PARAMETRICS AND THE MASCULINE

EXPLORING CONTEMPORARY MASCULINE QUALITIES THROUGH A PARAMETRIC DESIGN APPROACH

How might parametric design be utilised to express qualities of contemporary masculinity in men's products?

A 90-point thesis submitted to the Victoria University of Wellington in partial fulfilment of the requirements for the degree of Master of Design Innovation in Industrial Design

by

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ABSTRACT

This research examines the potential of parametric design and contemporary design practice according to the following question: "How might parametric design be utilised to express qualities of contemporary masculinity in men's products?" The goal of the research is to suggest a strategy that may be applied to contemporary design practise in order to more effectively support male consumer's identities, needs, and desires. This is addressed through a case study that prioritises the expression of contemporary masculinity and related qualities in the consideration of the employed materials, form and design details. In developing this research, participant interviews, and a series of questionnaires were utilised to gather responses leading to the construction of material photo studies and data visualizations. Based on the data collected, a parametric definition was developed that supports the customisation of product containers in addressing the expression of contemporary masculine qualities. The parametric definition was applied in the design of a series of initial product prototypes that expressed the contemporary masculine qualities as identified by participants. The prototypes were subsequently assessed through participant interviews alongside a series of material swatches of varying surface qualities. Feedback from the interviews led to refinements in the product container designs within the parametric interface and the generation of a series of higher fidelity digital prototypes. These prototypes sought to effectively reflect the participant's interpretations regarding the expression of contemporary masculinity.

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INTRODUCTION

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Parametric design is an aspect of CAD software that provides the designer with variable control of the digital model at any stage of the design process. Parametric design plays an important role in the flexibility afforded by computer aided design (CAD) technologies, as it enables product design and development to be simultaneously addressed in the generation of complex, unique and personalised objects. Parameters govern the model within a parametric definition, and can be defined by "dimension, geometry, or algebra driven constraints" (Camba, Contero, & Company, 2016, p. 18). Through parametric design, the designer is able to quickly iterate while still producing an accurate, modifiable, digitally controlled model. A major benefit of this approach is that alterations and customisation of the design can be made right up to the point of manufacture. Parametric design is no longer solely used within the architecture and design practise, and has been made available online through web interfaces for consumer customisation and the tailoring of products. Through the development of parametrically optimised web-based interfaces, consumers are able to customize and tailor products more easily.

This thesis explores the potential of parametric design tools and interfaces in enabling the customisation of material, form, and design detail considerations, addressed through a case study that prioritises the expression of contemporary masculinity and the effective expression of related qualities and attributes. The goal of this research is to suggest a strategy that may be applied to contemporary design practice in more effectively supporting consumer's identities, needs, and desires.

THE VALUE OF THE RESEARCH

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This research is important as it seeks to highlight New Zealand male perspectives of contemporary masculinity, while simultaneously addressing the needs of the consumer through offering customisation options in the materials, form and design details employed within products. This is done in an effort to address the consumer needs and express their interpretation of contemporary masculinity rather than imposing a prescribed model of 'branded' masculinity on them, which is the case for a number of male grooming products available commercially. Although parametric product customisation already exists in a number of online websites, the primary goal is to more effectively support consumer's identities, needs, and desires through an exploration of contemporary masculinity and its related qualities. The research carried out sought to discover which contemporary masculine qualities were important to participants, and develop a parametric definition to enable the customisation of products in expressing the identified qualities in the employed materials, form and design details of products. The function of an object plays a role in the perception of the expressed qualities (Karana, Owain, & Rognoli, 2013), therefore the object being customized needed to be abstract to better allow for the expression of contemporary masculinity in material, form and design details. It was determined that complex electronic products relying highly on function may become unusable if extensively customized; which is a secondary reason for why the product containers were selected as the object of focus, due to the abstracted nature and simplicity of the function.

AIMS AND OBJECTIVES

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AIMS	OBJECTIVES
1. To identify the expression of contemporary masculine qualities in material, form, and design details.	- Gather data through participant interviews incorporated as a part of an adapted 'Meanings of Materials' (MOM) tool (Karana, Hekkert, & Kandachar, 2010). - Analyse the collected participant data through the construction of data visualizations and photo studies paired with verbal responses.
2. To develop a strategy for the application of parametric tools and manufacturing processes that cater to the ranging desirable contemporary masculine qualities.	- Through the inclusion of literature reviews, identify and critique existing methods of manufacture to determine the most suitable option for the expression of a range of qualities through a parametric design approach. - Prototype through a parametric design approach a definition that enables the customisation of form and design detail considerations within a digital model.
3. Develop and manufacture a series of product prototypes and material swatches that effectively express contemporary masculine qualities.	- Assess initial product prototypes and material swatches through interviews. - Produce a final set of prototypes representing the range of participant responses to the initial prototypes and material swatches.

LITERATURE REVIEW

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The literature review included in this thesis has aided in providing background research in the areas relating to the research question: "How might parametric design be utilised to express qualities of contemporary masculinity in men's products?" The review of literature undertaken investigates the following sections; contemporary masculinity, mass customisation, parametric design, digital manufacturing, mass manufacturing, and materiality. The literature review has been constructed in a manner that indicates how each topic relates to the research question and aids the gathering and critique of relevant areas of existing research, grounding the key arguments, as well as identifying gaps in knowledge.

CONTEMPORARY MASCULINITY

Men's grooming is set to be one of the fastest growing categories in the beauty and personal care sector, which is largely attributed to the globally changing attitudes of men about grooming and self-care (Lennard, 2010). McNeill's and Douglas' (2011, p. 448) study found that:

> (2003) Growth in the male grooming market has been also attributed to an increased societal focus on appearance (Sturrock and Pioch, 1998); a growing number of men's style magazines (Byrnes, 2006); an increase male grooming product availability (Thompson, 2006 and Alexander, 2006) and the global health and well-being trend of looking after oneself (Thompson and Hirschman, 1995).

This research area, when investigated through the lens of design technology offers potential for customisation of products based on the male consumer's personal needs. In a study of the portrayal of masculinity in men's magazines, Alexander (2003) observed that the vast majority of men's grooming products only represented a single model of idealised masculinity, where the profits were prioritised. This approach results in expressing a form of masculinity that develops and promotes insecurities in men while simultaneously offering the solution in the form of consumer products. As a result, a gap in the market was identified in the availability of products that seek to effectively express the evolving and diverse nature of contemporary masculine identities.

Masculinity is a concept that is constantly undergoing change in regards to the roles, behaviours and qualities prescribed and are expected of men (Kimmel & Aronson, 2003). It is a societal construct and is hard to define as it is influenced by factors such as race, ethnicity, class, nationality, age and religion (Alexander, 2003). This definition for masculinity only highlights how masculinity is constructed, and not what the various masculine perspectives are, as masculinity is always changing and evolving. While the purpose of this research is not to define the full breadth of masculine perspectives, it has required the identification and collation of key qualities as they relate to material, form and design details.

A key issue with contemporary masculinity is that the expression of masculinity has been idealised, setting unattainable standards for men to reach. Through "Hollywood films, television programs, male lifestyle magazines, action toys, and sports" an unrealistic, idealised masculinity has been promoted (Pompper, 2010) and this undermines men's identity and self-image (Pompper, 2010, p. 684). The metrosexual image, which became popular in the late 1990's is an example of a form of idealised masculinity, where priority is placed on the appearance and lifestyle of men. This results in image-conscious men, who feel obliged to spend a considerable amount of money on consumer grooming products (Simpson, 2002). Within The Metrosexual Guide to Style: A Handbook for the Modern Man (Flocker, 2003, p.1), metrosexuality is defined as the following;

1: twenty-first century male trendsetter
2: straight, urban male with heightened aesthetic sense
3: man willing to spend time and money on appearance and shopping
4: man willing to embrace his feminine side

BRANDED MASCULINITY

The metrosexual perspective highlights the role consumerism plays in the construction of masculine identity. In a study by Pompper (2010), researchers found that men were unable to meet the standards of the metrosexual, in regards to the idealised body images promoted by the media, and as a result this left them feeling anxious, confused and frustrated. The image of the metrosexual man is just one of the many forms of idealised masculine identities that have impacted mainstream masculine culture over the last thirty years. Crewe (as cited in Tan, Shaw, Cheng, Ko Kim, 2013) stated that during the 1980's in western cultures men's lifestyle magazines were a major contributor in the portrayal and presentation of new masculinities through commercial product centric advertising. Segal (as cited in Tan et al., 2013) stated that the growth of men's personal care and fashion industries, led to masculinities being represented in lifestyle magazines where emphasis was placed on men's grooming, appearance, and fashion. Kolbe and Albanese (as cited in Tan et al., 2013) further reinforce the idea that this was achieved through the use of idealised images of men within advertising. The presentation of masculinity through the media is largely based in the images that accompany the products being marketed, and not the products themselves. Rather than providing a product that effectively addresses men's wants and needs, a desire to live up to the standard is fostered through idealised product marketing that aims to alter men's self-image and results in the need for men to attain and uphold this image.

Alexander (2003) defines masculinity that is based on and driven by consumer consumption as "branded masculinity". Branded masculinity is shaped by consumer culture and targets consumer choices with a focus on the physical appearance of men (Tan et al., 2013). It has been suggested by researchers Boni and Ricciardelli (as cited in Tan et al., 2013) that branded or consumption based masculinity is a global phenomenon. Boni (as cited in Tan et al., 2013) states that this results in global media representing a limited and prescribed model of branded masculinity, which is adapted to fit the markets of each country. Companies use branded masculinity in an effort to increase sales and the resulting profits (Alexander, 2003). This limits the expression, understanding and acceptance of an authentic form of contemporary masculinity. Furthermore, the global media and male cosmetic beauty companies who seek to turn male insecurities into profits have been largely attributed in the development of disorders such as body dysmorphia (Alexander, 2003). Another common example of a disorder resulting from branded masculinity is "the Adonis Complex", coined by Pope, Phillips, and Olivardia (2000). This disorder is described by common body image concerns that men do not share publicly. These body image concerns range from the need to: build bigger muscles, reduce fat, achieve a six pack of abs, and maintain a head of hair.

This research considers the implications of branded masculinity and proposes a parametric strategy that allows individuals to define a customisable design solution to meet their needs as contemporary male consumers. Branded masculinity has shaped the identities of consumers and has denied the individual expressions of men. This research argues that it is important to support consumers, and particularly men, in defining their own identities as expressed in and through consumer products, and that parametric tools and processes have the potential to facilitate this need. The research undertaken seeks to express contemporary masculine qualities through the parameterized design of products in regards to materiality, form and design detail. The qualities applied in this research are based on the perspectives of New Zealand men rather than on stereotypes put forth by global media or companies.

