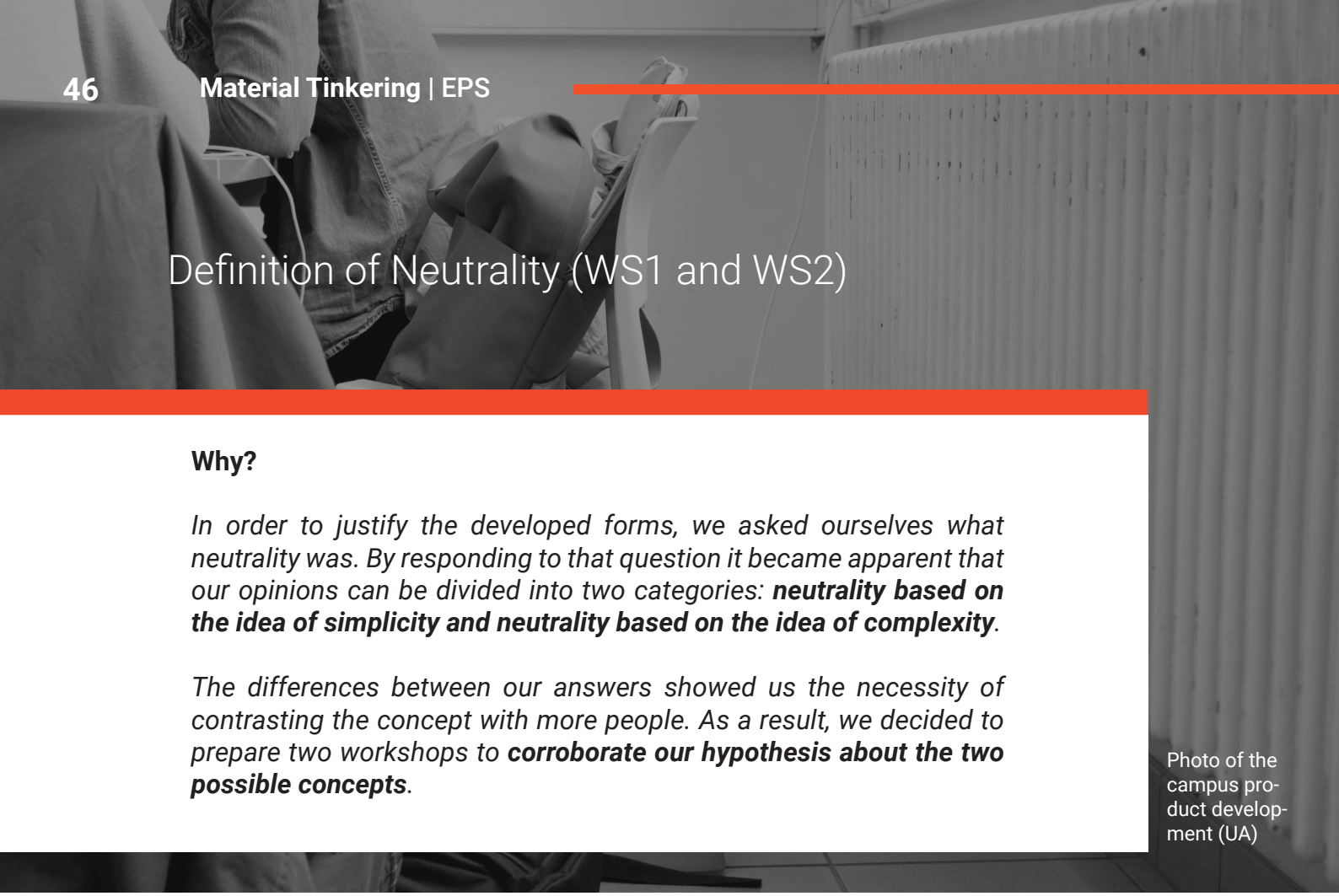

START
WS1
What is neutrality for you? Make a definition!
WS2
Make a neutral shape as fast as possible!
WS3
Which adjectives are related to forms? Choose 6!
WS4
WS5
WS6
WS5
WS4
WS7
WS8
END

Fig. 18



Definition of Neutrality (WS1 and WS2)

Why?

In order to justify the developed forms, we asked ourselves what neutrality was. By responding to that question it became apparent that our opinions can be divided into two categories: ***neutrality based on the idea of simplicity and neutrality based on the idea of complexity****.*

The differences between our answers showed us the necessity of contrasting the concept with more people. As a result, we decided to prepare two workshops to ***corroborate our hypothesis about the two possible concepts****.*

Photo of the campus product development (UA)

On the one hand, conceiving neutrality as simplicity means that the object does not evoke any feeling of the user. It is neither one meaning (for example aggressive) nor the other (for example calm).

On the other hand, conceiving neutrality as complexity means that the object has a wide range of meanings of which the user is not able to classify. The object can be a combination of several meanings (for example aggressive and calm at the same time).

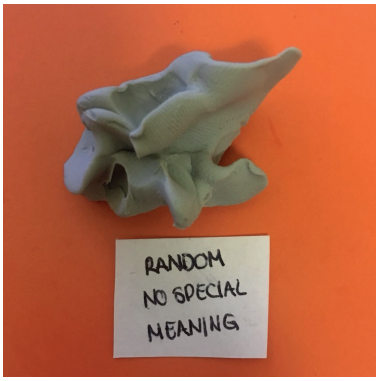
The first workshop aimed to go in depth about the idea of neutrality. Firstly, we requested people to explain their idea of neutrality in any way (by using keywords, drawing, writing adjectives, etc.). Then they were asked to write a definition for the word (Appendix 5: Questions Neutrality).

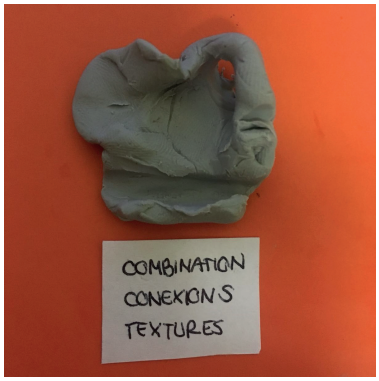
We asked a total number of 20 participants to fill the template in an average time of 10 minutes. The short amount of time provided, helped them to capture the intuitive and essential idea of the concept. All of the participants were design students. This fact supports the ability to reflect on abstract meanings.

The results of this first workshop confirmed our hypothesis, emphasizing the two ways of conception of neutrality (as simplicity and as complexity). However, these were on a theoretical level and it is more important to have practical conclusions. That fact led us to prepare the second workshop.

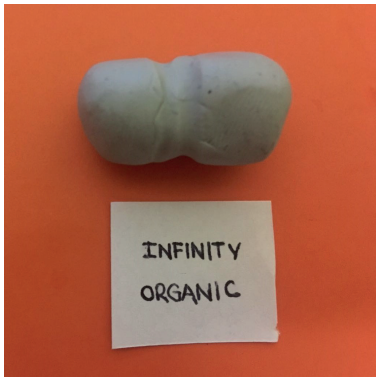
A central issue of this **second workshop** was to discover how people conceived neutrality in a physical way. We asked 30 participants (mainly second years of bachelor design students) to develop a neutral form by using plasticine and to explain us why they made that specific form. The average length of the workshop per participant was three minutes. (Appendix 6: Results WS2).

After analysing the results we concluded some physical requirements that a large number of forms had in common: generally the edges were round, a considerable number of participants identified balls or spheres as neutral, or in a similar way, a combination of several basic forms such as cylinders and they often include concave or convex parts (Fig. 21, Fig. 22). From a different point of view, other participants attempted to create neutrality based on complexity. They included as many meanings as possible in the form, creating neutrality from a combination of meanings (Fig. 19, Fig. 20).





Figures based on complexity



Figures based on simplicity

To sum up, both workshops confirmed the hypothesis of the double way of conceiving neutrality. Although neutrality should be evaluated based on a specific range of criteria.

Defining criteria to evaluate the neutrality (WS3)

Why?

*Karana and Rognoli developed a **list of adjectives in order to evaluate sensorial and intangible properties of materials.** This list (Determinator Box, Du Bois et al., 2017) is particularly interesting for our project and can be used as criteria for evaluating the developed forms in following workshops. The list includes a total of seventeen pairs of adjectives, such as futuristic and nostalgic.*

*This list, though, is all related to materials. **We are interested in adjectives that are related to forms in particular,** because we want to try and find out the neutrality of forms. Due to this reason, we aimed to reduce the list of adjectives to those that are related to forms. At first, we ordered the adjectives in relation with the shape by importance and discussed our choices. Instead of using our own arrangement of adjectives, we agreed on asking people to choose a total of six pairs of adjectives by doing a small workshop.*

In this third workshop we asked the participants to choose six pairs of adjectives from the list that, to them, were more related with the shape itself (Appendix 7: Template WS3). The participants of the workshop were 20 design students who filled the given template in an average time of 4 minutes.

The results of the workshop pointed out the six pairs of adjectives that were more related with the shape and, in consequence, the ones that we use in the next steps to evaluate the neutrality of the shapes (Fig. 23) . These pairs were: futuristic/nostalgic, toy like/ professional, male/female, aggressive/calm, delicate/robust and traditional/modern.

To sum up, after defining the concept of neutrality, we decided the criteria for evaluating the neutrality of the shapes by doing the third workshop of the project.

ADJECTIVES		VOTES
Cozy	Distant	2
Elegant	Vulgar	5
Futurish	Nostalgic	14
Toy like	Proffesional	9
Tissolute	Modest	4
Agressive	Calm	15
Just	Strange	4
Sexy	Boring	3
Male	Female	13
Delicate	Robust	16
Disponsable	Sustanable	2
Formal	Informal	5
Cheap	Sustainable	5
Classic	Trendy	6
Traditional	Modern	13
Honour	Misleading	2
Adulto	Youthful	2
	Total=	120

Fig. 23

Orange highlighted boxes are the used adjectives throughout the workshop.

Creating the poles/adjectives (WS4)

Why?

*In order for us to create forms that are neutral, we had to **understand that what is not neutral**. The aim of this workshop was to finally have several created forms with plasticine that are related to the adjectives in the list of which we could derive some conlusions of.*

We hoped that the results for each adjective would be approximately the same, or that there was some kind of logic behind the collection of forms. Using these findings, we would be able to draw conclusions on specific characteristics of each adjective.

The participants consisted of 10 male and 10 female participants, 10 designers and 10 non-designers. We asked them to create a form for each adjective on the list that they were given. The results, of which we created an overview, were quite overwhelming (Appendix 8: Results WS4)

The results pointed out that some of the characteristics were approximately the same but that other characteristics were entirely different. Nostalgic for example, resulted in a very varied collection of forms whereas futuristic resulted in a very similar collection of forms.

There was not a notable difference between the creations of our male and female participants. Their creations seemed more or less based on the same ideas and concepts. Even though the difference between the creations of designers and non-designers does not seem to be significant, we can conclude that non-designers tend to base themselves more on related concepts and associations whereas designers base themselves more on charachteristics of forms associated with the adjective or pole.

Besides concluding that the collection of forms varied between similarity and difference, we also made an overview of typical characteristics related to forms for each adjective. This list would help us with the following workshop (Appendix 9: Conclusions WS4).

Creating the averages of the poles (WS5)

Why?

*The great number of created forms in workshop 4 enabled us to think about a **representative form for each characteristic** (=pole) from the list. This representative form should symbolise an average meaning of the concrete adjective.*

Each member of our team took responsibility for creating one pair of characteristics and shaped one form from plasticine for each from the poles (Appendix 10: Result WS5). Because there are 6 pairs of adjectives and only 5 team members, Tereza created the representatives for two pairs. Besides the pictures of every form prepared by testers in the previous workshop we also used the list of conclusions (Appendix 9: Conclusions WS4) which we compiled according to the pictures of workshop four as a reference.

Each person had an individual attitude to creating a representative form because for some adjectives some of the input shapes were similar or even the same (for example aggressive and calm) but for the others they differed a lot (for example nostalgic and futuristic). Therefore, the representative form will always include the personal point of view of the creator. In order to remain as objective as possible we discussed the forms which we created together and we finished this step with a representative form for each adjective except for nostalgic and futuristic. Inputs for that pair were so different that we agreed on using three forms for each pole. The final 16 forms describing 6 different characteristics were used as the input for the next workshop.

Creating the forms that address both poles (WS6)

Why?

*For next the next step in the process, it was important to **define** what **neutrality does not look like.** We achieved this in the last workshop by creating distinctive representatives for each adjective from the list. Defining the very opposite of what is neutral, helped us to form neutral forms in the next workshop.*

According to our plan depicted in the graphic schema (Fig.18, Page 45), we took representative forms of each pair and attempted to merge them together in one forms so that their average form lost either adjective or inherited both adjectives. To do so, we decided to proceed gradually “step by step’ as it is shown in the chart (Appendix 11: Results WS6).. Each representative form was altered into one interim step and the final average form or “middle point”, highlighted with orange, is the result of the combination of these two interim steps.

As in the previous step, only the members of our team, were involved in this step and we used plasticine for creating the forms. Each member worked at one pair of adjectives except for Tereza, who created forms of two pairs. Again, to avoid unnecessary subjectivity, we all together analysed each of the 9 resulting middle points and we agreed on little changes which we implemented in their final design.

Creating the neutral form (WS7)

Why?

After workshop six, we had nine different forms that are neutral according to one pair of adjectives. One shape per pair of adjective with exception of the futuristic/nostalgic pair. Due to the variety of results that we had for this pair we decided to create three different representative forms instead of one. For attempting to achieve a neutral shape we need to analyse the common aspects of these forms and combine them before ***creating these neutral forms****.*

To achieve this goal, we put an overview of the result of the previous step and each member of the group created with plasticine around four different forms inspired by the overview. Excluding the futuristic/nostalgic pair, the resulting shapes obtained in step 6 were similar to these neutral forms.

We created a total number of 20 forms. Several forms that were created by each, individual team member had some similarities, confirming that the forms were indeed a good average of all the forms created in step 6. Therefore, we analysed and combined them to reduce the quantity of forms to six. After that, we asked ten design students to choose three of the six shapes according to the neutrality of the shape and to the interactivity potential.

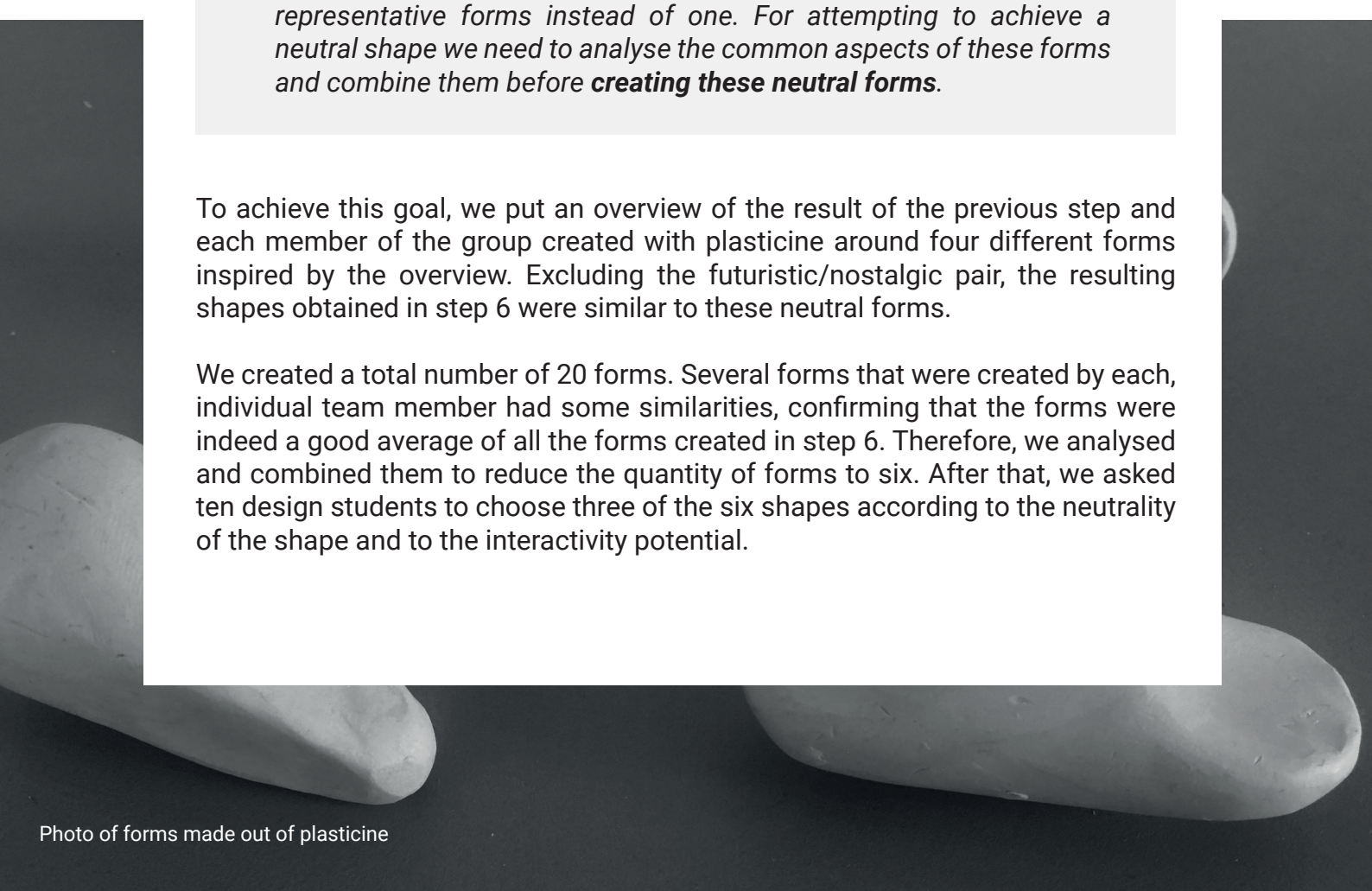


Photo of forms made out of plasticine

The results pointed four shapes out that were analysed by the team members by using the template prepared for the next step (Appendix 12: Template WS8). This template analyses the forms using the pairs of adjectives selected in step 2 as a criteria and giving the testers the option to express one or both adjectives.