MASS CUSTOMISATION

The ability to meet the needs and desires of individual consumers has become a key area of focus as companies are faced with the growing trend of mass customisation. Modern consumers are increasingly seeking to express their self-identity and anticipate products that will meet their specific needs. As a result, many companies are coming to terms with the necessity to address the needs and desires of consumers at an individual level, while also maintaining the efficiency of mass manufacturing (Piller & Muller, 2004). An important innovation that aided in the development of mass customisation was the access to web-based interfaces that allowed the consumer to be an active participant in the design of their products. Online customisation provides consumers with more control in the tailoring of a product to suit the individual's preferences, which can then be produced exclusively for them (Frank & Schreier, 2007). By offering a range of different options in the characteristics of products, the needs of the consumer can be better addressed (Piller & Muller, 2004). The consumer's primary concern within this system, is the custom tailoring of the product, as the production is the responsibility of the manufacturer (Franke, Schreier, Kaiser, 2010). Mass customisation meets the needs of the consumer by allowing them to express their individuality through enabling choices, and as a result, provides the means to reject product standardisation and branded masculine identity.

Dell and Nike were both early adopters of mass customisation. In the early 1990's, Dell was one of the first companies to capitalize on the potential of using the web to enabling the customer to be an active participant in the generation of economic value (Berman, 2002). The Dell website allowed consumers to select which components they required. This provided them with the means to assemble their own customized computer according to their individual preferences. Nike was the first sportswear company to offer mass customisation, which was made available to consumers in the form of NIKEiD in 1998 (Stoetzel, 2012). NIKEiD (www.nike.com/us/en_us/c/nikeid) is an extension of the NIKE website that enables customers to customize various nike shoes. Options for customisation include; colour, material, design and the performance aspects of the shoes. NIKE announced that by the end of the 2009 fiscal year the NIKEiD co-creation platform generated over $100 million in revenue (Wong, 2011). Dell and Nike have adopted online mass customisation as a part of their business strategy. This research hypothesizes that the flexibility afforded by parametric design can be further explored and benefit the expression of a range of qualities through online consumer customisation. This will sought to be accomplished through offering customisation through a parametrically optimised interface that focuses on the employed materials, forms and design details of products, with the aim of more effectively addressing the evolving needs of contemporary male identities.

PARAMETRIC DESIGN AND DIGITAL MANUFACTURING

Parametric design is algorithmic, consisting of a set of parameters and instructions defined by the designer and subsequently executed by the computer in a sequential process. Within contemporary architecture and design, parametric design is considered to be the generative aspect within CAD software that allows the designer to have control during every stage of the design process. The result is a digitally controlled model that is set up for future modifications as necessary. In his foreward, Fulvio Wirz, explains that generative parametric design is not a new process; designers have been using this approach in design for more than 20 years, but the focus has been predominantly on efficiently and flexibility in building rather than at a consumer product level (Tedeschi, 2014). Parametric design has been identified as a way that designers can move away from repetitive editing within software, and as a way of exploring a range of solutions. Designers realised this approach "could manage complexity beyond human capabilities" (Tedeschi, 2014, p. 22) and that, through the utilisation of parametric design, the designer can allow for a range of solutions which aids in iterative process as well as the customisation of the product.

Cardoso (2010) explains that computer aided design (CAD) software and digital manufacturing technologies afford small-scale batch production to be a viable method of manufacture within the industrial context (as cited in Adamson, 2010). Product design, development and manufacturing are able to be carried out more efficiently and rapidly through the inclusion of digital design and manufacturing as a part of the process (Chryssolouris et al., 2009). This method of manufacture, when directed through a parametric process, addresses the "need for customisation, increased product quality, and faster response to the market" by bringing the product and process together in the digital environment (Chryssolouris, Mavrikios, Papakostas, Mourtzis, Michalos, & Georgoulias, 2009. p. 1; Hufstetler. 2005).

MANUFACTURING

The majority of products in today's commercial environment are produced through mass manufacturing technologies. In the early years of mass manufacturing the produced objects were typically inferior to those produced by traditional methods of fabrication and hand craft. As David Pye noted in The Nature and Art of Workmanship, "This is far from true now" (Pye, 1968, p. 7). The quality of work produced by the early twentieth century increased with the development of mass manufacturing technologies, to a point where it had surpassed what could be achieved through craft (Pye, 1968). However Cardoso (2010) discusses that the primary focus of mass manufacturing prioritises machine production speed, accuracy and efficiency over quality (as cited in Adamson, 2010). The rise of contemporary mass manufacturing led to a change in the approach in manufacture, resulting in a shift from celebrating the variability in objects, to producing the standardized, repeatable, perfect form and finish on a large scale (Karana, Pedgley, & Rognoli, 2015). 'Perfect' machined, material finish is a dominant feature of mass production. Cardoso (2010) stated that the resulting finish achieved by mass manufacturing technologies and processes set a new aesthetic standard for designers, who reinforced the notion that the machine made was as "attractive as it was efficient and cheap" (Adamson, 2010, p. 327).

Traditional mass manufacturing technologies enable the production of a larger volumes at lower costs, in the production of standardized repeatable objects. The standardization of these objects, however, limits the expression of diverse qualities. David Pye reinforces this in stating that "the range of qualities which mass production is capable of just now is so dismally restricted: because each is so uniform and because nearly all lack depth, subtlety, overtones, variegation, diversity" (Pye, 1968, p. 3). Although Industrial mass manufacturing processes enable a range of materials to be used, this type of mass-manufacture lacks flexibility in material choices and does not allow for customisation at an individual product level. The result is products that are limited in their ability to effectively express variations in the material, form and design detail of objects, to the degree necessary to appropriately reflect consumer's diverse identities.

MATERIALITY

The standard design and manufacturing processes utilised in industrial production are no longer suitable in the expression of consumer's contemporary needs. While mass-manufacturing is superior when it comes to producing a large number of objects that require repeatability, it is not appropriate when manufacturing for the expression of a diverse range of qualities. The products marketed through branded masculinity are generally produced through mass manufacturing, which express qualities associated with the process and predetermined designs that are dictated by corporate entities. The tools and processes available within the contemporary manufacturing context, however, offer enormous potential in facilitating this growing need. This is especially true through the flexibility and customisation afforded by Computer-Aided Design (CAD) and, in particular, parametric design and digital manufacturing. Digital manufacturing when paired with parametric design provides an ideal environment for the embedding of diverse qualities through the design and manufacture phases. In response to the widespread standardisation of design and manufacturing and the resulting limitations to personalisable qualities expressed in products, this research argues that the customisation of qualities afforded by parametric tools and processes as applied to digital manufacturing deserves greater investigation in regards to its practical application.

Materiality has been addressed as a critical parameter within the design and manufacture of objects, and can be defined by "what the object is made of and how it's manifested, affecting the form, function, and the experience of the final design" (Doordan, 2003, p. 3). The background research on material presented in this thesis is based on the work of Dr. Elvin Karana and focuses on material meanings and selection. Karana's research on 'material experience' addresses how materials obtain and express certain meanings through participant perspectives on material experience and the 'Meanings of Materials' selection tool (2010).

Designers can achieve deeper emotive user-product interactions when materials are strategically employed (Gant, 2005). There are already a number of tools that have been established to aid in the material selection process, but the majority of them are engineering based and rely on quantifying numerical technical data (Farag MM, 1989; Ashby MF et al. 2005). This approach, however, is not necessarily adequate for designers who design with intangible qualities in mind such as "product personality, user-interaction, meanings, emotions in their material decisions" (Karana et al., 2010, p.1). Doordan (2003) outlined a framework for material selection, addressing the intangible qualities of materials. "I suggest, a new framework for the discussion of materials based on the triad: fabrication, application, and appreciation" (Doordan, 2003, p. 6). The focus was on how material choice and these three key factors affect the form, function, and perception of the final design.

When working with the framework researchers recognised that refinement was necessary because a simple listing of the terms did not fully articulate the dynamic relationship, interplay, and overlap between the terms of fabrication, application, and appreciation (Doordan, 2003). The 'Meanings of Materials' (MOM) tool was developed to aid designers in material selection when designing with intangible qualities in mind (Karana et al., 2010). The tool involves participants taking part in interviews, submitting photos which represent the quality/meaning sought after, and completion of questionnaires which assess the materials based on their physical properties. The tool requires the interaction between participant and designer/ researcher, with the aim of constructing a database of materials that express the chosen/ desired meanings. This requires participants to provide material images, provide a verbal explanation why and how the material expresses the given meaning, and to assess the material in regards to its sensorial/ physical properties using a five-point questionnaire. An adapted MOM tool was included as a core part of the methodology within this research, where form and design detail consideration components were added following the same format of the initial material section within the MOM tool.

Over recent years, the appreciation of materials has gained a lot of attention from the design sector as design for emotion and the celebration of intangible qualities has become more prevalent. 'Materials experience' was first coined by Karana et al. (2013) and is defined as: "the experiences people have with, and through the materials of a product" (p.18). This definition builds upon the term appreciation to include the sensorial experience of materials in its definition.

In product development, it is usually the industrial designer's role to cater to user experiences in regards to material selection. The designer defines the experience of materials for users according to a predefined context of use (Karana et al., 2013). Many of today's consumer products do not take advantage of the full range of materials and processes available to the contemporary designer, and this has resulted in products that are lacking in qualities and attributes that have the potential to create a meaningful material experiences. Designing for the sensorial experience of materials seems like a missed opportunity, and in response to these limitations, many designers have contributed to a shift in direction from mass production towards an aesthetic movement that embraces and holds variability in products in high esteem (Karana et al., 2013).

As this research is based of the work of Dr. Karana, the concept of material experience is a key aspect of the thesis in regards to the embedding and expression of masculine qualities. Through the application of an adapted MOM tool, the identified masculine qualities aim to be embedded and expressed through material, form, and design detail considerations.

The review of literature has been invaluable to the development of this research in providing a comprehensive context of the many considerations that factor into the application of parametric tools and processes in contemporary product design and manufacturing. The focus on men's grooming products is an area identified lacking in adequate expression of contemporary identities, and this has served as a viable case study for this investigation. Through gaining an understanding of the evolution of technologies relevant to design and manufacturing, this research is able to better situate itself in regards to the possibilities of these technologies in contemporary practice. Of particular value in regards to methodology is the inclusion of MOM tool (Karana et al., 2010), a material selection tool that has been adapted to include form/ proportion and design detail considerations. The parametric design tools and processes applied in the design development reflect participant responses according to this method in the development of a parametrically optimised interface that effectively exemplifies the research proposition.

METHODOLOGY

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The research objective is to investigate "How might parametric design be utilised to express qualities of contemporary masculinity in men's products?" The current research project is qualitative in nature. In addressing this, the research utilizes a number of methodological approaches. The majority of the research methods employed have been appropriated from the 'Meaning of Materials' (MOM) tool which was developed by Karana et al. (2010). This tool was adapted to extend the scope from the selection and evaluation of material to include form and design detail considerations as well. This adapted tool led to the development of a parametric definition which offered customisation in the form and design details of product containers. Within the MOM tool, Karana et al. (2010) employs; interviews, questionnaires and photo collages in the gathering and presentation of data.

STAGE 1.

Fig 5.1 - Participant material and form/ proportion Interviews

INTERVIEWS

Interviews were a vital part of the research, used to gather data and responses on participant perspectives on the expression of contemporary masculinity in material, form and design detail considerations. The interviews were conducted individually with nine male participants, where questionnaires were included as an element within the process. Participants were prompted prior to the interview to think about three different materials which they felt best expressed contemporary masculinity. At the beginning of the interview, participants were asked to do a web search for close up images for each of the three materials that they thought best expressed contemporary masculinity. After the participants had chosen their three materials, the interview began with the following opening question: "How do you feel the materials you have chosen express qualities of contemporary masculinity?" This question framed the interview between the researcher and participant, which led to an informal discussion. Participants were encouraged to describe how the qualities of each selected material related to their perception of contemporary masculine qualities, and were asked to elaborate on any aspect of their choosing.

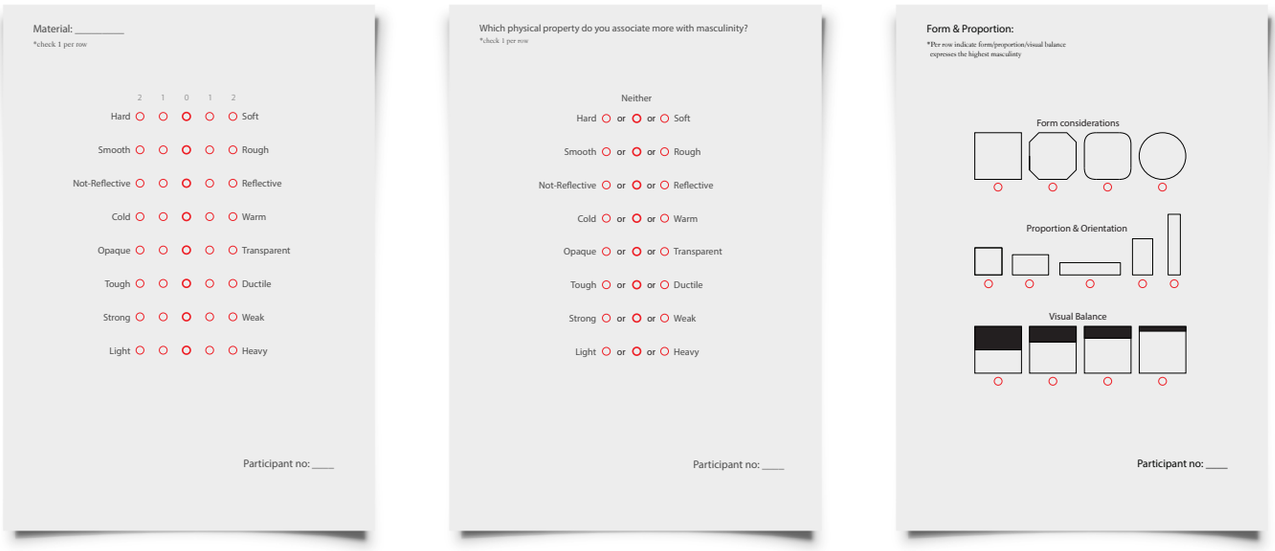


Fig 5.2 - Material, material property, and form/ proportion questionnaires

QUESTIONNAIRES

Referencing the three selected material images, participants were given a questionnaire sheet for each and asked to evaluate the materials based on their physical properties. Over the course of the interview process, participants completed a total of three different questionnaires which were all based on the MOM tool (Karana et al., 2010). The first questionnaire required participants to assess each material based on eight physical properties pairs. It included a five-point scale for each physical property pair, ranging from one extreme to the opposite. Participants indicated the degree for the eight pairs of the physical properties for each material sample. The material pairs included within the questionnaire were;

- Hard to soft
- Smooth to rough
- Not-reflective to reflective
- Cold to warm
- Opaque to transparent
- Tough to ductile
- Strong to weak
- Light to heavy

Upon completion, participants were given a second questionnaire which required them to indicate for each physical property pair which property they felt best represented contemporary masculinity, with the option for neither if they felt there was no standout property. The third questionnaire addressed form and proportion. The questionnaire contained three sections: formal considerations, proportion/ orientation, and visual balance. Participants were required to indicate which of the options in each category best expressed contemporary masculinity. If participants felt there were two that were equally expressive, they were able to select both. The questionnaires were a vital part of the research project which generated responses which aided in the evaluation of participant perceptions of expressed contemporary masculinity of the material samples, physical material properties, and form and proportion considerations. This enabled the construction of material palettes and the development of the parametric interface which led to the generation of a series of container prototypes that sought to express contemporary masculinity though material, form and design detail.

STAGE 2.

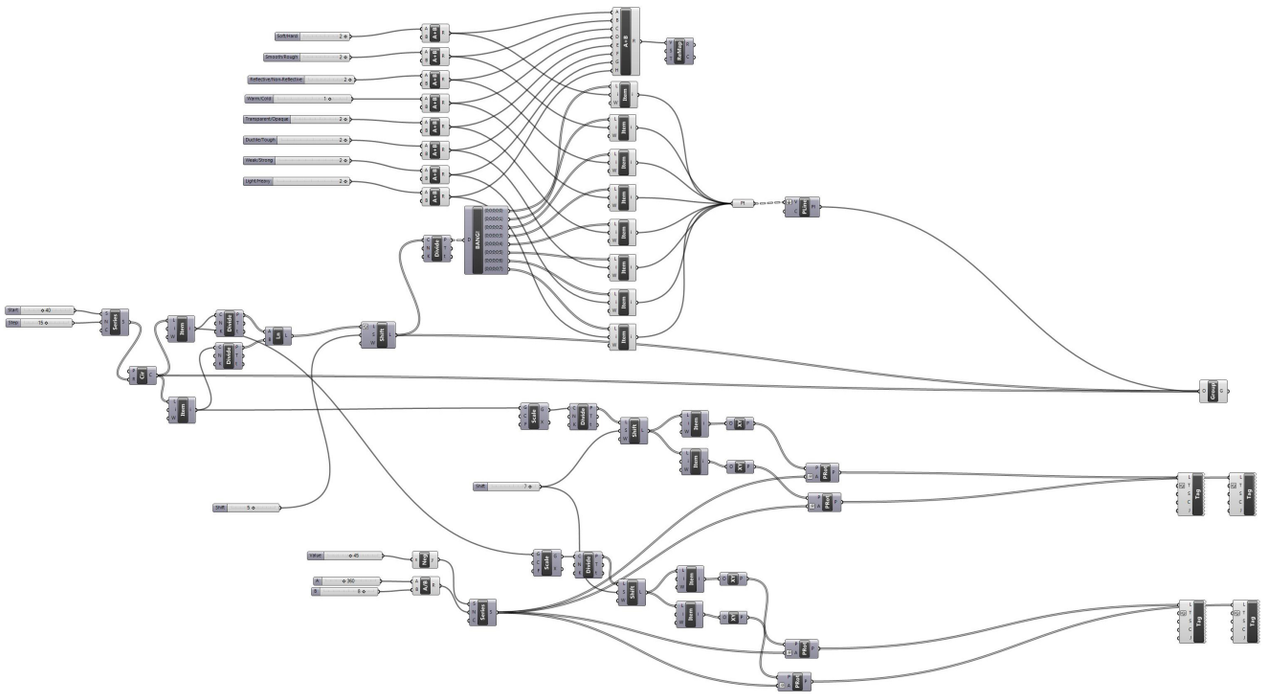


Fig 5.3 - Polar diagram parametric definition

PROTOTYPING

Prototyping was used extensively in the generation of data visualizations and the development of the parametric definition. Parametric definitions were built so the results from the participant questionnaires results could be directly input into the definition, which auto generated the graphs and the twenty-seven polar diagrams.

CAD software coupled with parametric design enabled the development and construction of the interface that offered parametric control of the digital model. The parametric definition offers customisation in the form and design detail considerations of the product containers. The considerations that the interface addresses are:

- X, Y, and Z dimensions
- Form consideration (box, fillet, or chamfer)
- Degree of fillet or chamfer
- Wall thickness
- Ratio between lid and container

This led to the creation of an initial set of prototypes that were shown to participants in conjunction with four sets (wood, metal, leather, and concrete) of material swatches. This enabled participants to further articulate their perspectives on the expression of contemporary masculinity in material, form and design detail. There were three material swatches for each category, demonstrating differing surface qualities which were sorted by each of the nine participants from most masculine to least. Both the initial product prototypes and material swatches were used to develop and refine the features needed in the parametric definition. Once updated, the parametric definition was used to generate a final set of product prototypes.

Fig 5.4 - Participant interview, swatches assessment and sorting

INTERVIEWS

As the last part of this stage of research, participants were involved in a final interview. Within this interview participants provided verbal assessments of an initial set of three physical product prototypes according to the criteria identified in the previous stage regarding the material, form and design detail considerations. Following this assessment, participants were asked to sort and verbally assess a series of material swatches from most masculine to least. There were four categories applied to the material swatches: wood metal, leather and concrete. Each of these included three samples of varying surface qualities for each. This concluding interview was undertaken if an effort to discover how the developed parametric definition and resulting physical prototypes could be improved in order to better express contemporary masculine qualities.

STAGE 3.

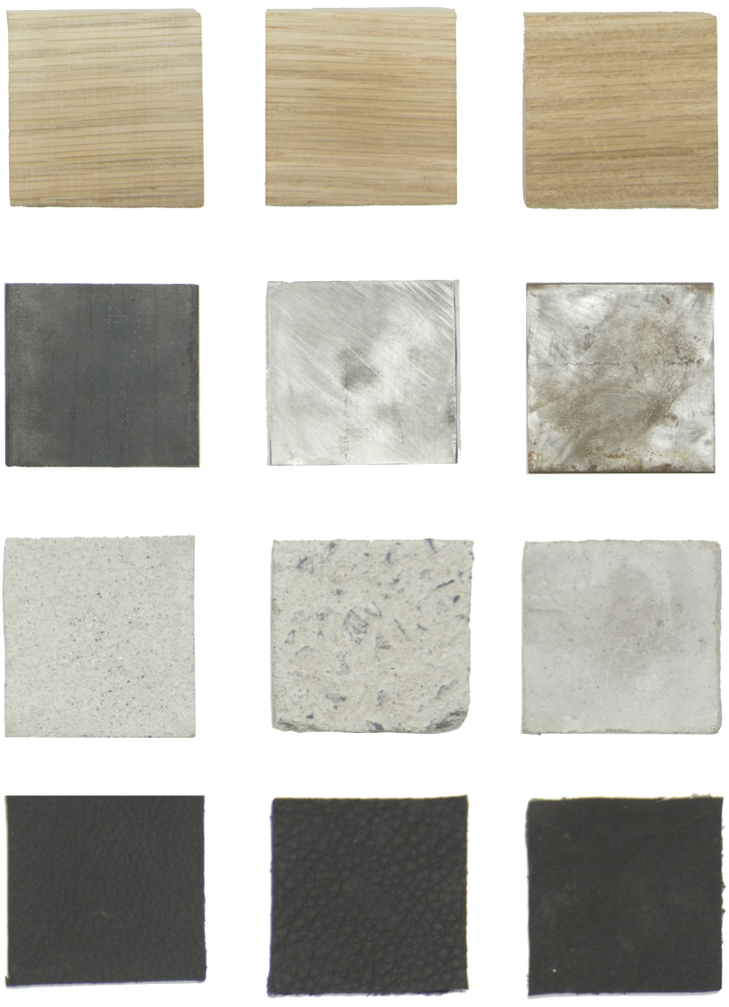


Fig 5.5 - Material swatches

PHOTO STUDIES

Material photo studies were constructed from the images supplied by participants. This aided in the categorization of the different types of materials from which four material theme collages were constructed from the images provided. These consisted of: wood, metal, leather, and concrete. The majority of the images supplied by participants fit into the four categories, where three did not. As a result the materials that were not categorized were not applied further in the research. Through the use of the photo studies a material palette was defined for each of the four material categories in the development of the final prototypes. Verbal responses from participants were used in the generation of word clouds that displayed the key words used to describe the materials within each category where the text changed in size based on the number of instances of words. Photo studies were also used to display the results from the sorting and assessment of the material swatches from the final participant interview. This aided in developing an understanding of the degree to which participants felt contemporary masculinity was expressed in the material samples.