Following list is an overview of the selected forms:

Form A: "Avocado"

It is a combination of a sphere and a cone that avoids the sharp edges and vertex by including a transition from the sphere to the cone. It also includes concave details in order to create an interaction with the user and invite them to touch and experiment with the form. This detail could be used to include different textures or surface finishes.

Fig. 24

Fig. 25

Form B: "Triangle"

This form is based on a pyramid but excluding the aggressive meanings by rounding the edges and transforming the lines to curves. The interactivity becomes intuitive by holding it with both hands, inviting the user to touch it and turn it. Two the surfaces are slightly convex and concave to stimulate the perception of the form.

Form C: "Plain"

It is a symmetric form based on a cylinder with flat endings that host special places for the fingers and for the inclusion of textures. The size and the lines make them easy and comfortable to hold.

Fig. 26


Fig. 27

Form D: "Twist"

This form is a variation of the Form C that includes a twist in the middle of the piece, eliminating the symmetry in one of the planes. This variation encourages the user to interact more with the piece by turning it and make it ergonomic and comfortable. It also includes the places for the fingers, but it eliminates the idea of balance that the Form C has.

So, we created a few examples of neutral shapes. In the next step, we will evaluate the neutrality and potential of each form. We need to evaluate this in order for us to improve the shapes and to verify their neutrality.

Evaluating and altering the forms (WS8)

Why?

After agreeing on the four previous, mentioned forms we were ready to test their neutrality with another workshop. This workshop used 3D printed samples in combination with a questionnaire (Appendix 12: Template WS8) with both open and closed questions. The testers were asked to interact with the forms and answer concrete questions. In order to emphasise the importance of the shape we decided to divide this process into two parts, the first step was based on perception through the touch and the second step was based on touch and sight.

Firstly we modelled the four chosen forms in a 3D software(*) and printed them with the 3D printing machine Prusa i3 MK3 using PLA string. As none of the forms did not have a flat surface we always had to print two halves of each shape and glue them together. This way we achieved a uniform quality of print over the entire surface. Printed plastic pieces in this workshop were supposed to represent the final forms in the toolkit made of plastics with the method of injection moulding. The testers of the workshop should touch them and interact with them. However, the surface quality of the layered 3D print is incomparable with the smoother surface of the injected plastic piece and therefore we used sandpaper to smoothen the surface a little bit.

* Rhinoceros, SolidWorks

Each tested person got a bag/ box with a set of 4 printed pieces and a sheet with questions. One member of our team stayed with the tester and explained him or her the following two stages of the workshop:

1

Stage 1

*In this step the plastic pieces were placed in a bag so the **tested person would not see them**. The team member asked the tester to interact with one piece only, using their hands and fingers in the bag so that an image had to be created based on only tactile experience. Another variation was that the testing person held the form and played with it while his or her eyes were closed.*

While the tester was playing with the form, the team member went through six closed and one open question of the first stage. During the closed questions, the tester had to answer whether he or she found the form e.g. “male” or “female”. As the main goal of the workshops is to define the relative neutrality of the form, the tester could also tick the option “none (of them)” or “both (of them)”. If the tester felt like associating the form with none of the adjectives, “none” could be given as an answer. If the tester felt like associating the form with both of the characteristics, ‘both’ could be given as an answer. These 6 closed questions were based on the 6 pairs of characteristics used in previous workshops and the tester could always tick only one answer for each question. In the end, the open question aimed to highlight which pleasant or conversely disturbing qualities the tester had discovered about the individual forms.

2

Stage 2

*Stage 2 seems to be the very same as stage 1 with only one difference – t**he testing person can see the samples** during the whole process.*

Similarly, the team member asked the testing person the same 6 closed questions with the same 4 options as answers. Also, the final open question about pleasant and disturbing qualities of the form was the same as before.

Photo of people doing a workshop

In this workshop we involved 20 participants, including 10 men and 10 women. From the total number, 10 testers were students of product development, the other 10 testers had other backgrounds than a design background. We characterised our results by gender and background, to give even further insight into the results. Each tested person spent about 10 minutes answering our questionnaire.

Results

After having organised and finished the workshop we needed to structure the data, analyse and interpret it. We have attempted several methods before finally concluding that we were going to use the data as qualitative information. At first, we intended to analyse the data quantitatively but because of the high threshold to make conclusions about the data, we agreed to use the data purely qualitatively.

First Attempt - using differences with nullification

The data is structured by gender and the field of study. Additionally, a general overview was created to make general conclusions (Appendix 13: Results WS8 Table 1) . To make conclusions about the data, we also structured the answers by 'neutrality' and 'difference', respectively consisting of answers 'both'/none' and 'adjective1/adjective2'.

The point of discussion for this method was our approach to the interpretation of the data. We wanted to nullify certain answers and consider this as 'neutral' by stating that if person A answered adjective 1 and person B answered adjective 2 (both being a pole of eachother) for the same shape, the answers were nullified. The problem with this approach is that you are ignoring a very important fact; namely that 2 people did not think the shape was neutral even though they are stating the opposite. You could compare this problem with the following situation: what if someone asked 'What is the state of the political opinions of the population?'. Would you answer 'neutral' even though 50% of the population answers 'I am an extreme communist' and 50% of the population answers 'I am an extreme liberal'? No, you wouldn't. People aren't considered as 'politically neutral' if they are all extremists – even though they are extremists of the opposite, political kind of view.

Therefore, the results under 'difference' were unfit for use. The following analysis of the data, more specifically the percentages and averages, were therefore also unfit for use.

Second Attempt - using differences without nullification

Because of the reasoning mentioned before, we wanted to use the data but without nullifying the answers on the adjectives. But then another question rose up. Aren't we making conclusions too easily? We have to statistically state that the answers are significant and applicable to a broader population. Hence why we wanted to calculate how people had to answer questions in order to make valuable conclusions about the data.

In order to calculate the significance threshold we used factorials to calculate chances. In total, the results consist of 6 different answers or chances:

- 6 answers referring to 'neutral' and 0 answers referring to 'difference' or 'non-neutral'
- 5 answers referring to 'neutral' and 1 answer referring to 'difference' or 'non-neutral'
- 4 answers referring to 'neutral' and 2 answers referring to 'difference' or 'non-neutral'
- 3 answers referring to 'neutral' and 3 answers referring to 'difference' or 'non-neutral'
- 2 answers referring to 'neutral' and 4 answers referring to 'difference' or 'non neutral'
- 1 answer referring to 'neutral' and 5 answers referring to 'difference' or 'non-neutral'

If the chance to answer one of the answer structures mentioned above falls into the 5% scope of significance, we will be able to make statistically proven conclusions. The question "Does a person tend to think of this shape as neutral (or non-neutral)?" Is our precedent to calculate the chances. Following chances were calculated:

1

P(6 answers referring to 'neutral' and 1 answer referring to 'difference' or 'non-neutral'**):**

$$\frac{6!}{0!6!}\left(\frac{1}{2}\right)^6\left(\frac{1}{2}\right)^0 = 0{,}0156 \text{ or } 1{,}6\%$$

This chance is less than 5% and is significant.
This result is the same for 0 neutral answers and 6 non-neutral answers.

2

P(5 answers referring to 'neutral' and 1 answer referring to 'difference' or 'non-neutral'**):**

$$\frac{6!}{1!5!}\left(\frac{1}{2}\right)^5\left(\frac{1}{2}\right)^1 = 0{,}1886 \text{ or } 18{,}9\%$$

This chance is higher than 5% and is not significant.
This result is the same for 1 neutral answer and 5 non-neutral answers.

Therefore, we should only rely on results that say 'neutral' or 'non neutral' if someone answered 6 times 'both'/'none' or if someone answered 6 times 'adjective 1'/'adjective 2'.

Conclusions

General Conclusions

We can look into the answers and make conclusions based on these statistic findings, but in fact, we can conclude that we rarely had the result 'significantly non-neutral' and 'significantly neutral'. Therefore we can say that we still believe that it is very hard to determine neutrality of a form.

This case pushes us back to the question whether true neutrality exists or not. For this workshops, we used students that resided in Europe. These students have a European cultural background and are therefore not comparable with students from e.g. China. True neutrality that covers cultural background and personality could, therefore, be considered as the 'holy grail' of this research.

In order to proceed with our project and make suggestions for the design research and design process after this project, we will continue with these results by interpreting them qualitatively. We will also focus on production, packaging and additional information to include in the final product.

Qualitative Conclusions

The results of the workshop pointed out that non designers tend to consider the forms more neutral than designers (Appendix 14: Results WS8 Table 2), especially non designer males. From a different point of view, female designers polarise the meanings, choosing usually one of the pole . This hypothesis is not relevant due to the small number of participants of the workshop, but could be proved in further steps.

If we just focus on the results of the first stage of the workshop (where the participant is not allowed to see the sample) the most neutral shape was the Form D and in second place the Form C (Apendix 13: Results WS8 Table 1). The Form C is symmetric which made it easier for people to understand the shape and to create an image in their minds.

The order of presenting the forms during the workshop had also an influence on the results. The Form D was presented after the Form C, so even though this shape was not symmetric, people understood it easily, arguing that it was the same shape but twisted.

In this first stage, the Form B was difficult to understand, and a wide range of participants expressed that it was a confusing or tricky form. This perception changed when we had analysed the second stage.

According to the second stage, the most neutral shape was the Form B, followed by the Form C and the Form D. The Form A was considered the least neutral in both stages (Appendix 13: Results WS8 Table 1). However, we explain the importance and possibilities of this form later on.

Taking both stages into account, the Form B and the Form D seemed to be the most neutral shapes. Despite of that, the Form C was considerably close to them. We could conclude then that comparing Forms B, C and D there was not one shape that was more neutral than the others.

We should highlight that we were using the results of the workshops to compare the neutrality of the forms which we had created and analyse the most disturbing characteristics of them in order to make them as comfortable as possible for the user. However, these forms are not completely neutral. The results showed for example that the Form B was considered as a modern form.

As we have explained based on the results of the workshop, comparing Forms C, D and B, there was not one that is clearly the most neutral. On the other hand, the Form A seemed to be less neutral in both stages. Although the Form A had an important potential. One of the conclusions of workshop two was that a great amount of people considered a ball or sphere as a neutral shape. The Form A combined with a proper packaging can be presented like a ball/sphere, providing the user with that tool. It can also implement the surprise component when the user extracts it, stimulating the brain and encouraging the user to explore the material.

Design Requirements.

After going through all previous steps, and having made all the conclusions, we were able to set up some design requirements for the final shapes before going into production. Design requirements are used for setting up a scope for the product. These requirements have to be able to be evaluated and verified – otherwise, we consider them as 'non-measurable requirements'. The latter can be interpreted as our desires and wishes of the product.

This list of requirements, which are in fact demands, are characterised by the method we're going to use for verifying them and the time when verifying them. We also divided them by following characteristics: machine, neutrality, designers and studios, interactivity and finally packaging.

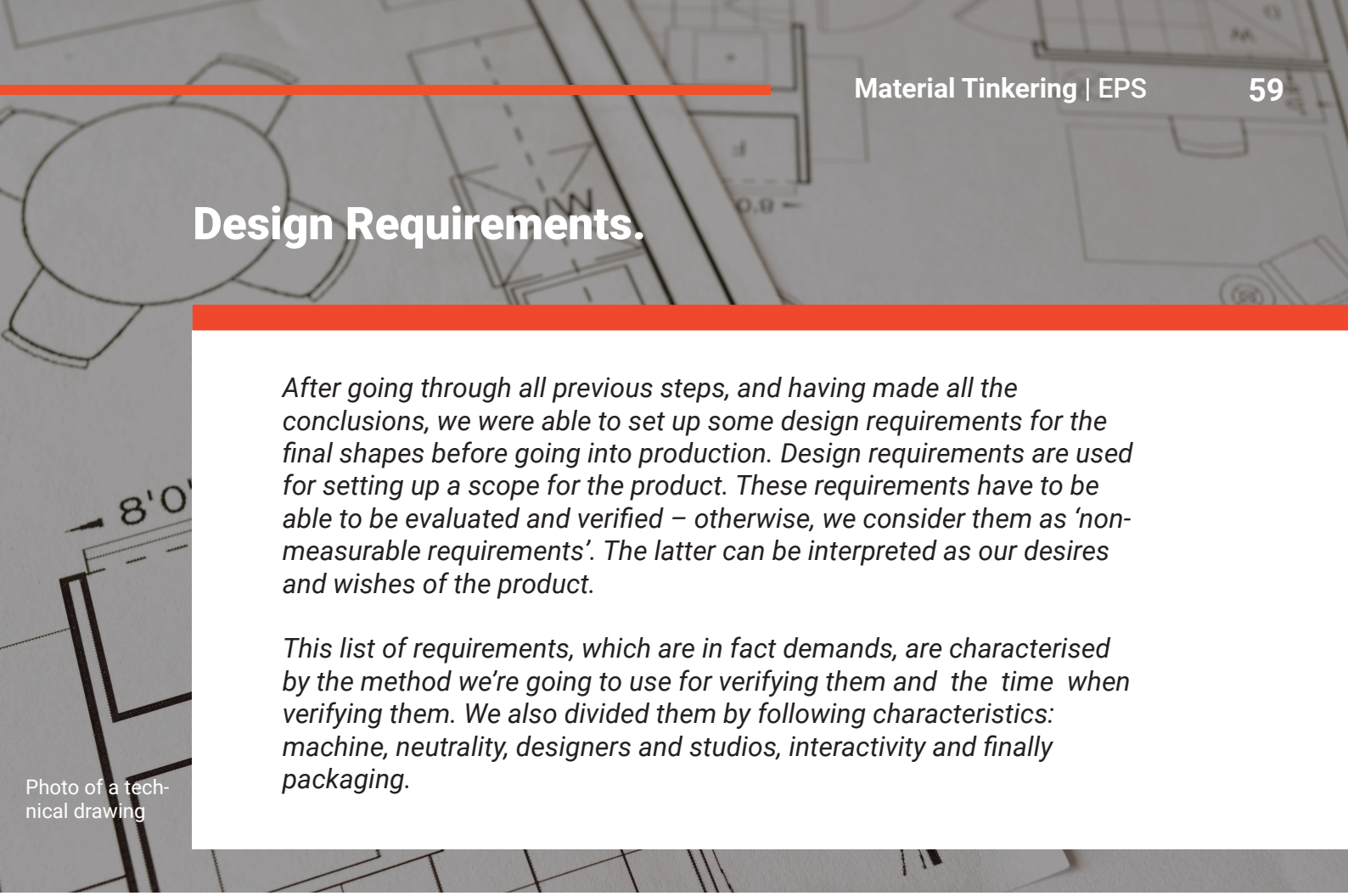


Photo of a technical drawing

Measurable Requirements

Machine

Demand	Verification	When?
The plastic samples should fit into the mould	The shape can't be longer than 70mm	When setting up the measurements for each part
The plastic should be able to be used in the injection machine	The plastic should have a melting point up to 180 degrees celsius.	During machine testing
The plastic sample should be able to be filled up with plastic in the mould.	The shape cannot have a volume value higher than 23 ml	During the design process and modeling process
The mould should be able to resist the high temperatures of the mould and the machine	It should have a temperature resistance up to 270 degrees celsius	During the mould testing
The mould should be able to resist high pressure	It has to be provided with air pipes to let out excess air and drop the internal pressure	During the mould design

Table 5

Neutrality

Demand	Verification	When?
The forms' neutrality should be based on complexity or simplicity (*)	It has to include both characteristics of each pair	Has already been verified throughout the workshops
It should not have sharp edges or points	Include rounded edges (fillets) instead of keeping them sharp	During the modeling process
It should not have a donut shape	/	During the design process. In fact this has aleady been verified throughout the workshops
The baseline for the shape should be a basic shape	It has to refer to basic shapes like cylinders, spheres, cuboids, prisms and cones.	Has already been verified throughout the workshops
Pyramids and cubes should be avoided	The shape cannot refer to pyramids and cubes even though they are basic shapes.	Has already been verified throughout the workshops

Table 6

** Simplicity principle refers to when an object doesn't hold any meaning from either poles of adjectives. Alternatively, the complexity principle refers to when an object holds both meanings at the same time.*

Designers and Studios

Demand	Verification	When?
The booklet included should provide more distilled information to aid designers in designing products that are applicable for a specific target groups.	The information should be characterised by cultural background, gender and ethnicity	During the design process of the booklet. Workshops will have to be organised to gather this information (though this won't be verified in this project yet)
The available textures should be applied on all the samples and be the same	/	During the design proces

Table 7

Interactivity

Demand	Verification	When?
It should have appointed space for interactivity	Does the shape include spaces for placing fingers? Does the shape evoke interaction?	During the design process and during the interaction with our testers
The sample should be able to be held by a single hand	The size should be less than 97 mm.	During the design process and 3D modeling process.

Table 8

Packaging

Demand	Verification	When?
The shapes should be presented seperately	/	During the design process of the packaging
The packaging should provide enough cover in order for the user not to see the forms immediately	Are we able to see the forms in the packaging without opening them?	During the design process of the packaging

Table 9

Non-measurable Requirements

Interactivity

The shape should evoke interaction and the interaction should be intuitive.

Packaging

- If we change the way of presentation in the packaging, meaning will also change.
- The packaging should be easy to transport by the user.
- It should include interactivity with the pieces.
- The packaging should be well organised.
- The packaging should include space for the booklet.

Production.

To make a final prototype and in order for us to know how we can make moulds and use it in the injection moulder, we produced some neutral shapes. The production, though, did not go without stumbling across some complications and, consequently, adjustments.