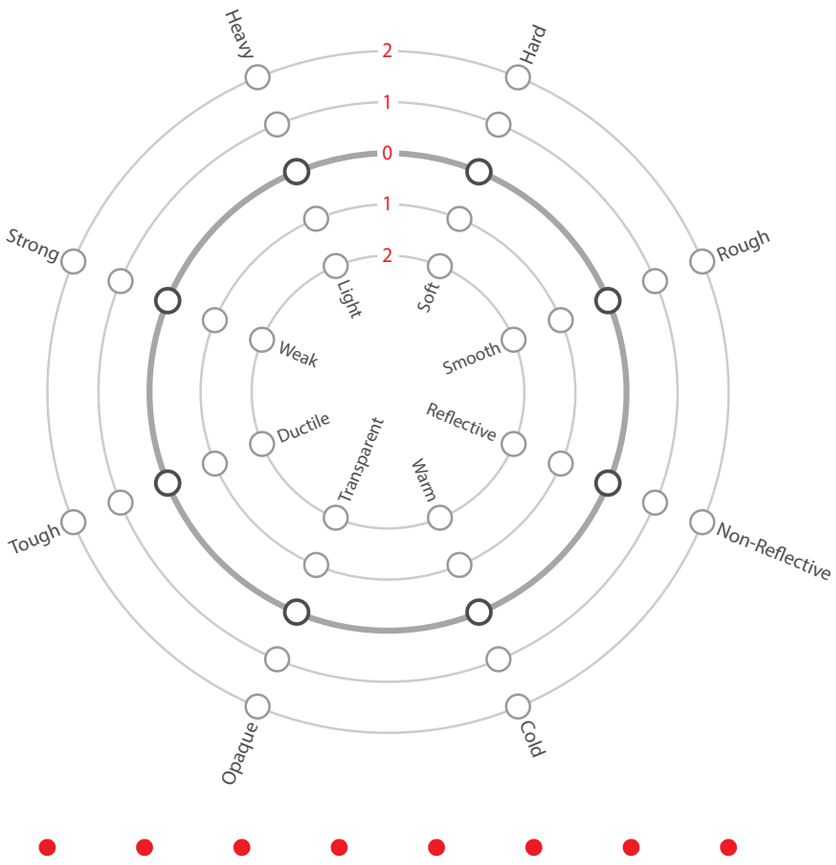


Fig 5.6 - Material property assessment polar diagram

DATA VISUALIZATIONS

The development of data visualisations were key in the analysis of participant perspectives on contemporary masculinity as well as in the presentation of the data. Visualisations consisted of polar diagrams, questionnaires and word clouds. These were generated as a result of the collation of data received from the participant interviews and questionnaires. The polar diagrams were constructed using the material property questionnaires results, where participants indicated which material properties best expressed contemporary masculinity. This resulted in the creation of a visualisation that sought to demonstrate 'how masculine' each material was perceived to be. Surveys were used in the presentation of the physical properties and the form and proportion questionnaires. The resulting surveys display the combined data of the nine participants in regards to which properties, forms, orientations and proportions were perceived as the most masculine. Word clouds were used to visualize the transcript data for each of the material categories constructed from images presented by participants.

WEB-BASED CUSTOMISATION

6

As 3D printing and digital design tools/ technology becomes more common and available to the consumer, the ability and skill required to model theses designs has been identified as a limiting factor (Hardesty, 2015). The design process in 3D modelling often requires proficiency with CAD software and the process is often very time consuming. The availability of web-based customisation seeks to provide consumers with an accessible, simplified interface that requires little to no CAD experience to use. These interfaces often employ slider based approach to customisation to better allow consumers to intuitively interact and make modifications to models and products. These systems give consumers more control in the customisation and creates a greater sense of ownership as they become an active participant in the tailoring of the design, leading to a model/ product that they can either download and make or purchase.

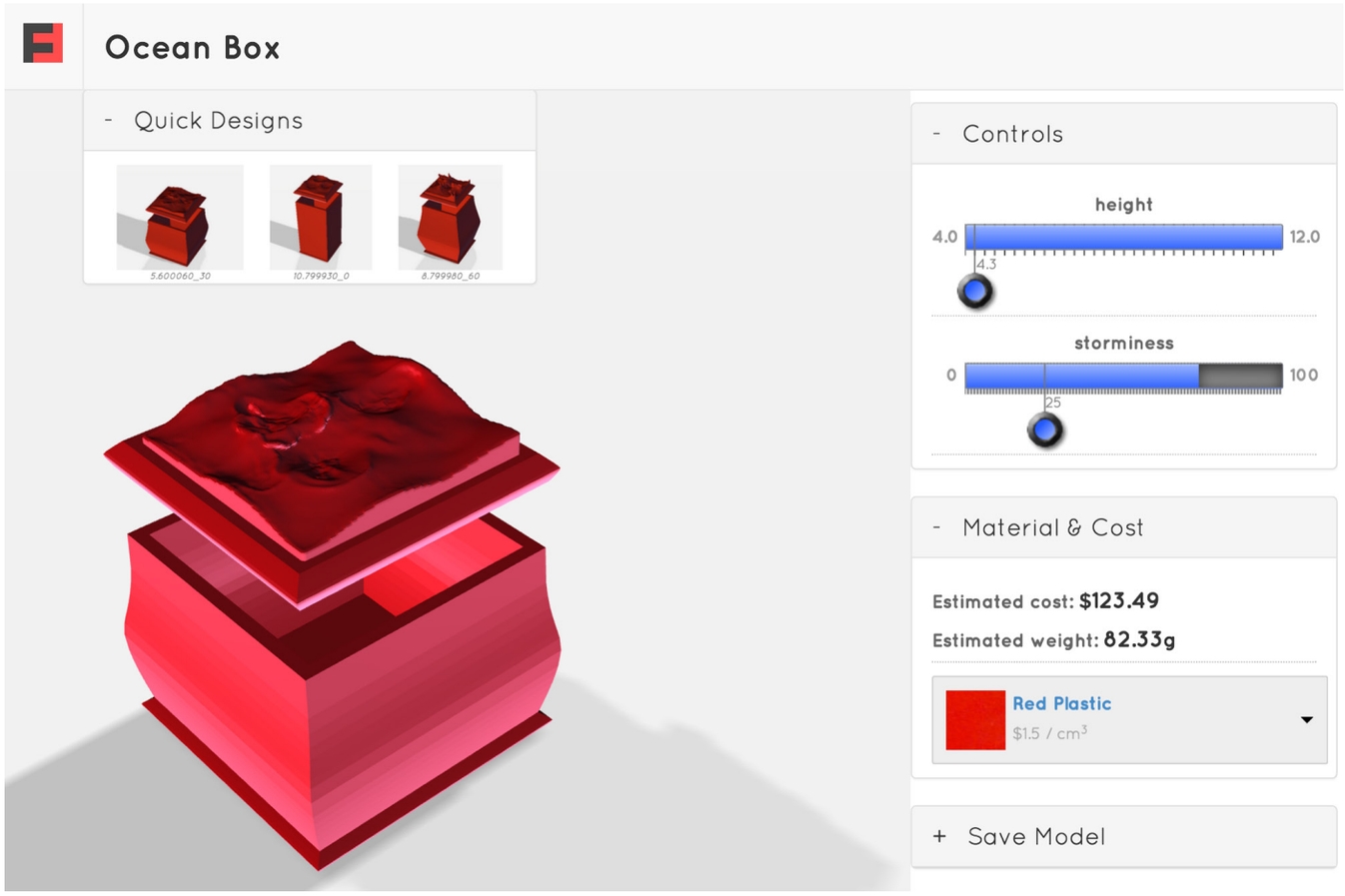


Fig 6.1 - MIT Fab Forms interface (MIT, 2015)

MIT FAB FORMS

MIT researchers are seeking to change that through a new system named 'Fab Forms' which enables CAD files to be automatically changed into models that can be customised in a web-based interface for 3D printing, in real time by using sliders. What sets Fab Forms apart is that CAD files can be loaded into the system, which then does pre-calculations on all the possible variations of the numerical parameters.

Here's how it works:

A CAD model is loaded into the system. Fab Forms automatically adjusts the numerical parameters used to make the design and generates variations of the original 3D model. Through this process "hundreds of thousands" of variations can be produced

Cloud servers run tests on all the variations for stability and printability. Parameters that result in an unstable or unprintable model are removed from the data set.

Fab Forms presents the results to the user in the form of a web-based interface. The user can use the virtual sliders in the interface to 'customize' the model, when really the models have already been generated and the system is simply cycling through the pre-calculated results.

This system aids consumers who don't have prior CAD experience to customize 3D models with relative ease and speed. Variations can be made in the 3D model by using the virtual sliders within the interface. Instead of relying on the computational power of the user's computer, all the calculations and mathematics are done through a cloud server which allows for faster results. This system further benefits the novice user by ensuring the resulting model is functional and manufacturable though the removal any parameters that result in an unstable or unprintable model.

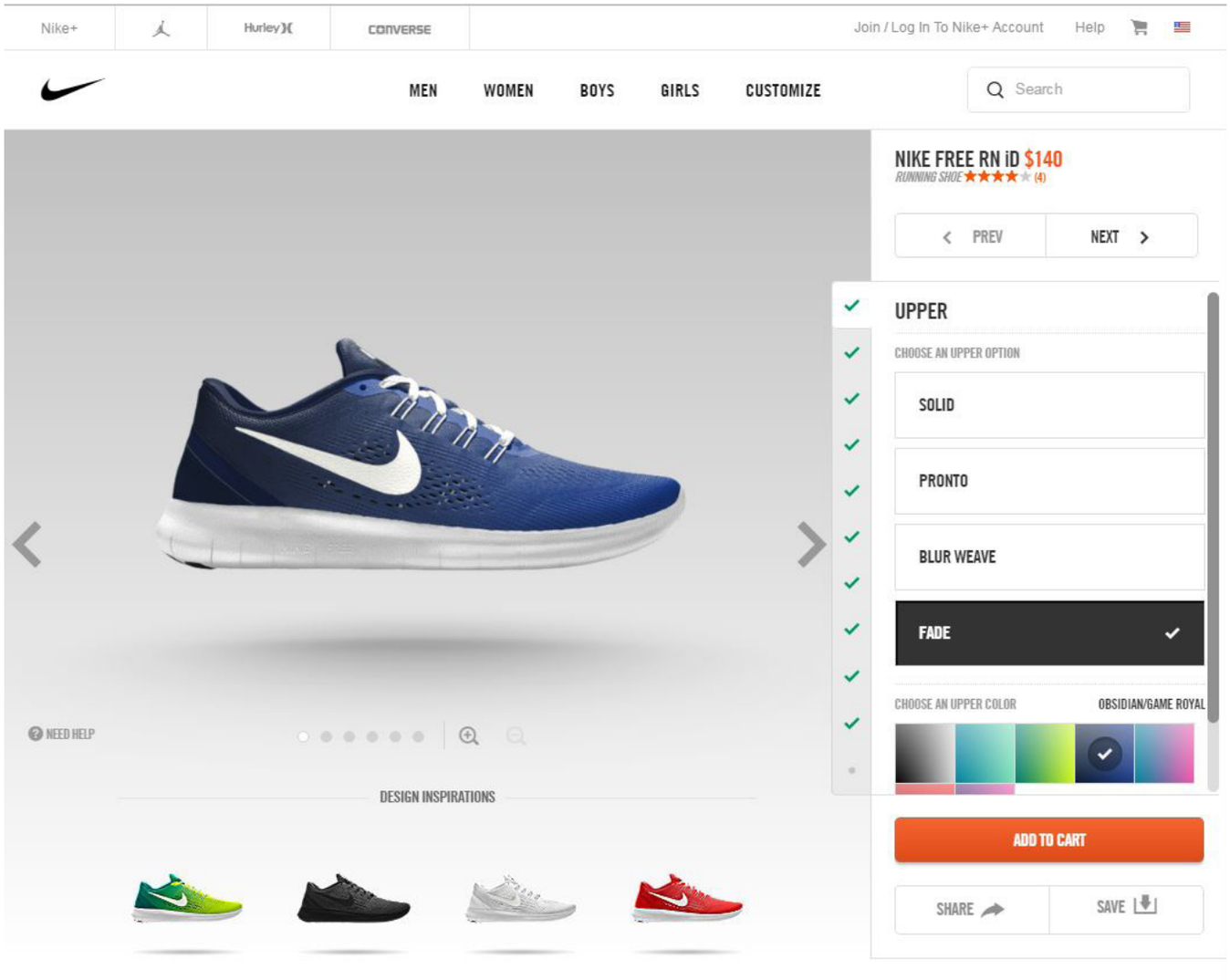


Fig 6.2 - NIKE iD interface (NIKE, 2016)

NIKE ID

Global sportswear corporation NIKE offers online customisation of their shoes as an extension of the online store (www.nike.com/us/en_us/c/nikeid). NIKE has called this feature 'NIKE ID', a web based form of customisation that allows the custom tailoring of NIKE shoes to meet the user's preferences, which can then be produced for them according to their personal specifications.

Once a base shoe has been chosen, the screen-based interface shows a view of the shoe where the user can identify the various customisable components by hovering over the individual components with the mouse. The shoe can also be rotated by selecting from the predefined views to better visualise and customize the shoe. Below the shoe that is being customized are four design inspirations that can be selected at any time to replace the current shoe, which can then be further customized. There are category tabs offered on the right hand side bar that the user can click on to customize the current shoe. Alternatively, the user can customize the shoe by clicking on any of the elements on the shoe model which will bring up the corresponding category tab, and chose between the available options. The available feature tabs vary slightly between shoes. In Fig.6.2 the categories are:

- Upper
- Underlay
- Lining
- Heel
- Laces
- Flywire
- Swoosh
- Midsole
- Midsole Topline
- Text/ Graphics
- Size

The price of the shoes is calculated upon the completion of the customisation process. The user is then able to share, save or purchase the tailored shoe. A limitation of this customisation interface is that only predefined choices can be made. These choices are limited to those that do not result in a change in the manufacturing system/ process.

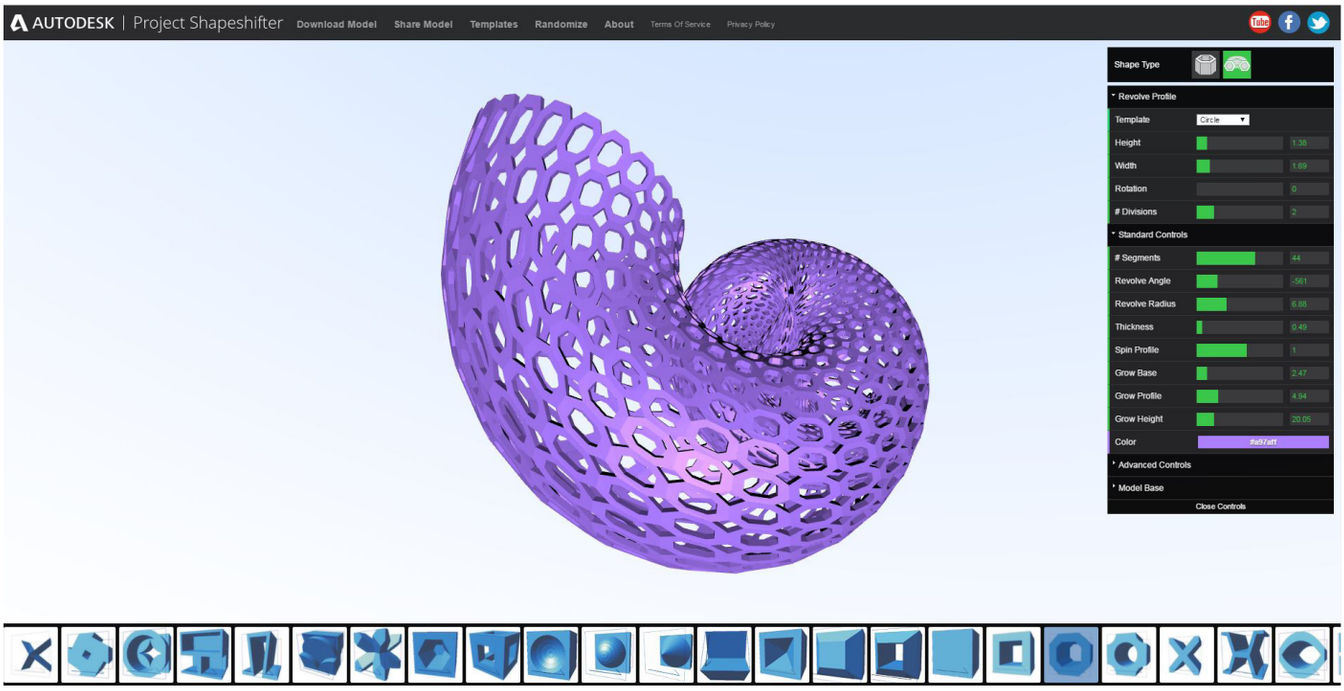


Fig 6.3 - Project Shapeshifter (Autodesk, 2016)

PROJECT SHAPESHIFTER

Project shapeshifter by Autodesk is a web-based parametric modelling tool that enables users to easily create 3D printable objects using sliders and base shapes. Shapeshifter allows users to create complex printable geometry with ease through the use of sliders and base shapes, as evident in Fig 6.3. The sliders affect the shape of the form and the base shapes are applied as 3D panelling. The modelling, customisation and exporting of .obj files for printing are all done from within the browser. Shapeshifter has a randomize function that can help with design inspiration, but also templates that users can load in and start customizing. These templates include:

- Vase
- Bowl
- Ring
- Bracelet
- Plate
- Candlestick
- Seashell
- Pendant
- Knot
- Sculpture
- Duo Vase
- Snake

Though shapeshifter, users are able to explore design alternatives through the generative modelling of complex meshes, ready for 3D printing all from within a web browser. Shapeshifter is a powerful tool in regards to generative modelling but one issue with this system is that it is possible to generate models that are unprintable. The models created through shapeshifter are often abstract in nature and it becomes difficult to make something functional.

PARTICIPANT DATA

Material: _____

*check 1 per row

	2	1	0	1	2	
Hard	○	○	●	○	○	Soft
Smooth	○	○	●	○	○	Rough
Not-Reflective	○	○	●	○	○	Reflective
Cold	○	○	●	○	○	Warm
Opaque	○	○	●	○	○	Transparent
Tough	○	○	●	○	○	Ductile
Strong	○	○	●	○	○	Weak
Light	○	○	●	○	○	Heavy

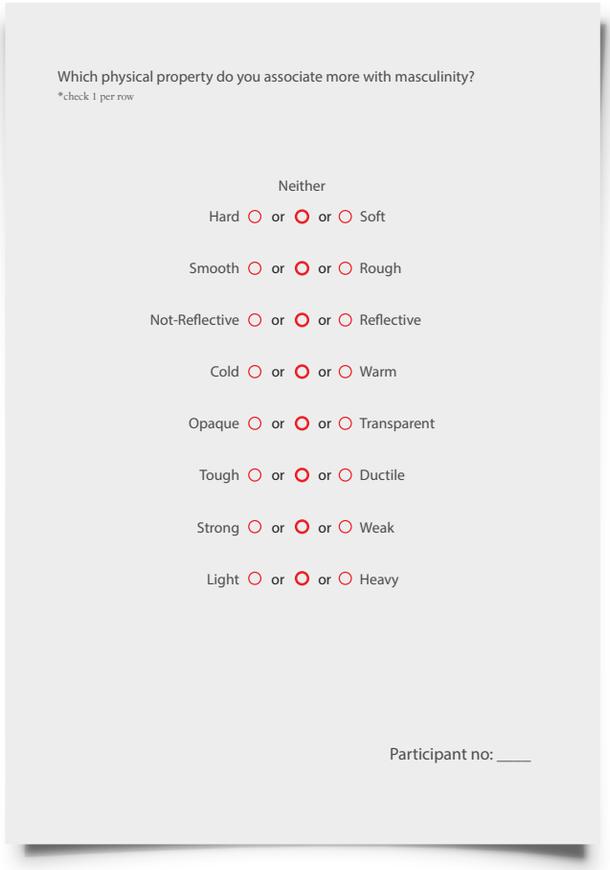
Participant no: ____

Fig 7.01 - Material assessment questionnaire

During the initial interview, after participants chose three materials which they felt best expressed contemporary masculinity they were asked to assess each material based upon its physical properties.