We have been creating our own custom moulds using several techniques and approaches, which all resulted in different outcomes. Although the result is not comparable to using a metal mould, the achieved results are those which we expected at the end.

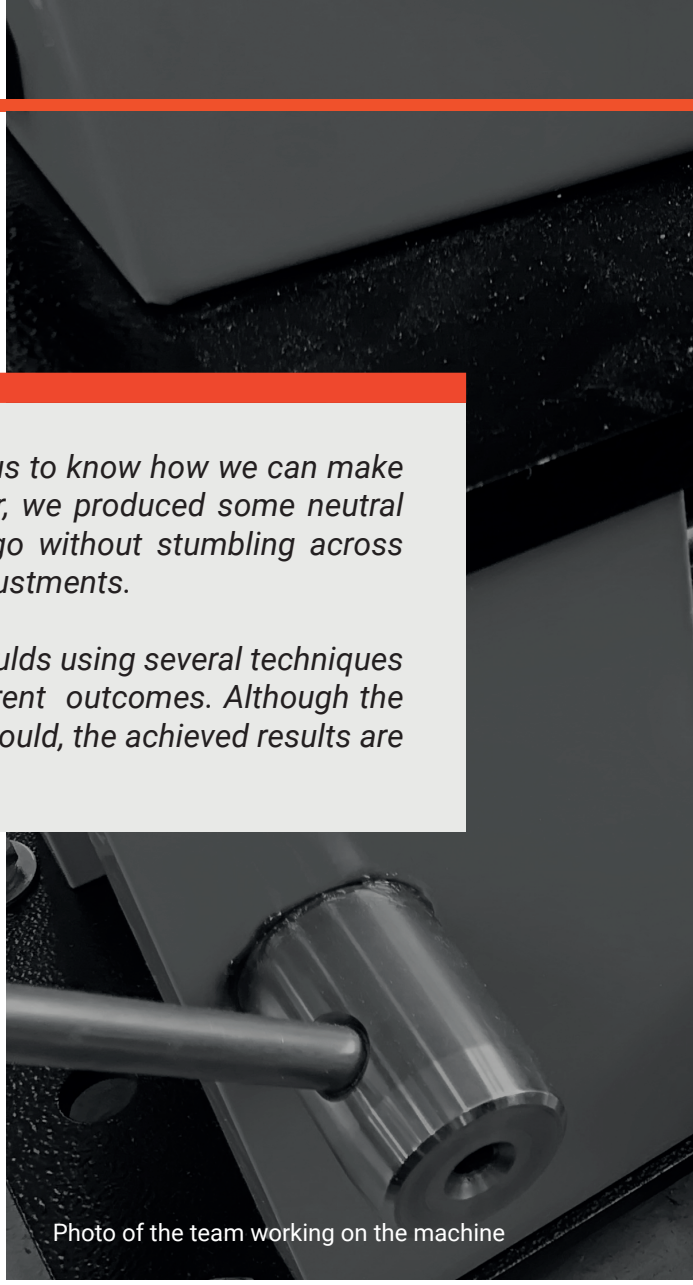


Photo of the team working on the machine

Exploration of the Machine

Before using the injection moulding machine it is necessary to have enough background knowledge about it. This includes some research about how the machine works and which problems can occur during the production process. Therefore, machine characteristics and a trial-error approach to the machine is required.

As a rule, any machine should have an instruction booklet to explain and give advice about the process to follow. Firstly, we studied the injection machine booklet and we searched for external information via certificated web pages as well. As a result, we achieved a good understanding of the injection moulding machine “Clarke 25” and its process.

Subsequently, we applied the requirements to the mould during the mould design. We unscrewed the industrial mould from the machine and wrote down the important measurements. An important measurement was the nozzle diameter because the mould nozzle should be the same diameter as the injection nozzle, otherwise it would be impossible to inject.

In brief, being assured of the machine features was fundamental to start using it, due to the fact of just having one injection moulding machine available for the project. Once all the research was done and properly studied, we moved to the next step; testing the materials. This test was released in order to know the best fitting materials according to the limitations of the machine.

Testing the Materials

We were required to use the given plastic pellets for injecting. Because of little experience and knowledge of their behaviour during the injection process, we were required to test them. The mould in which we tested the materials, was a default sample given along with the machine.

One of the first requirements that came into the picture was the maximum melting temperature. The machine is only able to melt plastics up to 200 degrees Celsius. Due to this feature, we only had six plastics available for injecting. These six were: Polypropylene and Polyethylene (PP-PE), Polylactic acid (PLA), KANEKA, Recycled Polypropylene (rPP), Low Density Polyethylene (LDPE) and Polypropylene (PP).

We used Polypropylene (PP) with our supervisors the first day, which was a successful test (Fig. 28). We also tried it for ourselves, because we wanted to have pictures of the process with the material. We intended to emphasize the difficulties while injecting due to the high melting point of PP, which is nearly 160 °C.

Fig. 28

Fig. 29

The next one we injected was “KANEKA” (Fig. 29) , a bioplastic. Its melting temperature is 160 °C as well, so it seemed that it had to work properly. However, after being injected several times, we did not manage to create a complete sample. The material was very sticky, viscous and hard to melt, which evoked several problems for injection and the clean-up. The material was hideous and unpleasant. Due to these findings, we decided to remove the material from the list.

The third one we explored was the Recycled Polypropylene (rPP) (Fig. 30, P. 64) , which has a melting temperature of 140 degrees Celsius. The injection process was surprisingly fluent and the results were great. The material melted and flowed correctly, allowing us to create an ideal sample. Its colour is blue and its texture was pleasant as well, so we included the material to the list of the valid ones. At this point, we only had two confirmed materials on the list. We were quite anxious to see the following results of the materials because there were only three other materials remaining.

The next material which followed was the Low Density Polyethylene (LDPE) (Fig. 31). Its melting point temperature is 110 ºC, so apparently we wouldn't have any problem. The result was the expected, namely that the material flowed perfectly and that the mould was completely filled. So the samples were created successfully and the texture and colour were also pleasant.

Polylactic acid (PLA) (Fig. 32), which is one of the materials used in the 3D printer machines so we had to cut it manually from the already made pieces created with that machine. It was an exhausting and large process, because it was hard and difficult to cut the material. However, once we had cut the material, we deposited the material into the injection moulding machine and we started injecting. The melting point was around 60ºC, hence the result was satisfactory and some samples injected successfully.

Finally, we experimented with the PP-PE (Fig. 33) , which was a plastic characterised by being a mix between Polypropylene (PP) and Polyethylene (PE). We did not know the concrete value of its melting temperature, although we knew the approximate value because it was a mixture of the mentioned, known plastics. The experience with this material was pleasant and we made quite good samples, so we included this material in the list of the available materials as well.

To make a brief conclusion of this trial and error process, we can assert ourselves that we have 5 materials available for injection. As mentioned, we used both aesthetic as well as technical requirements to evaluate the materials. In order for us to be able to inject, we also have to be able to use a self-designed mould, naturally.

Fig. 30

Fig. 31

Fig. 32

Fig. 33

Experimental Mould

After having tested the materials with the original mould (the one that came along with the machine), we were ready to design an experimental mould so as to minimise the errors before designing the final mould. Normally, injection moulds are created from metal. This process is too expensive for the project, so we were required to come up with solutions.

We designed a mould for a ball (Fig. 34) because it is an easy shape to check the quality of the injection. We used the 3D printer Prusa using PLA as the material. Being conscious of the fact that the melting point is a quarter lower than the top temperature of the injection machine, we wanted to ensure our believings and test it as well.

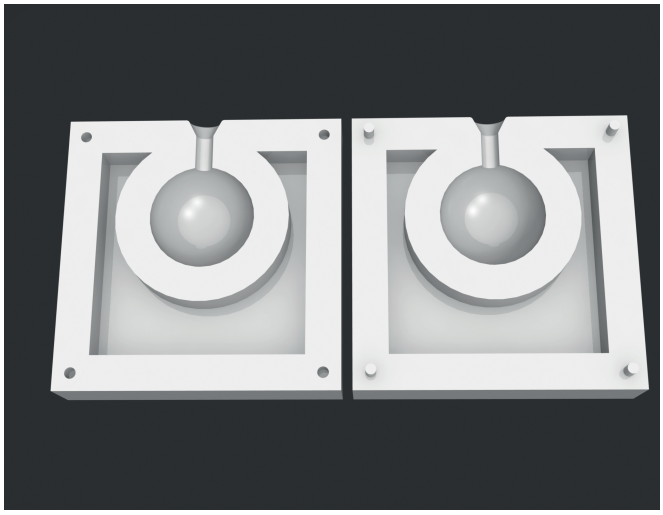


Fig. 34

Another critical issue that we're conscious of is that you normally would have a maximum thickness to the samples. Other recommendations such as avoiding a large variation in wall thickness are thus also ignored. We know that occurrences like non-uniform flow and shrinkage are therefore increased.

However, we wanted to try injecting without having a wall thickness because we might be able to inject smaller samples without taking the wall thickness into account.

The result was not what we expected (Fig. 35) . The injection nozzle melted every part of the mould that it touched. So printing the mould with a 3D printer alike to Prusa will be impossible. We had to think of some ways to make the mould using a different production technique.

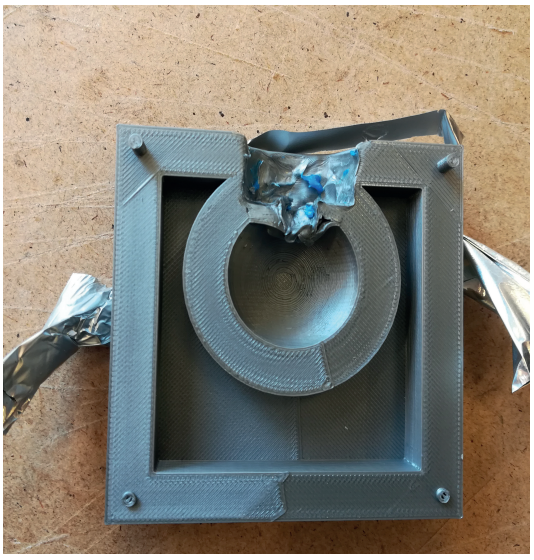


Fig. 35

Finding Solutions

Because of the mentioned issue, we had to do something completely different from what we attempted before. With our teachers' aid, we eventually came up with some ideas to solve our problem. The preferred idea was based on creating a mould support and a mould consisting of different materials.

The Mould Support

We designed a steel mould support (Fig. 36, 37) in order to inject the melted plastic properly. This support would be screwed to the machine to the bear pressures. Furthermore, this mould would have the correct measurements to fit in our bigger, designed shapes. (Appendix 15: Technical Drawing Mould Support)

Fig. 36

The Mould Material

As we knew, the material used for the first mould (PLA) was not suitable, so we had to find a new 3D printed mould which would have allowed us to print high temperature resistance materials. Apparently the ProJet, a 3D printer which could print with a high temperature resistance powder, was a suitable option.

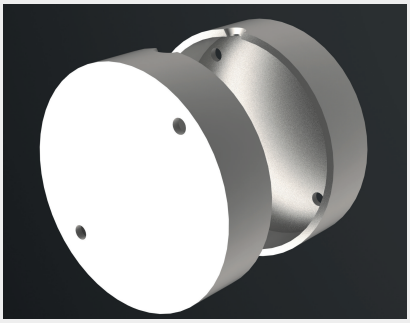


Fig. 37

Trial and Error

After having made the mould support, we designed a mould with a simple shape in order to verify if everything was correct (Fig. 38). The decision of creating a trial mould instead of using a mould with a final form was because we had a preference to make the first attempt with a form easier to inject.

This mould had the appropriate roundings and drafting to remove the injected part from the mould successfully. The shape was approximately the same size as the final forms, so that we could check things that were related to the final mould. Examples are the material quantity and the pressure of the mould compared to the size.

To spare material during 3D-printing, one of our teachers told us to reduce the material and cut parts of in the places where it could be reduced. We cut material at the back from each mould part, reducing the wall thickness between the back end and inner part of the mould.

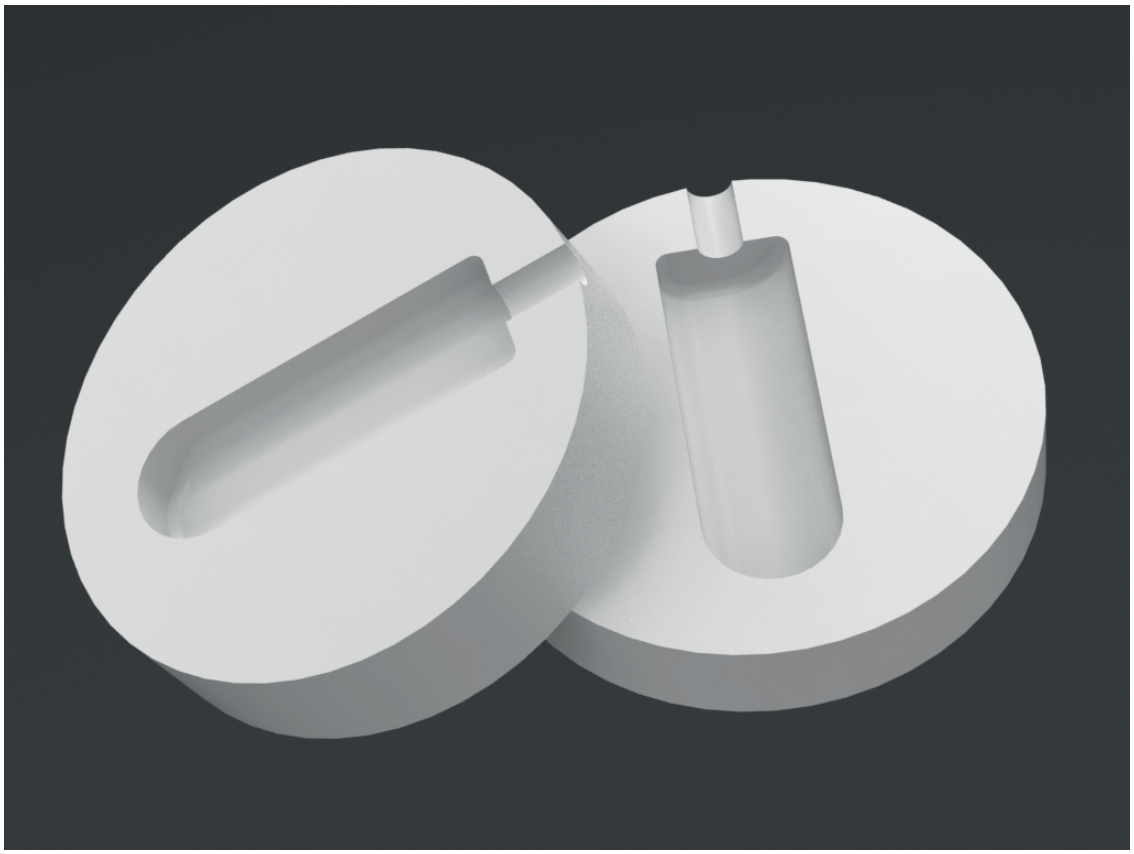


Fig. 38

First Attempt of Injecting

Now that the first mould was ready for testing, we installed it into the machine. When we started to inject the material into the mould, we noticed that it was a bit more challenging than the other ones – but we could manage the pressure. After opening the mould and letting it cool down for a bit, we saw the result: the mould was broken into two pieces. In fact, we did not expect this problem to occur, though we immediately knew why it might have happened. The mould was probably under a high pressure, too high for the material to resist, hence why it broke. Moreover, the wall thickness was probably too thin to resist the pressure.

To improve the next mould we should adjust our design based on the findings during this trial. We should increase the wall thickness, reduce the injection pressure and add air flows.

Following problems were noticed after opening the mould:

Flashes

The material filled all the gaps, but due to a difference of level between the support material and the mould material, flashes appeared all over the sample. To improve this problem we should level the plywood in such a way that the mould material aligns perfectly with the support material.

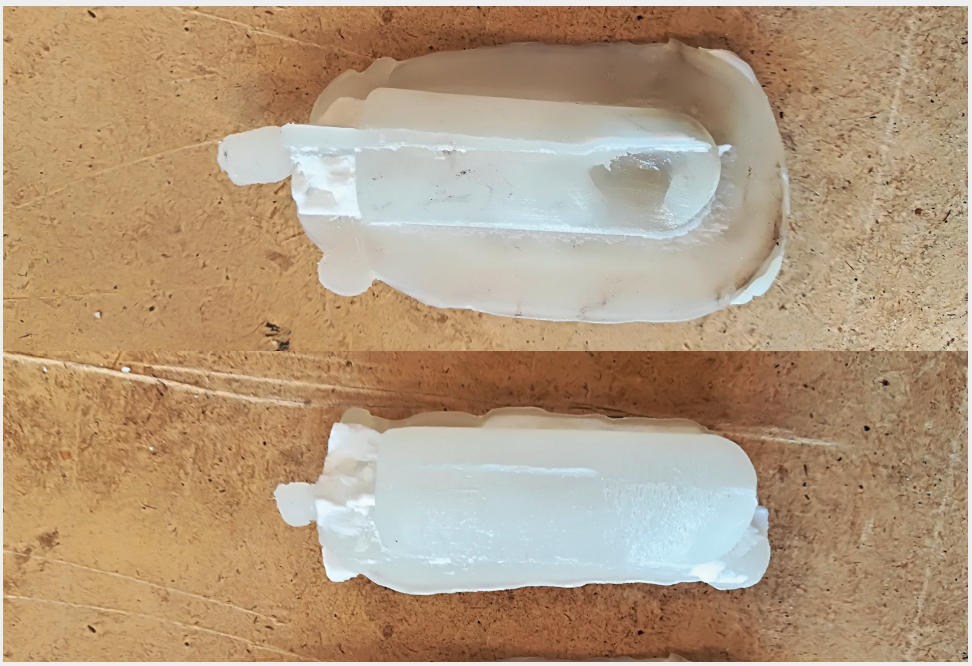


Fig. 39

Mould Split

The mould broke in two because of the reduction of the wall thickness explained before.

Fig. 40

Mould Wear and Tear

We had several problems to remove the injected shape from the mould, the powder material is not as effective as it should be and it is easy to scratch and harm it.

Fig. 41

Fixing Errors

In order to fix the previous mistakes, we developed a new mould with some new characteristics.

Because this would probably be our last mould, we decided to change the product design to the Avocado shape instead of the ball shape. The printing process is quite expensive with the ProJet machine, so even if the result were to be negative, we did not expect to make an additional one.

The new specifications are the following:

Thickness

Instead of reducing the material by cutting parts of the mould, we printed the mould with its original thickness. We designed the mould with a thickness between 27,25 and 30 mm.

Air Flows

The lack of correctly defied air flows could have influenced the excessive internal pressure that broke the previous mould. We made two ventilation channels located at 10 degrees respectively from the injection line. They have a diameter of 1,5mm.

The Resulting Shape

We used the Form A (Fig. 42) as it is one of the final forms of the project. As explained previously, we chose this form because this would be the last attempt to trial the mould. We did not have a great budget, which is why we were limited by money. However, if it worked we would continue with the injection process and just change the forms of the mould in order to create other samples.

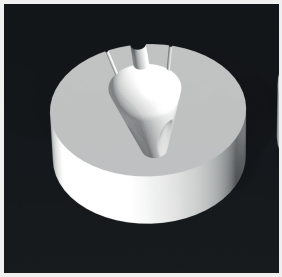


Fig. 42

Sample Production

We firstly designed all four moulds (Appendix 16: Pictures Renders Moulds), one per shape before we started producing all our samples. The mould for form A, or Avocado shape, was the first one to be printed (Fig. 45). The result was quite acceptable and the form was injected correctly, which was our cue to start printing the next mould with shape B (Fig. 44). Both moulds worked perfectly, though both of them caused several problems. (Appendix 17: Technical Drawing Mould Form B)

For both injected forms we used four different materials: PE, rPP, PLA and a mixture of PP and PE. Overall we can state that the result was satisfying, though PLA and PE caused some problems.

We required more strength to inject PE into the mould, and we had some difficulties removing the injected sample from the mould. The sample tended to stick to the mould, hence why the mould was scratched. Despite these imperfections, we were still able to use the mould to inject other plastics (Fig. 43). PE also caused a deformation of the support. Even though the support is made out of steel, and thus highly resistant to higher temperatures, it still had some deformations. We believe this is due to the fatigue because we tried to inject the material several times.

Fig. 43

Fig. 44

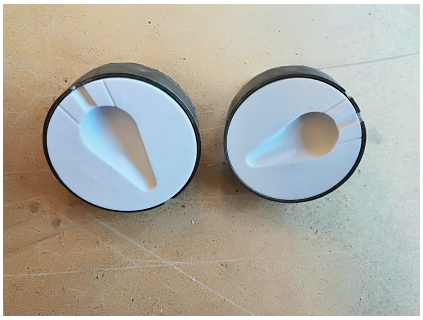
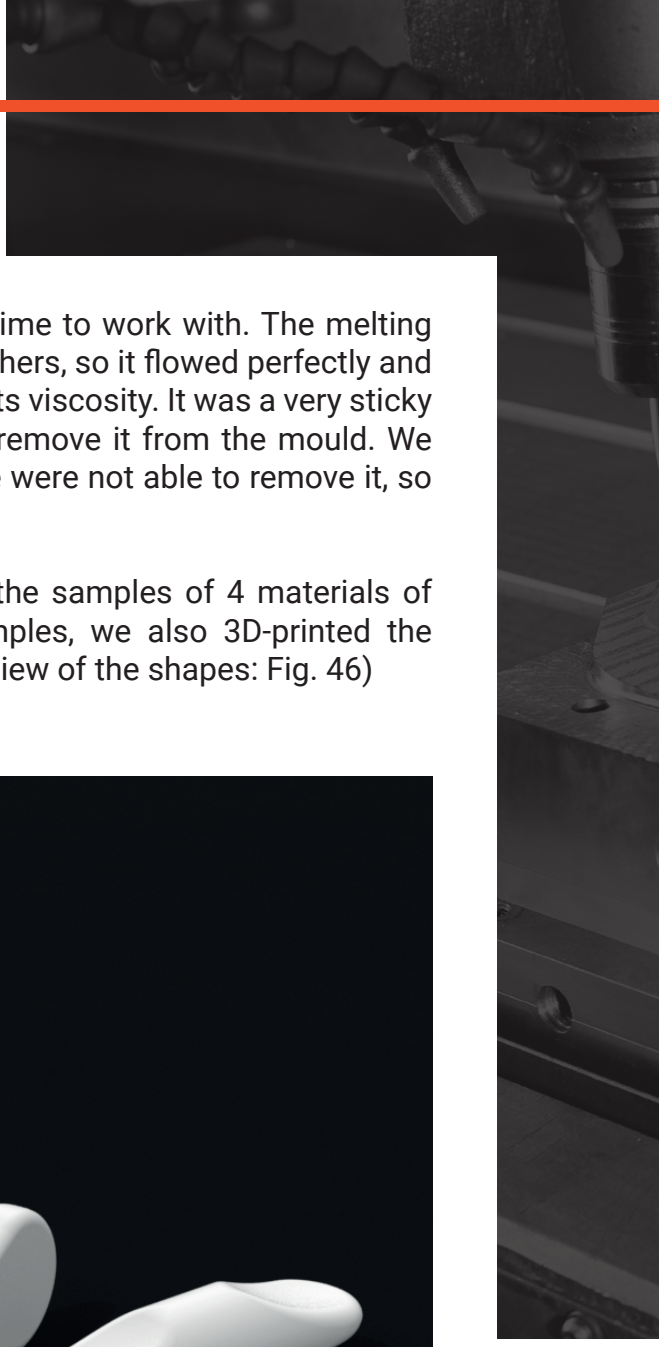


Fig. 45



Finally, the PLA was the one that took us more time to work with. The melting temperature was very low in comparison to the others, so it flowed perfectly and smoothly. The problem, though, was related with its viscosity. It was a very sticky material and we had several problems trying to remove it from the mould. We managed in the first try, but in the second one we were not able to remove it, so we had to destroy the mould.

So, as mentioned before, we managed to have the samples of 4 materials of 2 different shapes. Besides these injected samples, we also 3D-printed the remaining samples with the PRUSA printer. (overview of the shapes: Fig. 46)

Fig. 46

Conclusion

Because of our past experience with the injection machine and the 3D printed moulds, we can draw following conclusions:

Mould Material

The moulds should have been made out of steel. We had several problems working with the 3D printed moulds. The first ones we worked with had a melting temperature which was too low, hence why it melted during the injection process. The second ones, with a higher melting temperature, resisted the injection temperature and thus did not melt. Though they were easily breakable due to a low resistance to pressure. However, we could manage to inject all the shapes in different materials.

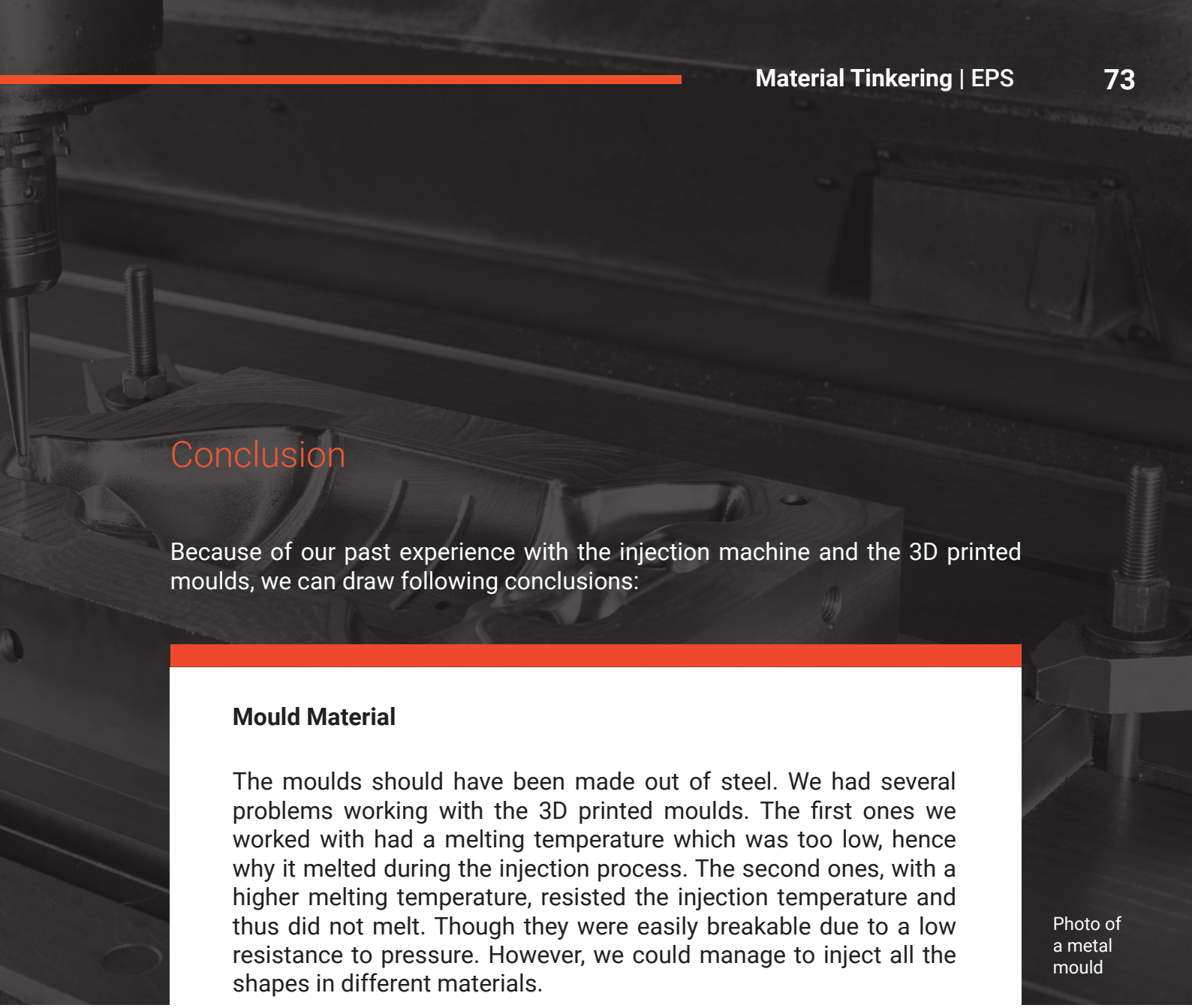


Photo of a metal mould

Production Technique

There are better ways for producing small quantities of samples than injection moulding. It would have been more suitable and efficient to create the samples with the Dimension sst 1200es 3D printer machine. The process would have been easier. Moreover, we did not have enough budget to provide ourselves with steel moulds, which of course, would have been the ideal situation.

Packaging.

Before starting to sketch and create the packaging we established some requirements. The idea of sustainability, encouraged us to focus on the material. We agreed that cardboard would be the most suitable material for our product. This material is easily recycled, cheap, has a good fatigue resistance and it is lightweight. Additionally, it is easy to manipulate. Taking the resources of the University of Antwerp into account, the laser cut was the most appropriate process to use for this material.

Apart from the developed forms, the toolkit should include a booklet that gives information to the designers about the different plastics and that helps them to create a proper interaction with the customer or user. The packaging allows the owners of the toolkit to preserve the shapes in good conditions, to facilitate the transport and to use the samples in a proper and intuitive way.

The developed forms are based on neutrality in order to be able to compare the intangible and sensorial characteristics of the material without being influenced by the shape itself. However, the plastics should be compared by using the same forms (for example, comparing the properties by exploring the Form B made in several plastics and then repeating the process by using the Form D). As we have explained before, the designer can choose specifically one of the forms or use all of them during the design process.

Due to that, the packaging has to group the samples according to form and not to material in an independent box. That means that each box includes the same form made out of different materials. Besides of being able to use each box independently, the packaging should include every element of the toolkit, making it easier to conserve and transport.

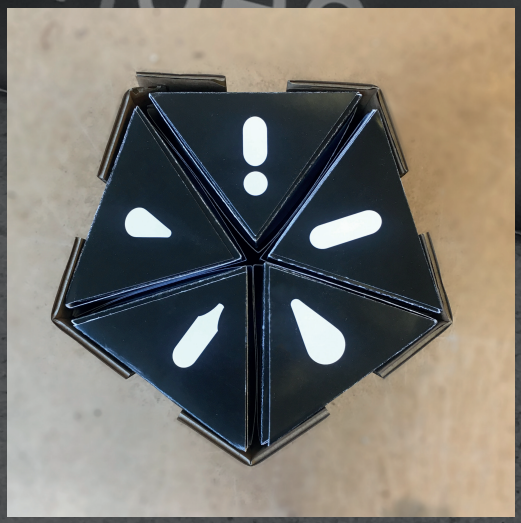


Fig. 47

Fig. 48

After brainstorming ideas, we decided to work with prismatic regular volumes, excluding rounded shapes, to respect the requirements previously set. In order to highlight the corporate identity we decided to create an external box that joins all the elements based on the logo (Fig. 47, Fig. 48). The result is a pentagonal prism that host a total amount of five independent boxes, one per form and the fifth one for the booklet (Fig. 48). In the box designated for the booklet (signalised with the “i” symbol of information) a blind mask is included to cover the eyes of the user in order to explore the forms by tactile experience.

Each of the independent boxes is a prism with a triangular base. The combination of all of them create a pentagonal prism that fits in the external box (Fig. 51). Inside the independent boxes, there are four samples included of the form made in different materials, held by PUR foam. Apart from conserving the samples correctly in the packaging, the foam presents the pieces from another point of view. This point is primarily interesting for the Avocado shape, because the foam represents the form as a ball in this case and stimulating the user because of the “surprise fact”.

These individual boxes include the logo of the project and an image of the contained form on the top part, so that the designer can identify the needed form in an intuitive and efficient way. The external box that assemble the five boxes includes an opening part on the top of each face that in combination with the hole positioned on the bottom surface of the other boxes facilitate the extraction of the independent ones (Fig. 49, 50, 51). In this case, we decided to preserve the natural colour of the cardboard and include the logo and the shapes of the forms to emphasise the material itself. The general measurements of the box are 250 mm x 190 mm x 190 mm (the technical drawings of the packaging can be found in the appendix).

The colours for the packaging are grey, orange and black, capturing the corporate identity and giving coherence to the toolkit. As a result of the packaging and the graphic design, the toolkit has its own identity, being more attractive to the stakeholders.

Fig. 49

Fig. 50

Fig. 51

Photo of the packaging

Booklet.

To use all qualities of the toolkit, we propose to include a special booklet which will contain additional information for the designer and eventually for his client. Guidelines will describe the possible content and the research that has been conducted to characterise the adjectives based on ethnicity, cultural background and gender. Besides this semantic information, the practical guide should also mention the technical parameters of each plastic in the box.

Secondly, since our goal was to create an intangible toolkit, we should present which feelings and meanings people usually associate with the concrete plastics in the box. It is important to emphasise that we are talking about the material and not about the shape. More research is urgently needed to establish a system which will be very similar to the one used in the booklet of the Determinator Box (Fig. 52, 53). This future research can be based on the same list of adjectives; however, proved by a number of participants in workshops with our new neutral forms and plastics which we used. This analysis should serve the designers in order to help them know which plastic evokes which feelings and meanings.

Finally, cultural background and regional aspect are relevant design criteria for the economically successful product. A considerable difference will appear between subjective associations of Asians, Americans or Africans. The analysis mentioned above should be undertaken considering the cultural heritage and geographical location of the final user.

A sheet of instructions could be another additional feature of the booklet. These instructions should help the designer to perform a short workshop that reveals which individual feelings the final customers feel of the plastic. These instructions would contain a list of intangible characteristics that are all structured by their poles and relevant values between them. This would enable the user to be more precise in his choice of feeling. The booklet can be placed together with the “blind glasses” in one of the inner boxes of the toolkit.

Fig. 52

Fig. 53

5

CONCLUSION

The final purpose of this project was to develop a toolkit for designers in order to help them choose materials based on semantic meanings. This project is just a part of this final purpose, setting the focus on the samples of the tool and its neutrality.

We attempted to create a transition of the abstract neutrality to the physical neutrality by conducting workshops and analysing the outcomes. The idea of neutrality has been defined: it can be either based on the complexity principle or on the simplicity principle. These are, respectively, evoking no feelings nor meanings or evoking a wide range of meanings of which the user is not able to fully define. In essence, we can state that it is fairly impossible to acquire a neutral form. Due to the difficulties throughout the steps and psychological background, we can safely conclude that true neutrality is impossible to achieve. Our brain is designed to create associations and ideas of every input. Additionally, factors like environment, texture and colour influence the user's perception.

Although we concluded that neutrality is impossible to achieve, we were able to create four different samples to evaluate materials. We recommend that further research and investigation is necessary to create a valuable toolkit. For further research, it is important to note that the focus should not be on the neutrality of forms but on the capabilities of being able to be compared and evaluated.

Besides recommending this shift of focus, we also proclaim that injection might be a good method if following demands are met: possessing sufficient materials to inject successfully and having the capability of creating metal moulds. We made moulds out of powder, which had a matte effect on the results. If you want to highlight certain characteristics of materials and include textures on surfaces, metal moulds are necessary.

Finally, we would like to point out that research is needed to create a valuable booklet for the toolkit, enabling users to compare semantic meanings of materials on a cultural level. We certainly think that it is valuable to continue investigating in this field because we believe that this toolkit is a great opportunity.