Referencing the three selected material images, participants were given a questionnaire sheet for each and asked to evaluate the materials based on their physical properties. Over the course of the interview process, participants completed a total of three different questionnaires that were based on the MOM tool. For the first questionnaire, participants were required to assess each material based on eight physical properties pairs. It included a five-point point scale for each physical property pair, ranging from one extreme to the opposite. Participants indicated the degree for the eight pairs of the physical properties for each material sample. The material pairs included within the questionnaire were;

- Hard to soft
- Smooth to rough
- Not-reflective to reflective
- Cold to warm
- Opaque to transparent
- Tough to ductile
- Strong to weak
- Light to heavy



Which physical property do you associate more with masculinity?
*check 1 per row

		Neither		
Hard	○ or	○	or ○	Soft
Smooth	○ or	○	or ○	Rough
Not-Reflective	○ or	○	or ○	Reflective
Cold	○ or	○	or ○	Warm
Opaque	○ or	○	or ○	Transparent
Tough	○ or	○	or ○	Ductile
Strong	○ or	○	or ○	Weak
Light	○ or	○	or ○	Heavy

Participant no: ____

Fig 7.02 - Material properties assessment questionnaire

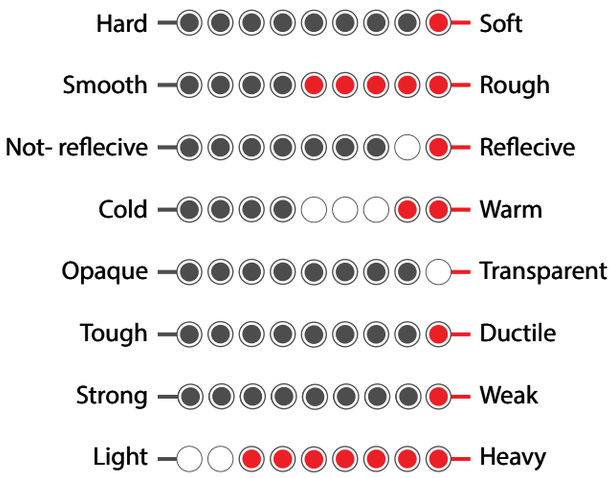


Fig 7.03 - Masculine properties combined participant results

After the completion of the material assessment questionnaire (Fig 7.01), in order to better understand participant perspectives and to visualize the survey results, each participant completed a questionnaire (Fig 7.02) indicating which property for each of the eight property pairs they associated most with contemporary masculinity. Participants were given the option of choosing neither if they felt there was no standout.

Fig 7.03 visualizes the results of the nine participant responses to the survey. The properties on the left are represented by grey, and the ones on the right by red. There are nine circles between the pairs, each correlating to a participant. Circles that have no colour is where the participant indicated that neither physical property were more masculine than the other, a neutral response. For each pair, the material property that was indicated the most, became the variable which later aided in evaluating the expressed contemporary masculinity of each material through polar diagrams.

The material property within each pair that was indicated the most overall within Fig 7.03 identified which properties became the variables that defined the expressed masculinity within the polar diagrams (Fig 7.05, and enabled the generation of the polar diagrams and furthered the understanding of the expression of contemporary masculinity through the physical properties of materials.

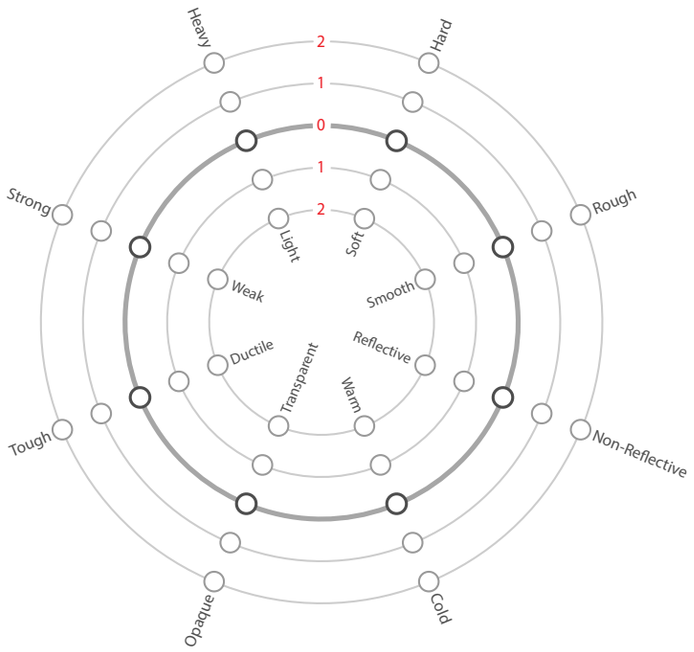


Fig 7.04 - Material property assessment polar diagram

OAK

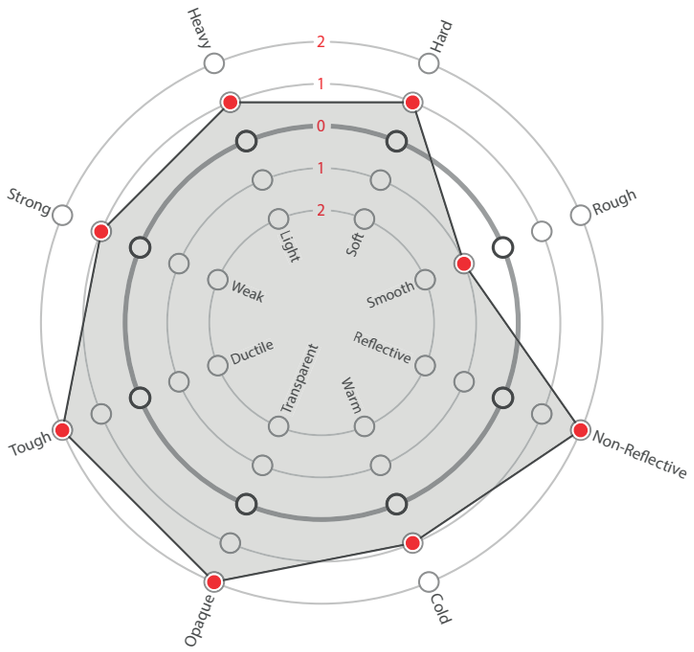
Fig 7.05

PARTICIPANT ASSOCIATIONS

Lumberjacks and Ron Swanson. Woodworking. Cultural associations make it manly

PARTICIPANT NO.1

	2	1	0	1	2	
Hard	○	●	◎	○	○	Soft
Smooth	○	●	◎	○	○	Rough
Non-Reflective	●	○	◎	○	○	Reflective
Cold	○	●	◎	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	●	○	◎	○	○	Ductile
Strong	○	●	◎	○	○	Weak
Light	○	○	◎	●	○	Heavy



IRON

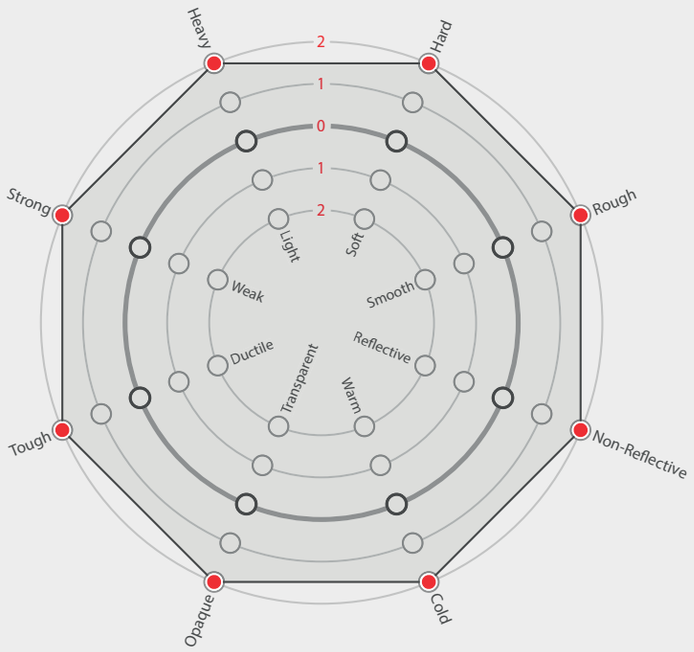
Fig 7.06

PARTICIPANT ASSOCIATIONS

Medieval knight fighting league. Re-creation of medieval weapons and armour. Fighting in battle.

PARTICIPANT NO.1

	2	1	0	1	2	
Hard	●	○	◎	○	○	Soft
Smooth	○	○	◎	○	●	Rough
Non-Reflective	●	○	◎	○	○	Reflective
Cold	●	○	◎	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	●	○	◎	○	○	Ductile
Strong	●	○	◎	○	○	Weak
Light	○	○	◎	○	●	Heavy



LEATHER

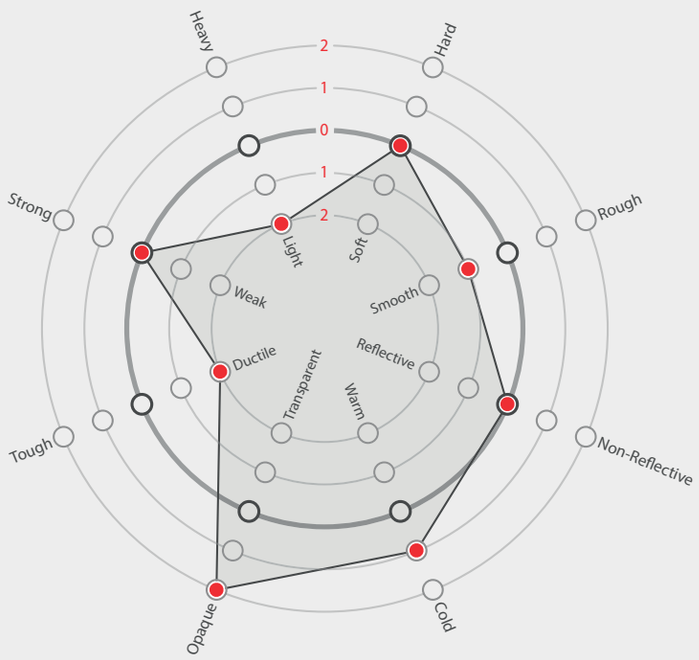
Fig 7.07

PARTICIPANT ASSOCIATIONS

Hard work. Is worn due to repeated physical activity. The material has a history and is hard wearing

PARTICIPANT NO.1

	2	1	0	1	2	
Hard	○	○	◉	○	○	Soft
Smooth	○	◉	○	○	○	Rough
Non-Reflective	○	○	◉	○	○	Reflective
Cold	○	◉	○	○	○	Warm
Opaque	◉	○	○	○	○	Transparent
Tough	○	○	○	○	◉	Ductile
Strong	○	○	◉	○	○	Weak
Light	◉	○	○	○	○	Heavy