PERSONAL REFLECTIONS

Personal Reflection: Eduard Casadevall Gras.

The aim of this text is to highlight my contribution to the group project besides to provide a personal feedback of the European Project Semester concluded in Antwerp, Belgium.

There were several benefits from being part of the EPS. Separately in the schedule there were courses and project time, although both were somehow related, the way of learning and knowledge acquired have been completely different.

On one hand, during courses I had the opportunity to learn from nice teachers over Europe. Besides the important information taught, the fact of being from foreign countries makes it more interesting and exotic. Every teacher had its own specialization and that made the lessons dynamic, entertaining and well prepared.

On the other hand, about the project itself, I believe the most important values I acquired are working in a team and writing reports. Evidently, both are essential in my academic and professional future. Otherwise working in a project such as important it pleased me in a student way.

First of all, I would like to talk about the team and my contribution to the project work. Despite the poor cohesion between the group members when we began, as the weeks were going on, we started knowing each other better. This includes in having a better role inside the project due our special field. Therefore, the first steps of the project were achieved as a group without giving a specific role, all members were helping each other and every phase was decided and discussed as a team.

Once we introduced ourselves thoroughly, I got involved mostly in the mechanical aspects of the project. I was the “headman”, with another team member, of everything related with the machines usage and the know-how to bring up the prototypes and the physical final shapes too. Naturally, it was necessary the participation from other team members on some decisions. In the same way, I have been contributing in a secondary row to other steps of the project where the leader was another team member, such as preparing workshops or the shape creation.

My point of view about the fact of managing project work process was acceptable. Day after day the amount of work was increasing dramatically, however, we believed in the schedule and we did not step aside from the work plan. Consequently, after the midterm we were asked to change our project course due to lack of veracity in our decisions. Nevertheless, we managed to reorganize the following steps and gradually start performing several achievements.

According to the specialisations learnt during the project, compared to other team members, I learnt in producing and modelling physical objects with different machines owing to my situation as a samples co-producer.

Concerning the results achieved, before the midterm, I believed they were not satisfying both information and detail. The lack of time and the topic misunderstood tricked us. However, we changed completely the approach and a new project plan appeared. We bet on performing several workshops in order to have more valid data to finally conclude with a certain argument. Furthermore, the involvement and positivity of some teachers, as the supervisors, were grateful for the right continuity of the project.

Lastly, I will provide some background about the team members' connection. With the EPS I could experience how people of other cultures understand, feel and act. I contributed to my team with a friendly and pleasant presence. The team helped me developing personally some attitudes as participation and discussion due to the constant talks and decisions we had to achieve as a group.

The team connection was unsurpassable and there was a good work atmosphere. Despite the fact that there were some issues that we finally could arrange, in general everything flowed correctly. About myself, every meeting I attempted to increase my speaking and have more collaboration in order to improve my contribution to the team.

To sum up, the EPS was an incredible and unique experience due to the cultural combination between the team members, too, the project work and the different subjects. Even though we were not happy at all with the project topic given in the first instance, things changed and now we are shouting proudly to the four winds; we are material tinkering group and this is our project.

Personal Reflection: Adrià Fenollosa.

This text will be a reflection of my personal experience and participation in the project that I was assigned with, called Material Tinkering. This has been realized by a group of five people, so it is a joint project, which means that team building and cooperation play an important role in order to build and develop the project. Even so, I will try to explain how my contribution was, and make some conclusions about my general opinion of the work and the specific ones related with the steps and procedures that we followed, as well as the relation with my team.

First of all, I will describe the experience that I have achieved doing the EPS and the general opinion that I have from it. I am actually going to finish the program, which means that I have almost finished the project and that I have coursed all the subjects that I was required to study.

So, since I came here on February, I believe I have improved considerably my English level, which makes me feel so happy and motivated. I have also enjoyed so much the Dutch and English lessons and I have felt so guided by the teachers. Thus, I can conclude that I have reached the goal I made myself at the beginning, which was to leave this country with a fluent speech and a better understanding of this language.

On another note, I have also been very impressed with the equipment of the university and all the possibilities and events that it offers to the students. The treatment from all teachers has also been always correct and, from the first day, I felt very welcomed here.

However, I have also some complaints; I found that some of the courses we have done here were not so much interesting and useful. We have spent so many hours in some topics that I have already done or which are not related with my degree. Personally, I consider that this program in this university is more oriented to designer students rather than the technical engineer ones. I also consider that we should have done more projects and more practical lessons.

Talking about the time given for the project, I cannot understand why we had to submit the project so early. We consider that we did not have enough time to perform it as we would have liked. Most days we have been stressed because the time was running out and we did not know if we would finish the project on time. In my opinion, students would reach better results if they had more days to work in the project without worries and hurries. Due to this, I could suggest two things: doing fewer unnecessary lessons or just giving more weeks to finish it.

In this paragraph I will explain my contribution to the project. I want to make clear that all members of the group have worked hard in the project and, usually, we have distributed the work between us in an equal way.

We divided the project on different parts and nominated different captains for each section, in order to create specific responsibilities to ensure the compliance of the process. In my case, with Eduard, we were the captains of the machine and technical requirements of the pieces. Due to this, I studied how the injection machine and the 3D printer work and all the necessary requirements to create the forms in the right way. We also designed and created molds for doing tests with the injection machine. All this previous work, finally, allowed us to create the final molds and, consequently, the final forms.

On the communication field, I have always tried to give my opinion and give useful advices. By the way, being honest, this project was something totally new for me. All of my partners are designers and they have done some subjects related with the background of the project, which means that they had more knowledge and tools for working. I'm not excusing myself, but I have to admit that sometimes I could not follow them or understand what they were talking about.

Also, a lot of things that we did, such as workshops, templates, designs, etc. come from the field of design. They knew also the technical aspects that we had to apply in the project, because in their degrees they studied also materials and its strengths. With this, I mean that I consider this project is more for designer/ psychology students, rather than for someone coming from my field.

Talking about the project, I consider that it should have been more defined at the beginning of the course. We spent so much time in things that we consider unnecessary and we clearly understood on which way we had to proceed when only five weeks to finish the project were remaining.

So, as we were the developers of the project, it was our fault, but I believe that both parts, which includes the supervisors and us, did not have a good communication process, and it is something that both needed to improve to guarantee the correct development of the project.

These were my feelings before the midterm report and presentation. Fortunately, after that, we had various meetings with our supervisors and we finally defined a clear way to carry on the project. Due to this, we agreed on defining a new planning and also a new perspective which would represent the project.
As result, we managed to finish the project and we accomplished our goal. With this, I would like to recognize the work done from my workmates and, of course, the help that our supervisors have given us every week.

In conclusion, I don't regret coming here and if I could come back to choose again, I would say yes to Antwerpen. However, I believe that some things should improve for future EPS programs and I also thing that the university should define clearly for which kind of students is the program directed in relation with the subjects and projects offered.

Personal Reflection: Gloria Diaz.

European Project Semester (EPS) is an exchange program created with engineering students in mind, in order to help them to take responsibility for their learning process and to approach them to the professional world. In this programme, the students should develop a project and course some complementary courses being part of an interdisciplinary team. These courses include subjects related with team cohesion, languages (English as the official one and Dutch as a complement) and integrated design.

In this reflection I explain my current experience as a member of the Material Tinkering team from the EPS, expounding firstly my personal opinion about the programme, secondly how this experience is contributing to my training and finally my perception of the results.

In my personal opinion, the implementation of the subjects can be improved. We can divide the students of the EPS in two groups: the product development students and the students from other fields. For the first group (including myself) the content of the subject is too basic, so it does not stimulate the students or help them to learn new things. Students from different fields are not really interested in the topic.

Because of these facts, we are not motivated to do our best. In addition, during the first weeks there are a wide range of lessons and assignments, so we do not have time enough for working in our project. The assignments are usually similar or not related to the project itself and the short amount of time assigned to some of the lesson provides us a poor introduction to the topic. In the majority of the cases we have not received any feedback about the assignment which could be implemented in the project process. In consequence, some of them are not especially useful.

Despite those facts, the EPS is contributing on my training by helping me to develop skills such as team working and communication. The differences between the team members provides us the opportunity of combine our experiences, knowledge and roles.

My experience and personality encourage me to contribute to the team and the project by working on management and communication tasks. I consider myself a practical person and I can see the influence that it has on my work and my team. Occasionally I can be too strict or immovable, in these cases my teammates advise me and help me to be more receptive. I usually attempt to analyse the problems from a critical and technical perspective focusing on the possible mistakes in order to prevent them or to find potential solutions. This characteristic can show me as a negative or cold person. However, I rarely neglect the goals or focus on the problems and not on the solutions.

Though I am used to team working it was complicated in the beginning to cooperate with other members of the team, because of the different perceptions, personalities and manners of working. Nevertheless, the workflow and atmosphere were improved after some weeks. I would like to highlight the benefits of having an interdisciplinary team; even when in our team we are primarily product developers the different backgrounds increase significantly our resources, helping us to solve the problems that appeared.

Finally, as a reflection about the project results, I would like to emphasise the irregular time management. The initial information that we received at the beginning of the project was limited and consequently it took at a great amount of time to get to know the project and its aims, notably taking into account the highly abstraction component of our project. As I have explained, before the Easter Break we did not have much time for working in the project. Due to these two fact we have a large amount of work during the second part of the semester. This change in the content, the reduction of the time and the numerous problems we have had with the machines forced us to reduce the initial goals of the project and the physical results obtained, causing stress and frustration on the team members.

In short, participating in the EPS Programme is a good opportunity to work in an interdisciplinary and complete project and to develop the personal autonomy. However, the content and the timing of the Programme should be improved, in order to motivate the students and increase considerably their knowledge.

Personal Reflection: Eva Wenborn.

This personal reflection is meant to shortly describe what I gained during the past months, what and how I have contributed to the project and team and finally draw some conclusions from my discussion.

During the past months, I have had classes about teambuilding, project management, cross-cultural theories, business canvasses and sustainability. I have already had some of these classes, so I did not enjoy all of them. I found project management and business canvasses particularly educating because it was the first time I ever heard of the theories involved.

We had to create a project plan for project management, where we needed to divide all tasks over the given period and calculate how much time it would take to complete every task. I believe we tackled this part in a great way because we took every personal character, skill and background into account while setting up the project management plan. Moreover, we succeeded in estimating the time spent on every task. However, apparently, our approach to the project was inherently wrong. The project is in fact not focused on creating a toolbox for designers, but on creating a neutral shape where after the toolbox would have to be created. Although our team had this complication, I believe that we had the right capabilities in order to adjust the project management plan to the new aims of the project.

Because of the mentioned misdirection we were heading in as a team, we received negative but constructive feedback on the midterm presentation and report. Our supervisors told us that they were somewhat disappointed in the work that we have realised in the past weeks, and that they expected more results. This was due to the amount of work besides the project work and the bad communication between the team and our supervisors. Although the team would have wished for more guidance and guidelines, with which I agree upon, we should have communicated more with our supervisors.

After readjusting the project plan and project goals, we were heading steadily in a fixed and improved direction. Our team roles came into play and everyone contributed greatly to the project in his or her own way. In the beginning, I tended to do a lot of communicative work like correcting English and translating Dutch though this shifted as we proceeded with our project. I was able to do more graphic work and play with my insights of how workshops should be carried out, structured and analysed.

I have had different views and opinions on the project during the past weeks, which caused some friction. Although we have had some disputes, the harmony in our team is so strong that it did not cause any problems. I was prepared to lay my preferences aside and prioritise based on the outcome of a team discussion. It also became clear that my communication skills are generally well developed which caused me to be a bridge between all team members. I tend to summarise opinions and make conclusions about them in order for me to rephrase them and recommunicate with the team. This way, everyone is able to understand what the other is saying.

Besides contributing to the team on a communicative level, I learnt a lot about myself as a person. I am stubborn, which led to me realising that I need to lay my opinions aside if they are not accepted by the team unanimously. Although stubbornness could be something negative, it also causes to maintain the team motivated in less interesting times.

I also learnt that I am a person who looks at the bigger picture instead of going into details. I tend to create concepts, propose them and argument why that kind of approach is better than the other. In fact, I did not know that I was able to reason to this extent and I am happy that I learnt this skill of mine. Although concepts are the start of a good and well thought out approach, you also need to be able to not overlook any important details along the way. Therefore, I was happy that Gloria and Tereza were able to fulfil this role as we really needed to focus on details for some parts. However, this is also a cue for me to improve my lack of skills in this field.

Finally, as a conclusion, you could say that I have learnt about my role in a team as well as in a project. It seems that it would be interesting for me to develop my communication skills even further and become a monitor of a project. I also learnt that my English is in fact still well developed, even though I have not used it on a regular basis for the past fourteen years. I hope that the EPS courses will improve over the years and teach other students about themselves and about working in an international team.

Personal Reflection: Tereza Vackova.

Introduction
This paper presents my personal reflections to my participation in the EPS project at University of Antwerp. The aim of it is to highlight the skills which I have learned during last five months and to outline my future intentions in personal improvement.

Gained knowledge
During the EPS courses I learned adequately about project planning and organisation. My home university offered me a course of economics focusing on business canvas so it was familiar to me. The EPS program also organised lectures of usability and sustainability. Unfortunately, the learning benefit of them was very little since they consisted only of introduction and limited theoretical basis.

Personal contributions
One of my specialisations in our project was the graphic design, because I work like a graphic designer and I can use a wide range of softwares. I have also the product design background and I often use 3d printer for prototyping. Therefore, I was ready to contribute my experience in modelling designs of our plastic forms for 3d print.

Besides my computer skills, I also intentionally get involved in debate. At the beginning of our brainstorming I often set the main questions or statement which were there to be discussed or further developed. Interpersonal communication was important for our team work and we all, including me, responsibly used communication platforms such as google drive, whatsapp or trello.

Good communication helped us in the middle of the semester when a distinct unexpected misunderstanding appeared between us and the project mentors what led to dissatisfaction of both involved parts. Our team understood the main task of the project differently than our supervisors meant it and after two months of work we had to move our attention in different direction. We were still able to finish within the set deadline; however, the results correspond the shorter time spent on the final task.

The tasks of project work process were delegated equally to all members. There were specified roles of each member, for example Gloria was doing most of the administration and Eva most of the translation, both based on their personal character. Adria and Eduard moved to keep controlling the injection machine over time.

As I mentioned before, I have recently started to work as a freelance graphic designer in order to make use of my experiences from creating graphic designs for my friends and university. Besides that, I study industrial design and I am experienced in design process and 3d modelling. In comparison with my team mates I can say that my home university is less focused on engineering part of the design process. I do not have skills in dynamic and static software simulations which all my team members have. During our project any kind of simulations was not needed, therefore I need to learn it on my own. Finally, my original intention was to improve my English, both spoken and written, which was significantly poor while comparing with Eva or Gloria. My language skills still have reserves even though I have made some progress.

Project achievements

According to our mentors we misunderstood the goal of the project. From the description of the project we did not understand that the main goal of the project was to create a neutral shape. Our decision was that the goal is to create a toolkit with samples which shape does not influence feelings of the user. Additionally, the shapes should also be interactive to enhance the user to play with them. They also should be covered with varied textures to promote more tangible properties of different materials. Finally, thinner parts, for example hinges, could be involved in the design to emphasize tactile perceptions from the material.

My team did not agree with opinion that is possible to incorporate all these aspect into a neutral shape because all these features particularly change the shape and the main aspect of neutrality would be lost. Despite these communication difficulties we were able to propose new modified plan of our work flow to the supervisors and finish with a prototype of a toolkit which draws on the theoretical research of the neutrality concept.

In summary after the midterm report me and my team based all our steps on consultations with our supervisors to avoid failures. In fact, we changed the whole attitude to the project goal and followed the new project plan with the main focus on defining the concept of a neutral shape. This was accomplished throughout a design research based on varied workshops. We used the gained data as a baseline for other workshops and at the end we manufactured final shapes with the injection machine.

From my personal point of view, on one hand we have reached sufficient results of the project even after obvious change of the concept of the project work and I appreciate the effort which me and my team made. On the other hand, the project topic and the task described in the initial outline differs distinctly from the real project work. This unexpected but important shift from practical to abstract design has negatively changed my level of motivation and pleasure because I do not find purely theoretical research neither interesting nor important for my studies. Moreover, the significant amount of assignments (essays and presentations) for the other subjects of the EPS during the semester distracted me and my team from the main goal of the EPS, what was the project work.

Personal development

At the beginning of the semester, I was worried about my capability to work in a team because I never contributed with anyone on my university projects. Fortunately, I could build on my experiences from membership in a sport team. Based on those I know the importance of humour, compromise and friendly cooperation in a group. In my team I attempted to ask for opinion of each member to get broader image of each situation.

My international team has helped me to get over some cultural stereotypes which I was unaware of. I also learned from Gloria that administration and planning seems to be a boring part of the project. However, it saves a lot of time and helps to focus on more creative parts. My group also inspires me to improve on multitasking and organisation. Lack of both has complicated my working process in recent years and after five months of the team project I find both essential for effective group work. Although multitasking never was natural for me, I found few methods to be better in it.

From my personal point of view, I should become a more organised person. Some of my team mates showed me that my work can be much more productive when I am not distracted. This way I can arrange not only my professional life but also create more time and space for friends and family.

Conclusion

In this reflection, the aim was to assess what I have learned and what I find important for my next development. From this point of view, it appears that I am good team worker without a clear organisation. Therefore, the second half of the project I focused on my weaknesses in planning. It also clarified that I was not satisfied with the project topic, nevertheless the final achieved results were good enough to meet the requirements of the task.

7

BEX COINS

The bex coins is the official money for the EPS Programme. At the beginning of the semester every team had five coins to hire members of other teams in order to help them on specifics moments.

In our case, the necessity of participants in our workshops led us to give one coin to each team to arrange the participation of the workshops. This point was interesting because every team is composed of designers and non-designer students, giving us the opportunity to easily find the necessary profile for every workshop. In total, we spent three of the five given coins.

Besides that, other teams asked for our help and gave us a bex coin as a reward. Before the “Marché choché” we helped the organising team with their logistics by preparing the tents. In addition, the “Energy wizards” asked us to help them with the InDesign software, in order for them to prepare the layout of the report. Thanks to these facts, we earned two bex coins from different teams.

The bex coins have helped us during some points of our project. However, we are not sure whether they were a real value. If they did not exist we would have probably been able to find participants for our workshop led by the idea of collaboration, co-working and helping each other. Finishing the project with or without the coins does not have any relevant meaning or consequence.

8

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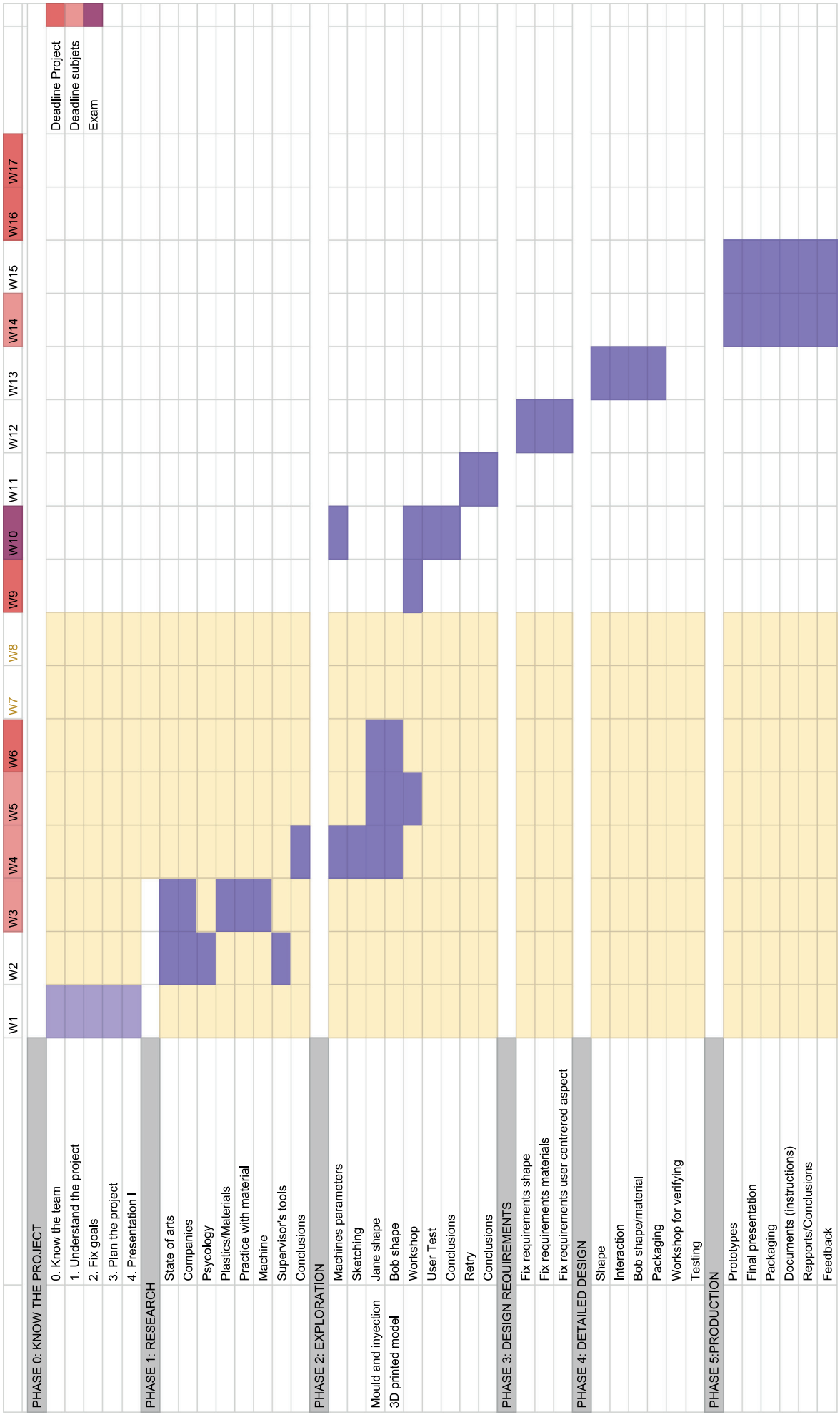
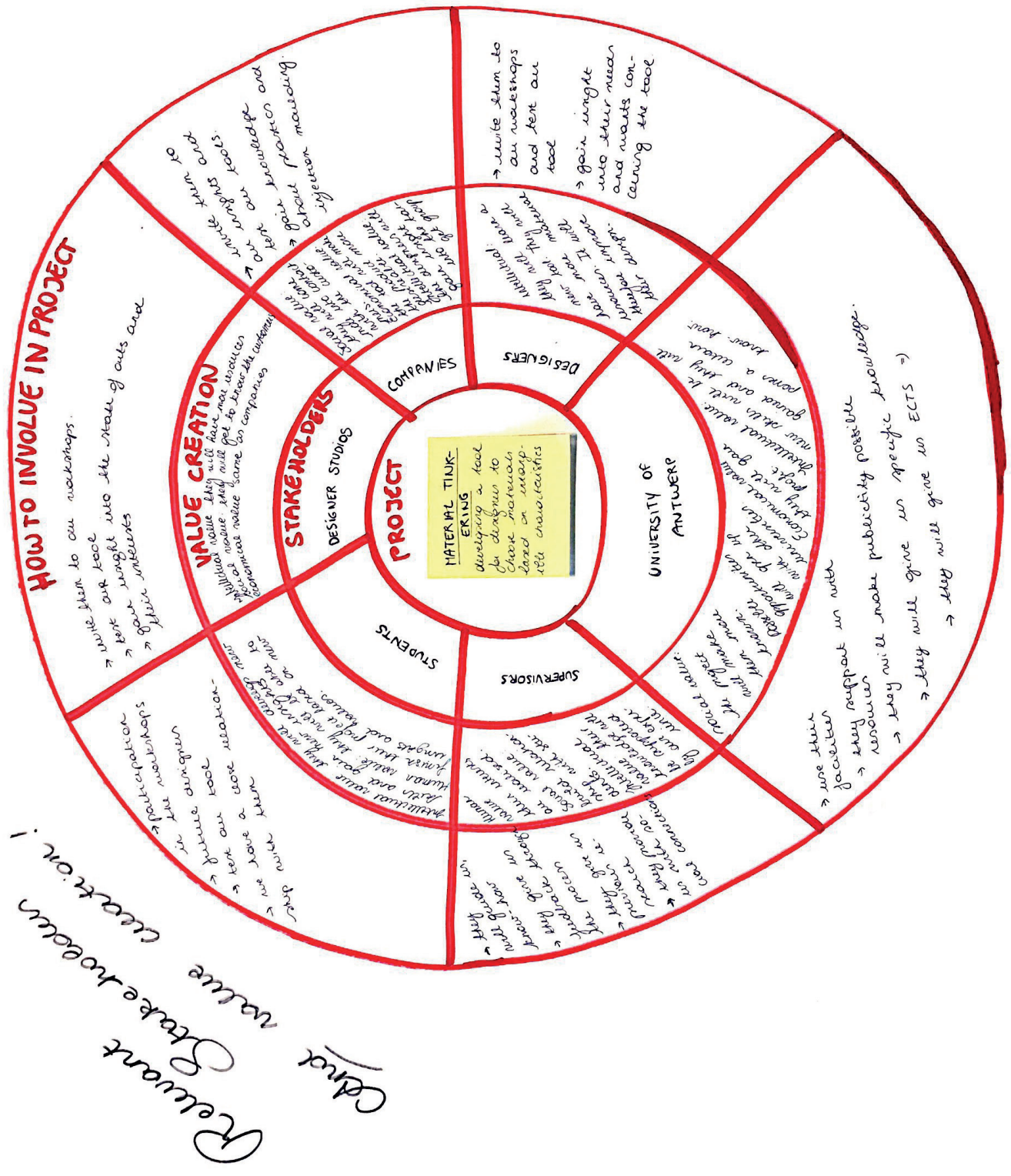
APPENDICES

APPENDIX 1: Gantt Chart

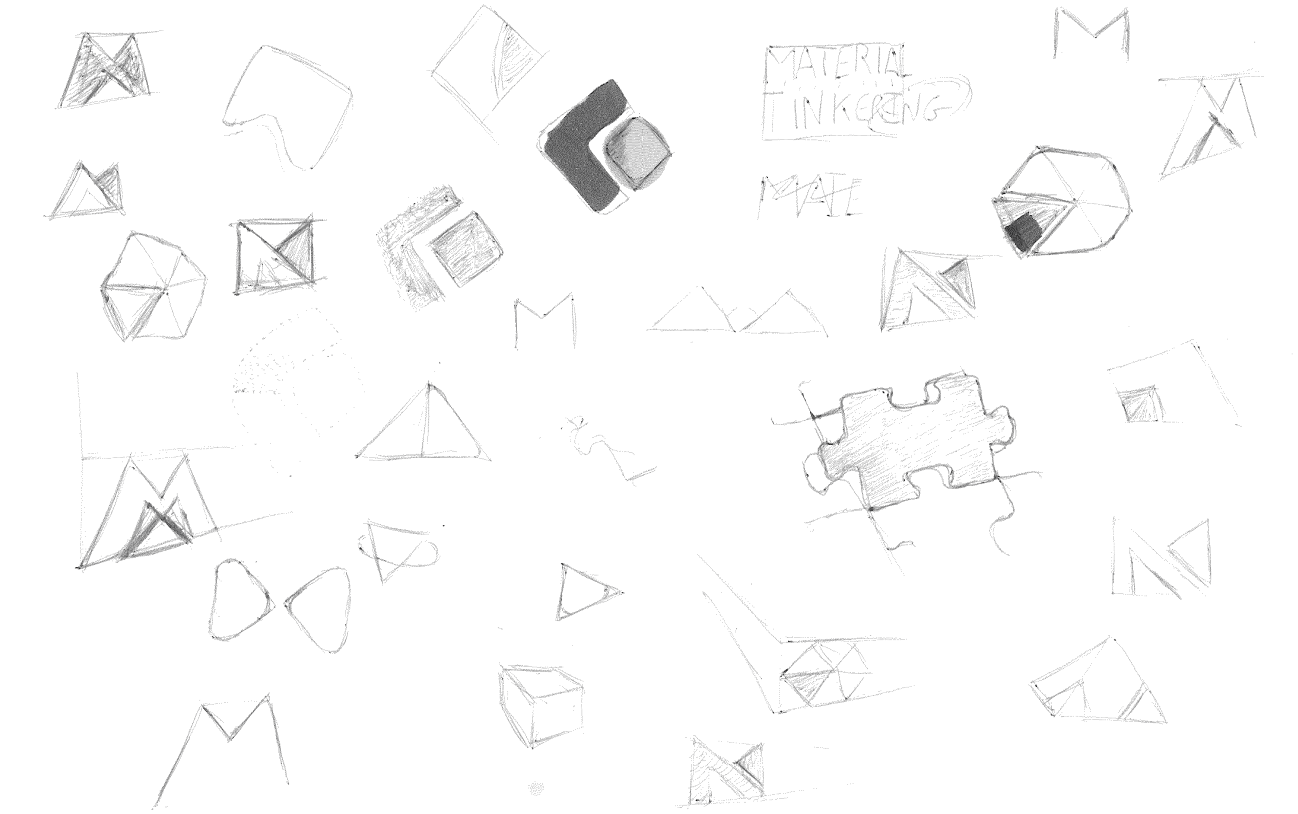


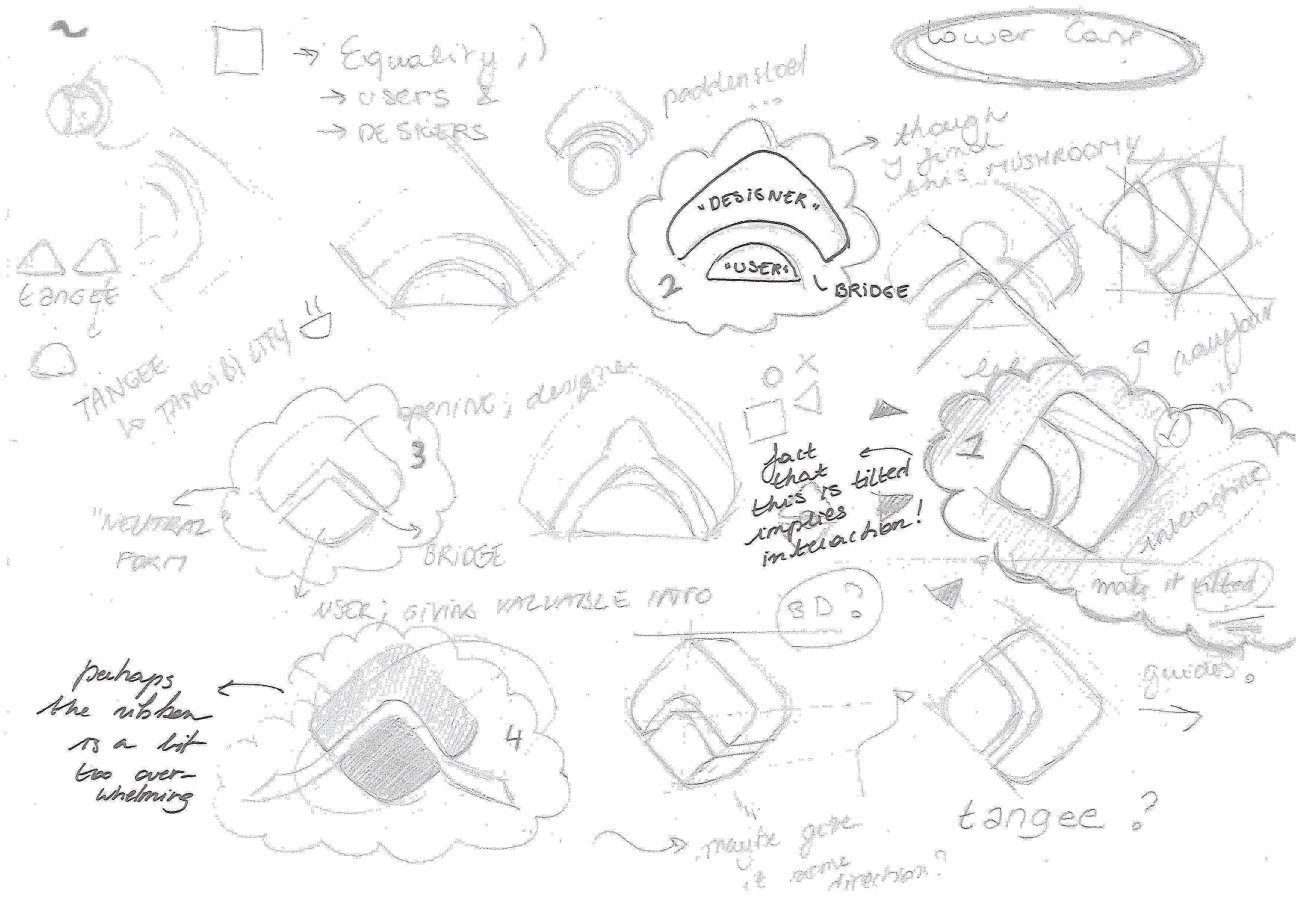
APPENDIX 2: Persona

APPENDIX 3 : Stakeholders



APPENDIX 4: Logo Sketches





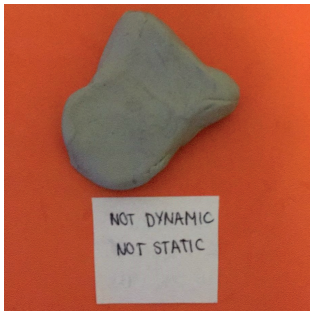
APPENDIX 5: Questions Neutrality

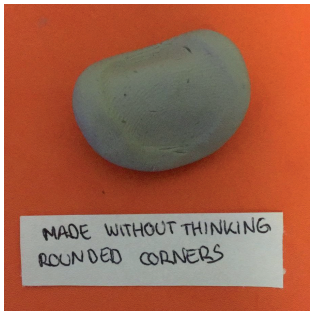
What is neutrality for you?	Make a definition of your concept of neutrality

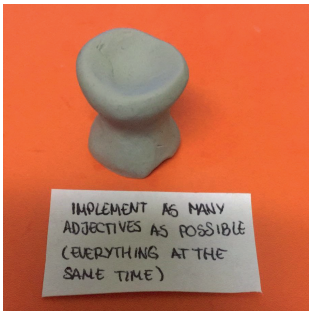
APPENDIX 6: Results WS2

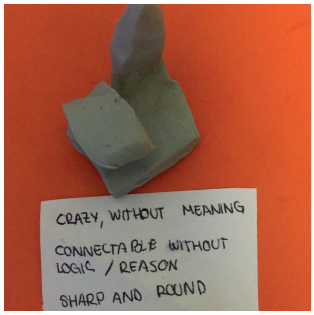
Comments underneath are the comments of the creators.