WOOD

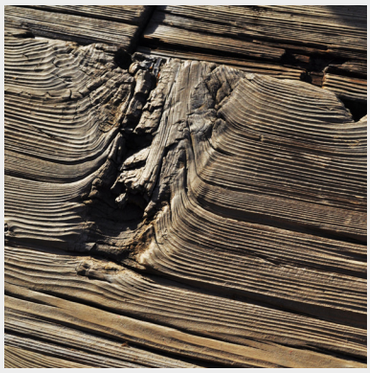


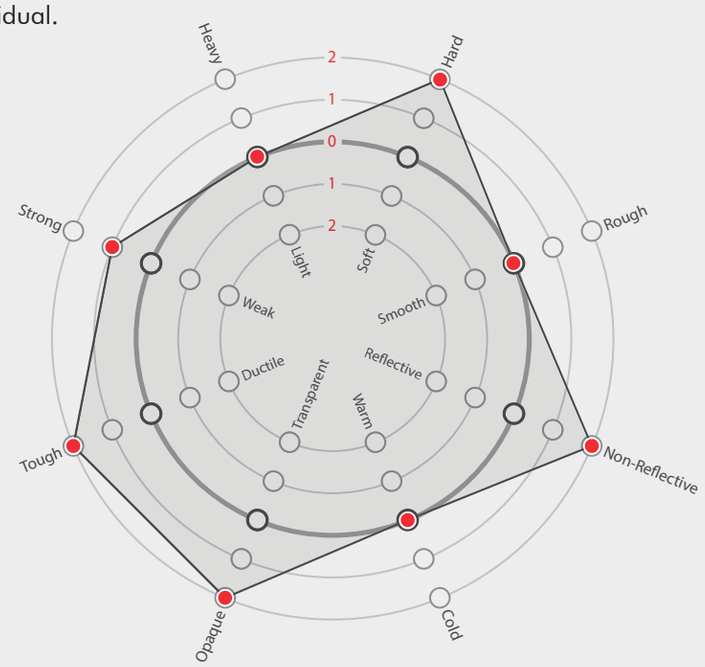
Fig 7.08

PARTICIPANT ASSOCIATIONS

Burnt, been through a process, it's not crisp, clean or manufactured, worn and durable but still functional. Now speaks of other qualities unlike a standardised manufactured piece. Individual.

PARTICIPANT NO.2

	2	1	0	1	2	
Hard	●	○	◎	○	○	Soft
Smooth	○	○	●	○	○	Rough
Non-Reflective	●	○	◎	○	○	Reflective
Cold	○	○	●	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	●	○	◎	○	○	Ductile
Strong	○	●	◎	○	○	Weak
Light	○	○	●	○	○	Heavy



STEEL

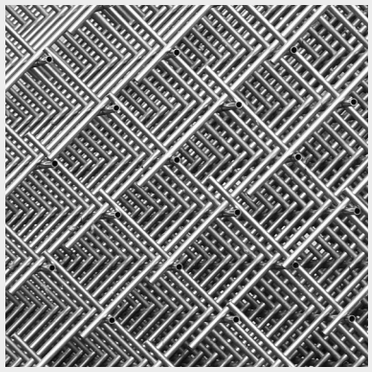


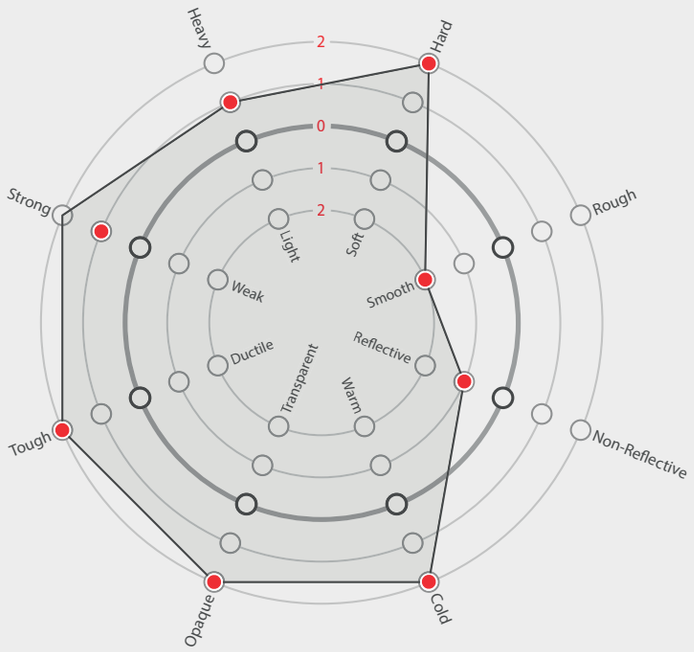
Fig 7.09

PARTICIPANT ASSOCIATIONS

Strong wearing and durable.
Welded through a craft practice,
either by machine or hand.

PARTICIPANT NO.2

	2	1	0	1	2	
Hard	●	○	◎	○	○	Soft
Smooth	●	○	◎	○	○	Rough
Non-Reflective	○	○	◎	●	○	Reflective
Cold	●	○	◎	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	●	○	◎	○	○	Ductile
Strong	●	○	◎	○	○	Weak
Light	○	○	◎	●	○	Heavy



CLAY DIRT

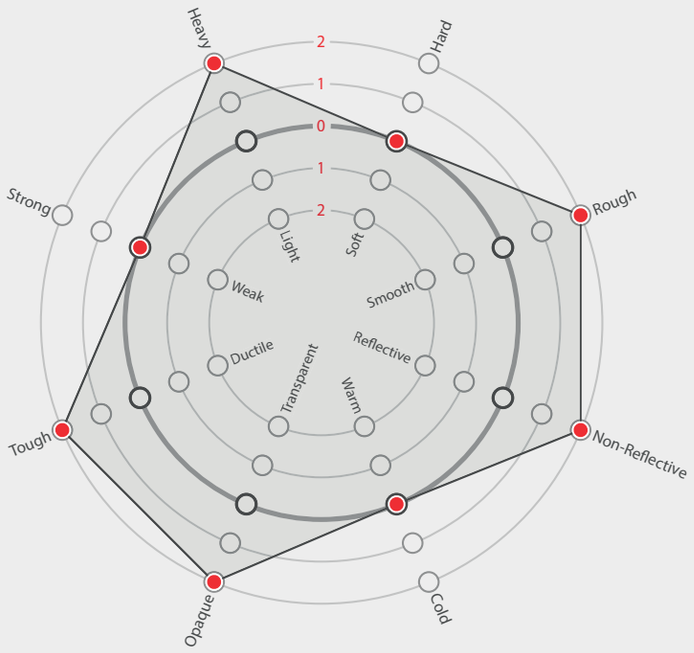
Fig 7.10

PARTICIPANT ASSOCIATIONS

Expansiveness, large scale, weathered by the environment. Subjected to the elements.

PARTICIPANT NO.2

	2	1	0	1	2	
Hard	○	○	◉	○	○	Soft
Smooth	○	○	○	○	◉	Rough
Non-Reflective	◉	○	○	○	○	Reflective
Cold	○	○	◉	○	○	Warm
Opaque	◉	○	○	○	○	Transparent
Tough	◉	○	○	○	○	Ductile
Strong	◉	○	○	○	○	Weak
Light	○	○	○	○	◉	Heavy



MAHOGANY

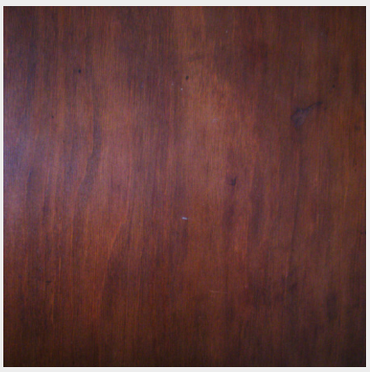


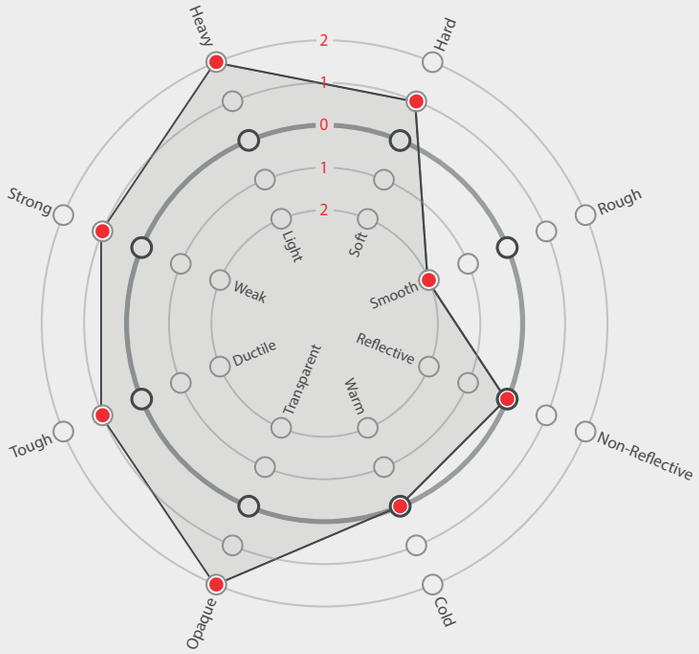
Fig 7.11

PARTICIPANT ASSOCIATIONS

Aged. Takes time to grow. Dense, strong, and flexible. Easy to carve. Heavy.

PARTICIPANT NO.3

	2	1	0	1	2	
Hard	○	●	◎	○	○	Soft
Smooth	●	○	◎	○	○	Rough
Non-Reflective	○	○	◎	○	○	Reflective
Cold	○	○	◎	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	○	●	◎	○	○	Ductile
Strong	○	●	◎	○	○	Weak
Light	○	○	◎	○	●	Heavy



BRASS

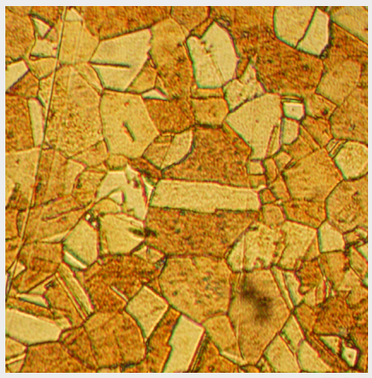


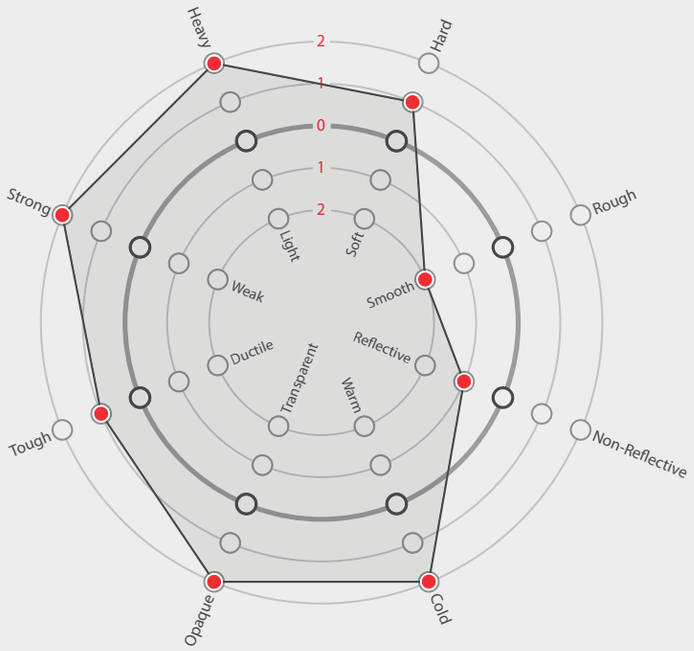
Fig 7.12

PARTICIPANT ASSOCIATIONS

Combination of two materials. One is soft the other is strong. The material is workable. Variable in finish from polished to rough. The older it is the more distinguished the patina.