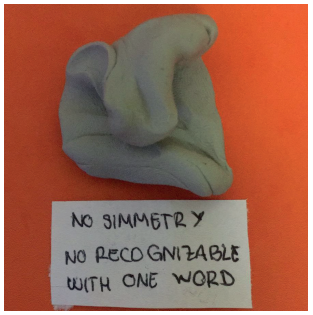
Shapes based on the complexity principle:

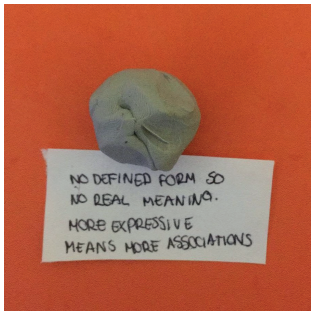


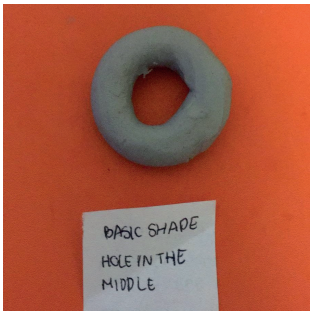


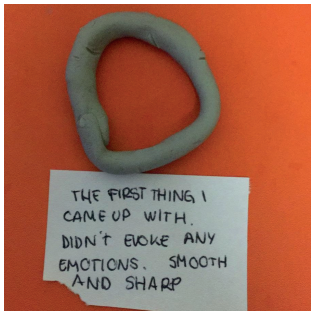


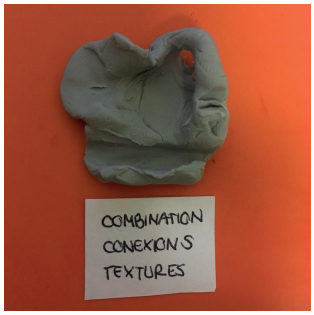


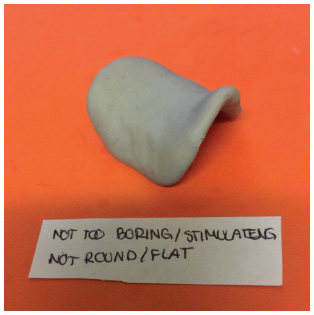


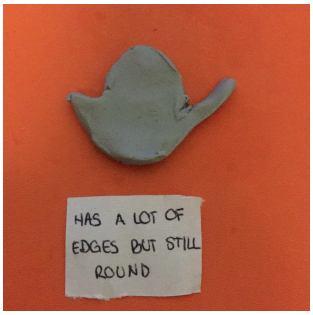


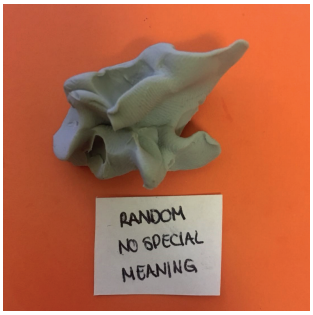












Shapes based on the simplicity principle:

Erasmus programm - EPS project - Material Tinkering team

tangee

questionnaire

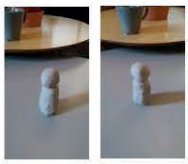
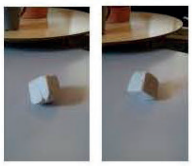
Please, choose which **pairs of characteristics** (adjectives) are related to **shapes**. Tick **6 pairs.**

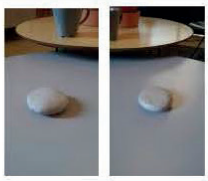
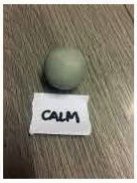
Kies een koppel van **adjectieven of karakteristieken** die gerelateerd zijn aan **vormen**. Duidt **6 paren** aan.

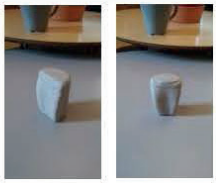
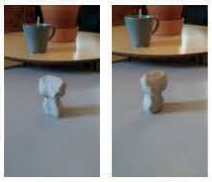
- ☐ cozy (knus) X distant (aftandelijk)
- ☐ elegant (elegant) X vulgar (vulgair)
- ☐ futuristic (futuristisch) X nostalgic (nostalgisch)
- ☐ toy like (speelgoedachtig) X professional (professioneel)
- ☐ tissolute (losbandig) X modest (ingetogen)
- ☐ agressive (agressiev) X calm(kalm)
- ☐ just (gewoon) X strange (vreemd)
- ☐ sexy (sexy) X boring (saai)
- ☐ male (mannelijk) X female (vrouwelijk)
- ☐ delicate (delicaat) X robust (robuust)
- ☐ disponsable (wegwerp) X sustainable (duurzaam)
- ☐ formal (formeel) X informal (informeel)
- ☐ cheap (goedkoop) X sustainable (duurzaam)
- ☐ classic (klassiek) X trendy (trendy)
- ☐ traditional (traditioneel) X modern (modern)
- ☐ honest (eerlijk) X misleading (misleidend)
- ☐ adult (volwassen) X youthful (jeugdig)

APPENDIX 8: Results WS4

Nr.	FUTURISTIC		NOSTALGIC	
1; 2				
3; 4				
5; 6				
7; 8				
9; 10				
11; 12				
13; 14				
15; 16				
17; 18				
19; 20				

Nr.	TOY LIKE		PROFESSIONAL	
1; 2				
3; 4				
5; 6				
7; 8				
9; 10				
11; 12				
13; 14				
15; 16				
17; 18				
19; 20				

Nr.	AGRESSIVE		CALM	
1; 2				
3; 4				
5; 6				
7; 8				
9; 10				
11; 12				
13; 14				
15; 16				
17; 18				
19; 20				

Nr.	MALE		FEMALE	
1; 2				
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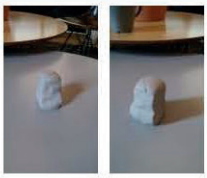
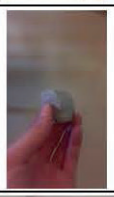
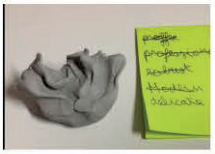
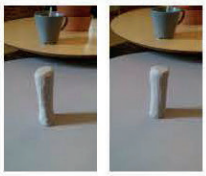
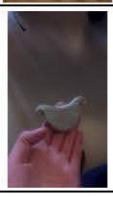
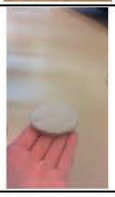
5; 6				
7; 8				
9; 10				
11; 12				
13; 14				
15; 16				
17; 18				
19; 20				

Nr.	DELICATE		ROBUST	
1; 2				
3; 4				
5; 6				
7; 8				
9; 10				
11; 12				
13; 14				
15; 16				
17; 18				
19; 20				

Nr.	TRADITIONAL		MODERN	
1; 2				
3; 4				
5; 6				
7; 8				
9; 10				
11; 12				
13; 14				
15; 16				
17; 18				
19; 20				

APPENDIX 9: Conclusions WS4

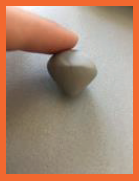
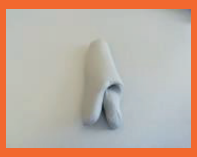
characteristic	properties	characterstic	properties
futuristic	Rather Sharp ends Abrupt surface changes with very smooth surface changes Grooves Slightly curved edges that end in sharp points	nostalgic	Forms are more referring to or forms that correlate with childhood (pokemon) or forms that correlate with previous art styles like Art Nouveau etc. Often a helix/ spiral shape These forms are very diverse
toy like	Mostly consisting of multiple forms Round shape with a hollow/s to put finger in Sometimes referring to toy like forms (bone for a dog) Mostly consisting of ball forms (but never alone! Always in context of multiple forms)	professional	Very geometric and basic forms like cubes and pyramids Often given a twist, like putting the forms on a side by applying a chamfer of some sorts Often given a twist, like putting the forms on a side by applying a chamfer of some sorts Mainly squares
aggressive	Very sharp edges (more sharp than futuristic) Often having difference in surface levels, connected by plain chamfers Sometimes consisting of multiple sharp ends Protruding parts Often having straight lines	calm	Very rounded forms Fluent shapes Very subtle and big spline changes Sometimes, they have slight surface changes. Very subtle! Often referring to stones rounded by rivers e.g.
male	Geometric shapes with slight softened edges Sometimes referring to a phallic form Very similar to robust, but more in balance in terms of symmetry Heavy forms	female	Very elegant curves= fluent and rounded Often referring to female parts of the body (like breasts, genital parts) Drop shape Not to be confused with fragile. Female forms are far from fragile: They often refer to some sort of balance
delicate	Very thin body structure combined with very thick body structure Sometimes consisting of seemingly multiple forms because of the thin-thick contrast Spaghetti/wire shape	robust	Geometric shapes but mostly referring to cube-ish forms Often having chamfers Often having flat surfaces (no rounded, convex, concave) but also combined with a slightly rounded surface (mostly just one) Compact
traditional	Often referring to art styles that are 'traditional' -> classical Poles Stars 'Old' forms, forms that have been used over the past 1000000 years Donut shape Balls and variation	modern	VERY geometric Barely having any changes to basic forms like cubes and cylinders Can be composed of multiple forms Fluent and organic curves/twist A "heading" shape - shape in look of an arrow

APPENDIX 10: Results WS5

characteristic	representative form	common features for the input forms	repetitive shape of the input form
traditional		balls with varietion of holes, poles	"bowl"
modern		basic geometeric bodies - prisms, cylinders, balls or curved and twisted organic fluent bodies	helix
aggressive		very sharp edges or ends	“sea mine”
calm		very round forms, subtle and big spline changes	"worm"
toy like		mostly consisting of ball forms, consisting of more shapes, shapes with holes for fingers	"snowmen"
professional		very geometric and basic forms like cubes and pyramids, flat square shapes	flat square
male		heavy geometric basic forms	cube, prism
female		very elegant curves, fluent and rounded	"drop"

characteristic	representative form	common features for the input forms	repetitive shape of the input form
robust		thick cylindrical or prismatic shapes	cylinder, prism
delicate		very thin body structure combined with very thick body structure	"arch", "wire shape"
futuristic A		slightly curved edges that end in sharp points, abrupt surface changes with very smooth surface changes	"space ship"
futuristic B			
futuristic C			"space ship"
nostalgic A		very diverse forms	
nostalgic B			"helix"
nostalgic C			"helix"

APPENDIX 11: Results WS6

1	step 0	step 1	AVERAGE	step 1	step 0	2
traditional						modern
aggressive A						calm A
toy like						professional
male						female
robust	 					delicate
futuristic A	 				 	nostalgic
futuristic B					 	nostalgic B
futuristic C						nostalgic C

APPENDIX 12: Template WS8

EPS 2018

WORKSHOP

MATERIAL TINKERING TEAM

SENSORIAL - INTANGIBLE MATERIALS -

Age:
Gender:
Nationality:
Field of study:

tangee

We are developing a tool in order to help the designers choose a material according to the sensorial and intangible characteristics of the materials. Please, follow, the instructions and if you have any questions do not to heasitate to ask us. We are looking for a neutral shape for the toolkit so don't hesitate to tick one of the neutral answers. Do not think too much about your answers, the first impression is usually the best. Thank you!

SHAPE A

EPS 2018
WORKSHOP
MATERIAL TINKERING TEAM

STAGE 1

Choose the option that, to you, fits best with this shape.

A	☐ TOY LIKE	☐ PROFESSIONAL	☐ NONE	☐ BOTH
B	☐ FUTURISTIC	☐ NOSTALGIC	☐ NONE	☐ BOTH
C	☐ AGRESSIVE	☐ CALM	☐ NONE	☐ BOTH
D	☐ MALE	☐ FEMALE	☐ NONE	☐ BOTH
E	☐ TRADITIONAL	☐ MODERN	☐ NONE	☐ BOTH
F	☐ DELICATE	☐ ROBUST	☐ NONE	☐ BOTH

Which associations do you make with this shape (other objects, animals, whatever)?

STAGE 2

Now explore the shape, you can use all of your senses.

Choose the option that, to you, fits best with this shape.

A	☐ TOY LIKE	☐ PROFESSIONAL	☐ NONE	☐ BOTH
B	☐ FUTURISTIC	☐ NOSTALGIC	☐ NONE	☐ BOTH
C	☐ AGRESSIVE	☐ CALM	☐ NONE	☐ BOTH
D	☐ MALE	☐ FEMALE	☐ NONE	☐ BOTH
E	☐ TRADITIONAL	☐ MODERN	☐ NONE	☐ BOTH
F	☐ DELICATE	☐ ROBUST	☐ NONE	☐ BOTH

Which associations do you make with this shape (other objects, animals, whatever)?

STAGE 3 -

What is the most PLEASANT and the most DISTURBING quality of this form?

pleasant

disturbing

tangee

SHAPE B

EPS 2018
WORKSHOP
MATERIAL TINKERING TEAM

STAGE 1

Choose the option that, to you, fits best with this shape.

A	☐ TOY LIKE	☐ PROFESSIONAL	☐ NONE	☐ BOTH
B	☐ FUTURISTIC	☐ NOSTALGIC	☐ NONE	☐ BOTH
C	☐ AGRESSIVE	☐ CALM	☐ NONE	☐ BOTH
D	☐ MALE	☐ FEMALE	☐ NONE	☐ BOTH
E	☐ TRADITIONAL	☐ MODERN	☐ NONE	☐ BOTH
F	☐ DELICATE	☐ ROBUST	☐ NONE	☐ BOTH

Which associations do you make with this shape (other objects, animals, whatever)?

STAGE 2

Now explore the shape, you can use all of your senses.

Choose the option that, to you, fits best with this shape.

A	☐ TOY LIKE	☐ PROFESSIONAL	☐ NONE	☐ BOTH
B	☐ FUTURISTIC	☐ NOSTALGIC	☐ NONE	☐ BOTH
C	☐ AGRESSIVE	☐ CALM	☐ NONE	☐ BOTH
D	☐ MALE	☐ FEMALE	☐ NONE	☐ BOTH
E	☐ TRADITIONAL	☐ MODERN	☐ NONE	☐ BOTH
F	☐ DELICATE	☐ ROBUST	☐ NONE	☐ BOTH

Which associations do you make with this shape (other objects, animals, whatever)?

STAGE 3 -

What is the most PLEASANT and the most DISTURBING quality of this form?

pleasant

disturbing

tangee

SHAPE C

EPS 2018
WORKSHOP
MATERIAL TINKERING TEAM

STAGE 1

Choose the option that, to you, fits best with this shape.

A	☐ TOY LIKE	☐ PROFESSIONAL	☐ NONE	☐ BOTH
B	☐ FUTURISTIC	☐ NOSTALGIC	☐ NONE	☐ BOTH
C	☐ AGRESSIVE	☐ CALM	☐ NONE	☐ BOTH
D	☐ MALE	☐ FEMALE	☐ NONE	☐ BOTH
E	☐ TRADITIONAL	☐ MODERN	☐ NONE	☐ BOTH
F	☐ DELICATE	☐ ROBUST	☐ NONE	☐ BOTH

Which associations do you make with this shape (other objects, animals, whatever)?

STAGE 2

Now explore the shape, you can use all of your senses.

Choose the option that, to you, fits best with this shape.

A	☐ TOY LIKE	☐ PROFESSIONAL	☐ NONE	☐ BOTH
B	☐ FUTURISTIC	☐ NOSTALGIC	☐ NONE	☐ BOTH
C	☐ AGRESSIVE	☐ CALM	☐ NONE	☐ BOTH
D	☐ MALE	☐ FEMALE	☐ NONE	☐ BOTH
E	☐ TRADITIONAL	☐ MODERN	☐ NONE	☐ BOTH
F	☐ DELICATE	☐ ROBUST	☐ NONE	☐ BOTH

Which associations do you make with this shape (other objects, animals, whatever)?

STAGE 3 -

What is the most PLEASANT and the most DISTURBING quality of this form?

pleasant

disturbing

tangee

SHAPE D

EPS 2018
WORKSHOP
MATERIAL TINKERING TEAM

STAGE 1

Choose the option that, to you, fits best with this shape.

A	☐ TOY LIKE	☐ PROFESSIONAL	☐ NONE	☐ BOTH
B	☐ FUTURISTIC	☐ NOSTALGIC	☐ NONE	☐ BOTH
C	☐ AGRESSIVE	☐ CALM	☐ NONE	☐ BOTH
D	☐ MALE	☐ FEMALE	☐ NONE	☐ BOTH
E	☐ TRADITIONAL	☐ MODERN	☐ NONE	☐ BOTH
F	☐ DELICATE	☐ ROBUST	☐ NONE	☐ BOTH

Which associations do you make with this shape (other objects, animals, whatever)?

STAGE 2

Now explore the shape, you can use all of your senses.

Choose the option that, to you, fits best with this shape.

A	☐ TOY LIKE	☐ PROFESSIONAL	☐ NONE	☐ BOTH
B	☐ FUTURISTIC	☐ NOSTALGIC	☐ NONE	☐ BOTH
C	☐ AGRESSIVE	☐ CALM	☐ NONE	☐ BOTH
D	☐ MALE	☐ FEMALE	☐ NONE	☐ BOTH
E	☐ TRADITIONAL	☐ MODERN	☐ NONE	☐ BOTH
F	☐ DELICATE	☐ ROBUST	☐ NONE	☐ BOTH

Which associations do you make with this shape (other objects, animals, whatever)?

STAGE 3 -

What is the most PLEASANT and the most DISTURBING quality of this form?

pleasant

disturbing

tangee

Absolute Values

	FORM A				FORM B				FORM C				FORM D			
	STAGE A		STAGE B		STAGE A		STAGE B		STAGE A		STAGE B		STAGE A		STAGE B	
	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENCE
NON-DESIGNER FEMALE	**12**	**10**	**13**	**7**	**14**	**8**	**12**	**6**	**14**	**8**	**11**	**7**	**10**	**12**	**11**	**11**
NON-DESIGNER MALE	**13**	**7**	**9**	**13**	**9**	**13**	**15**	**9**	**16**	**8**	**12**	**10**	**16**	**10**	**18**	**8**
DESIGNER FEMALE	**6**	**14**	**6**	**8**	**6**	**10**	**10**	**12**	**7**	**7**	**9**	**9**	**8**	**10**	**5**	**9**
DESIGNER MALE	**6**	**10**	**6**	**10**	**11**	**17**	**12**	**12**	**8**	**10**	**6**	**8**	**12**	**10**	**10**	**12**

Average1	9,25	10,25	8,5	9,5	10	12	12,25	9,75	11,25	8,25	9,5	8,5	11,5	10,5	11	10
	Average Neutralities		Average DIfferences		Average Neutralities		Average DIfferences		Average Neutralities		Average Differences		Average Neutralities		Average Differences	
Average2	8,88		9,88		11,13		10,88		10,38		8,38		11,25		10,25	
AvNeut-AvDiff	-1,00				0,25				2,00				1,00			

Percentage Values

	FORM A				FORM B				FORM C				FORM D			
	STAGE A		STAGE B		STAGE A		STAGE B		STAGE A		STAGE B		STAGE A		STAGE B	
	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENC	NEUTRALIT	DIFFERENCE
NON-DESIGNER FEMALE	**50**	**41,7**	**54,2**	**29,2**	**58,3**	**33,3**	**50,0**	**25,0**	**58,3**	**33,3**	**45,8**	**29,2**	**41,7**	**50,0**	**45,8**	**45,8**
NON-DESIGNER MALE	**43,3**	**23,3**	**30,0**	**43,3**	**30,0**	**43,3**	**50,0**	**30,0**	**53,3**	**26,7**	**40,0**	**33,3**	**53,3**	**33,3**	**60,0**	**26,7**
DESIGNER FEMALE	**25,0**	**58,3**	**25,0**	**33,3**	**25,0**	**41,7**	**41,7**	**50,0**	**29,2**	**29,2**	**37,5**	**37,5**	**33,3**	**41,7**	**20,8**	**37,5**
DESIGNER MALE	**20,0**	**33,3**	**20,0**	**33,3**	**36,7**	**56,7**	**40,0**	**40,0**	**26,7**	**33,3**	**20,0**	**26,7**	**40,0**	**33,3**	**33,3**	**40,0**

Average1	34,6	39,2	32,3	34,8	37,5	43,8	45,4	36,3	41,9	30,6	35,8	31,7	42,1	39,6	40,0	37,5
	Average Neutralities		Average DIfferences		Average Neutralities		Average DIfferences		Average Neutralities		Average Differences		Average Neutralities		Average Differences	
Average2	33,4		37,0		41,5		40,0		38,9		31,1		41,0		38,5	
AvNeut-AvDiff	-3,5				1,5				7,7				2,5			

APPENDIX 14: Results WS8 Table 2

SHAPE B: TRIANGLE

DESIGNERS

stage 1

TOYLIKE		PROFESIONAL	6	NONE	2	BOTH	
FUTURISTIC	8	NOSTALGIC		NONE		BOTH	
AGRESSIVE	4	CALM	3	NONE	1	BOTH	
MALE	3	FEMALE	1	NONE	3	BOTH	1
TRADITIONAL		MODERN	7	NONE	1	BOTH	
DELICATE	1	ROBUST	2	NONE	5	BOTH	

ASSOCIATIONS	
Duck foot	1
door stop	1
Allien	1
None	1
Transport vehicle	1

stage 2

TOYLIKE	1	PROFESIONAL	6	NONE	1	BOTH	
FUTURISTIC	6	NOSTALGIC	1	NONE		BOTH	1
AGRESSIVE	1	CALM	3	NONE	1	BOTH	3
MALE	1	FEMALE	1	NONE	4	BOTH	2
TRADITIONAL	1	MODERN	6	NONE		BOTH	1
DELICATE	1	ROBUST	2	NONE	3	BOTH	2

ASSOCIATIONS	
Drop	2
Shoe	1
None	1
Door stop	2
Clothes clip	1

QUALITIES			
PLEASANT		DISTURBING	
Touching it with both hands	1	Too small	1
Symetric	2	None	1
Surfaces are seperated but togheter they make a Flowing form	1	Different diameter of the basic circle curve	1
	1	Too sharp edges	1

NON-DESIGNERS

stage 1

TOYLIKE	1	PROFESIONAL	5	NONE	1	BOTH	
FUTURISTIC	5	NOSTALGIC	1	NONE	3	BOTH	
AGRESSIVE	2	CALM	2	NONE	5	BOTH	
MALE	2	FEMALE	2	NONE	5	BOTH	
TRADITIONAL		MODERN	6	NONE	3	BOTH	
DELICATE	2	ROBUST	3	NONE	4	BOTH	

ASSOCIATIONS	
None	2
Tilt	1
Clothes pin	2
Relaxing object	1
Study	1
Eraser	2
Pyramid	2
Stone	1
Guitar pick	1

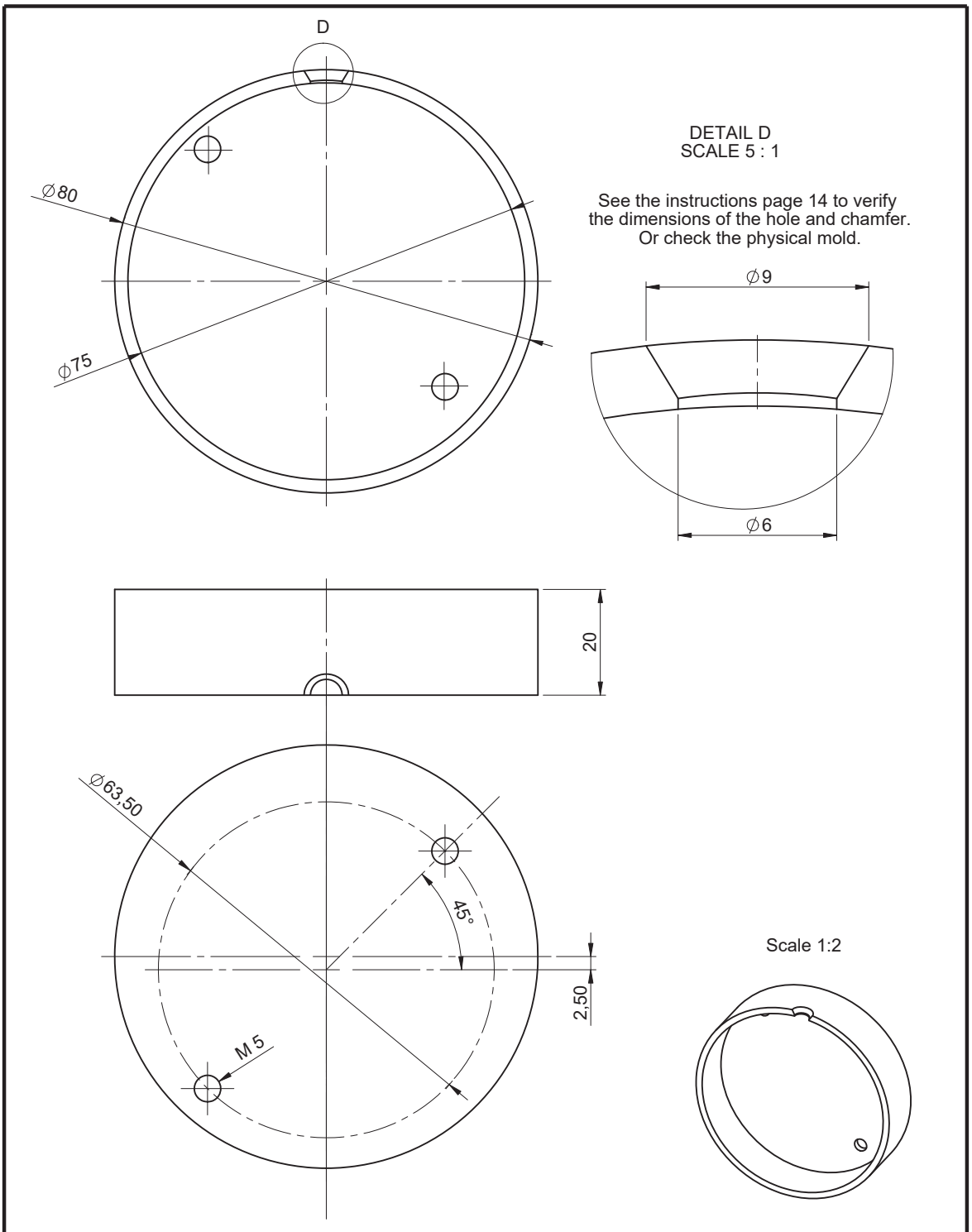
stage 2

TOYLIKE	2	PROFESIONAL	5	NONE	1	BOTH	1
FUTURISTIC	5	NOSTALGIC	1	NONE	3	BOTH	
AGRESSIVE	1	CALM	1	NONE	5	BOTH	2
MALE	1	FEMALE	5	NONE	8	BOTH	
TRADITIONAL	1	MODERN	5	NONE	3	BOTH	
DELICATE	1	ROBUST	4	NONE	3	BOTH	1

ASSOCIATIONS	
Eraser	1
Tilt	1
Clothes pin	2
Defined rocks	1
None	1
Door stop	1
Futuristic car	1
Mobile phone support	1
Wissel	1
Guitar pick	1
Pyramid	1
Tipex	1

QUALITIES			
PLEASANT		DISTURBING	
Handle	1	None	2
Thick of surfaces	1	Size	1
None	1	Confusion	2
Shape	1	Touch	1
Symetric	1	All flat surfaces	1
Playful	1	Asymetric for handle	
Touching both sides	1		

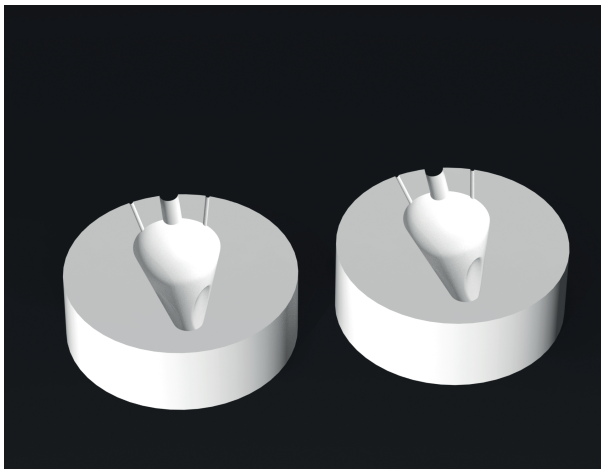
APPENDIX 15: Technical Drawing Mould Support



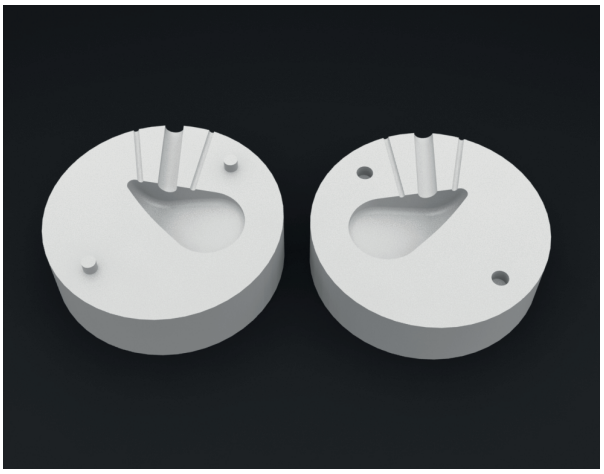
		Data	
Autor	Material Tinkering EPS	07/05/2018	Universiteit Antwerpen
Tutor	XX		
	Nom Projecte: Mold support		Nº Plànol: XXX.00_00.00_0
Escala 1:1	Descripció: XX		Material: XX
Pes XXXg			Tractament / Acabat: XX / XX

APPENDIX 16: Pictures Renders Moulds

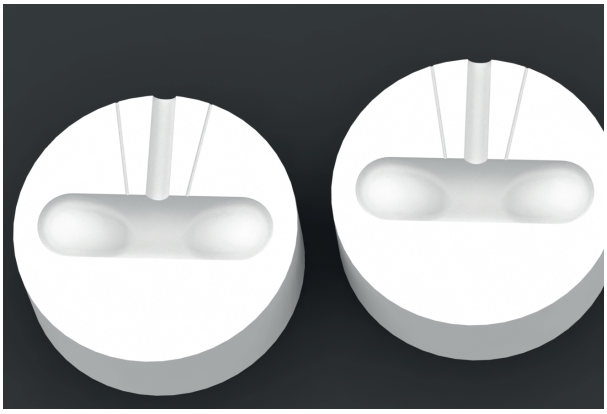
Render Mould Shape A, Avocado



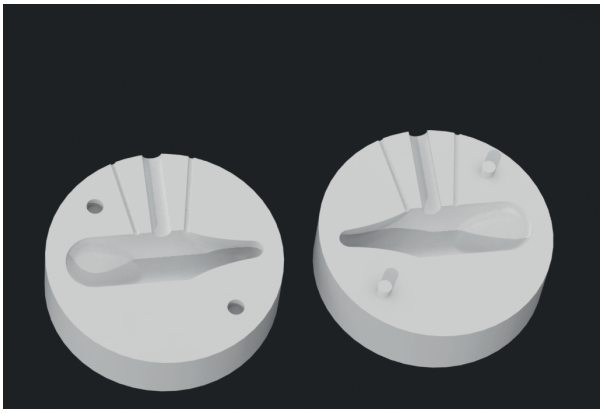
Render Mould Shape B, Triangle



Render Mould Shape C, Plain

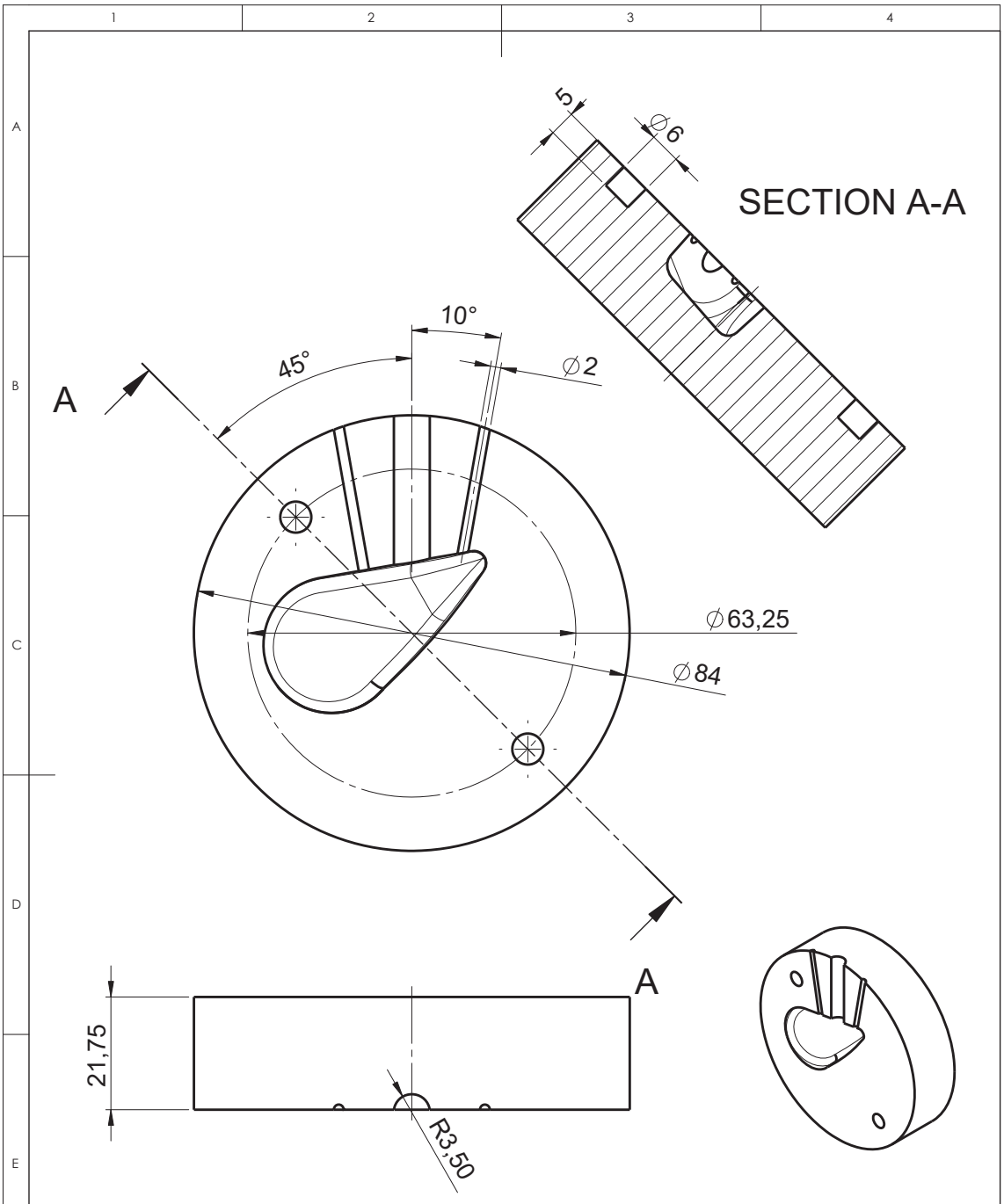


Render Mould Shape D, Twist



APPENDIX 17: Technical Drawing Mould Form B

We were not able to make technical drawings of all the moulds because of errors in SolidWorks.



			Universiteit Antwerpen		Materiaal: XXXX	Algemene tolerantie DIN ISO	
					Oppervlaktebehandeling: XX	Oppervlakteruwheid vlg. DIN ISO 1312	
				Datum:	Naam:		
Rev.	Datum	Omschrijving	Get.:	5/06/2018	XX.XX.XX	Tekeningnummer: XXXX	XX
			Gecon.	XX.XX.XX	XX.XX.XX		
Universiteit Antwerpen Ontwerpwetenschappen Ambtmanstraat 1 2000 Antwerpen			Schaal: 1:2		Blad: 1 / 1	Benaming: XXXX	A4
						Filenaam: Jane_triangle_female	Massa: kg

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