PARTICIPANT NO.3

	2	1	0	1	2	
Hard	○	●	◎	○	○	Soft
Smooth	●	○	◎	○	○	Rough
Non-Reflective	○	●	◎	○	○	Reflective
Cold	●	○	◎	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	○	●	◎	○	○	Ductile
Strong	●	○	◎	○	○	Weak
Light	○	○	◎	○	●	Heavy



LEATHER

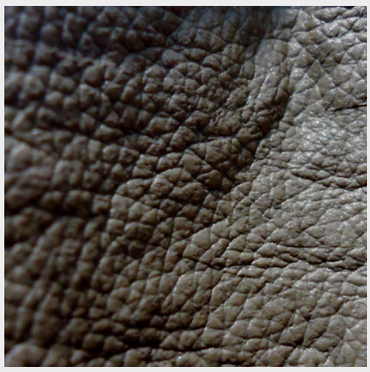


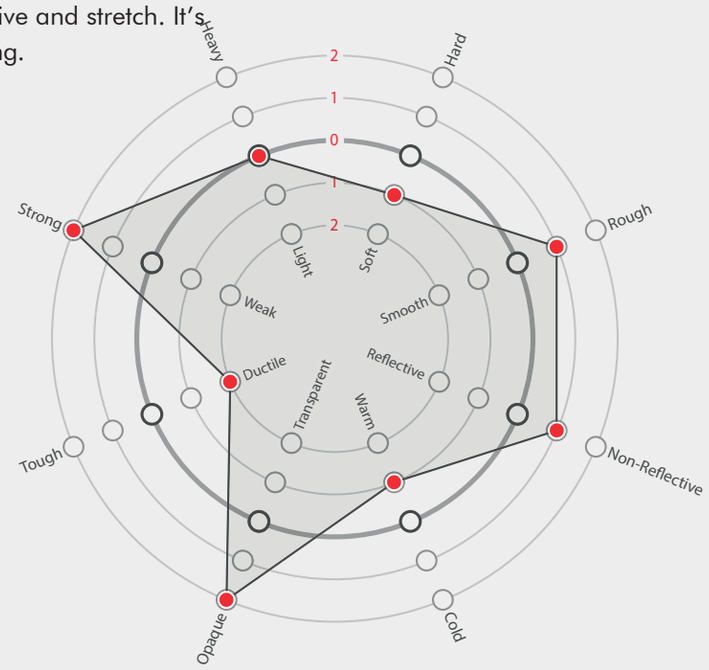
Fig 7.13

PARTICIPANT ASSOCIATIONS

Harvested from another animal. Process of killing the animal and turning the leather into a workable material. Protective fabric. Strong and durable but has some give and stretch. It's hard wearing.

PARTICIPANT NO.3

	2	1	0	1	2	
Hard	○	○	◎	●	○	Soft
Smooth	○	○	◎	●	○	Rough
Non-Reflective	○	●	◎	○	○	Reflective
Cold	○	○	◎	●	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	○	○	◎	○	●	Ductile
Strong	●	○	◎	○	○	Weak
Light	○	○	◎	○	○	Heavy



LEATHER

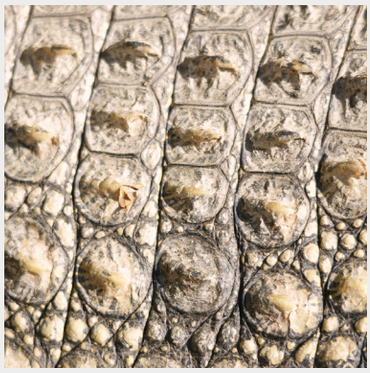


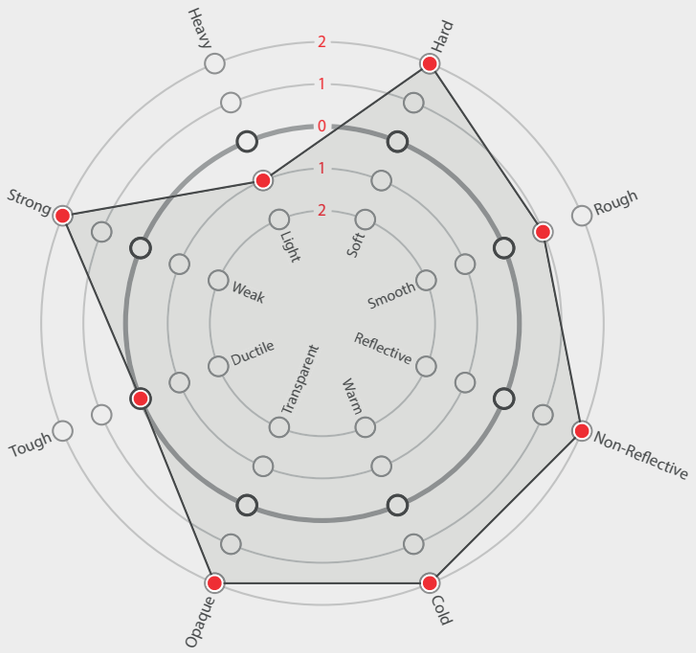
Fig 7.14

PARTICIPANT ASSOCIATIONS

Rough, strong and resilient. Like amour. There is a pattern that runs throughout it. There is a hardness to it. Sleek and streamlined. Functional and aesthetic.

PARTICIPANT NO.4

	2	1	0	1	2	
Hard	●	○	○	○	○	Soft
Smooth	○	○	○	●	○	Rough
Non-Reflective	●	○	○	○	○	Reflective
Cold	●	○	○	○	○	Warm
Opaque	●	○	○	○	○	Transparent
Tough	○	○	●	○	○	Ductile
Strong	●	○	○	○	○	Weak
Light	○	●	○	○	○	Heavy



STEEL

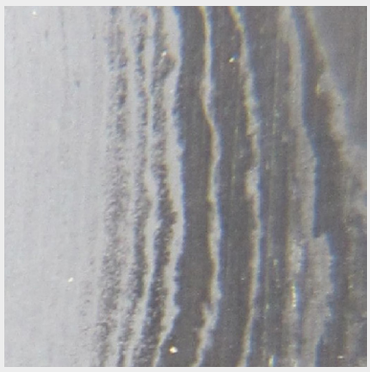


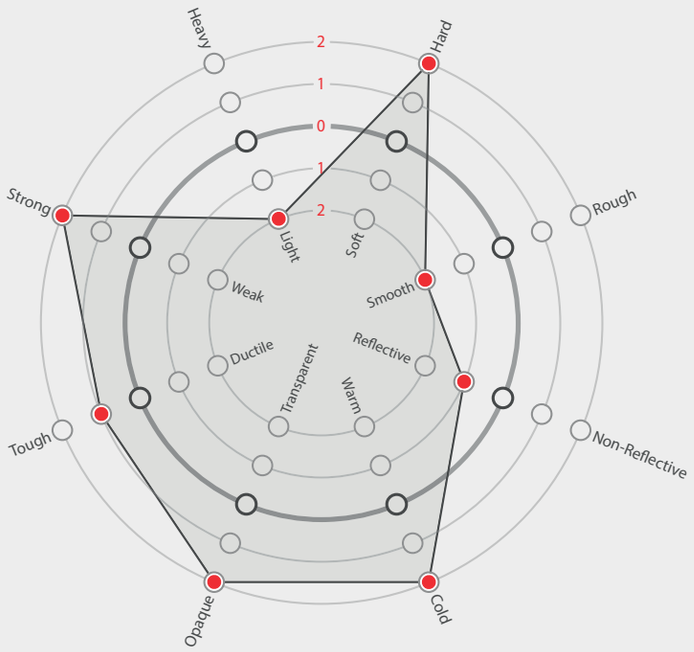
Fig 7.15

PARTICIPANT ASSOCIATIONS

Drawn out process to make. Taken from ore, heated and worked, strengthen through the process, and comes out a strong product. Sleek material. Power

PARTICIPANT NO.4

	2	1	0	1	2	
Hard	●	○	◎	○	○	Soft
Smooth	●	○	◎	○	○	Rough
Non-Reflective	○	○	◎	●	○	Reflective
Cold	●	○	◎	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	○	●	◎	○	○	Ductile
Strong	●	○	◎	○	○	Weak
Light	●	○	◎	○	○	Heavy



CEDAR

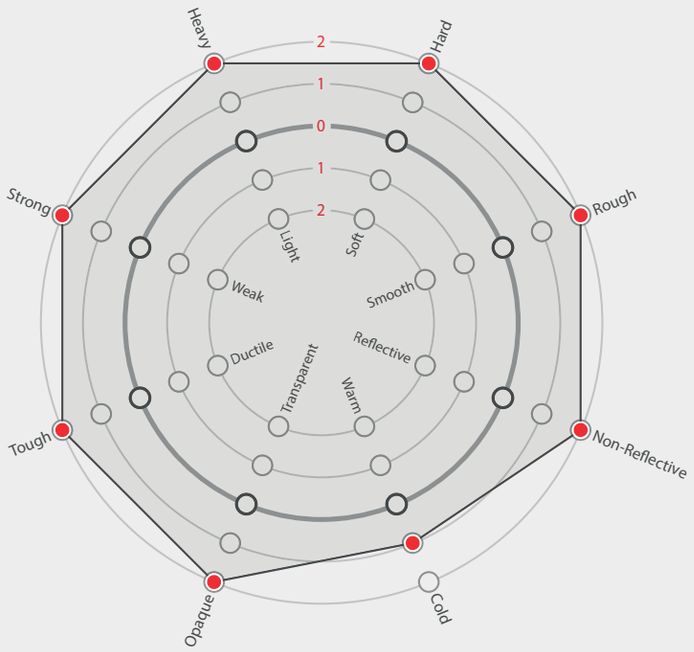
Fig 7.16

PARTICIPANT ASSOCIATIONS

Good for building, strong. Not too heavy. Easily workable. High in demand and hard to source. Not going to budge or fall to pieces.

PARTICIPANT NO.4

	2	1	0	1	2	
Hard	●	○	○	○	○	Soft
Smooth	○	○	○	○	●	Rough
Non-Reflective	●	○	○	○	○	Reflective
Cold	○	●	○	○	○	Warm
Opaque	●	○	○	○	○	Transparent
Tough	●	○	○	○	○	Ductile
Strong	●	○	○	○	○	Weak
Light	○	○	○	○	●	Heavy



SLATE

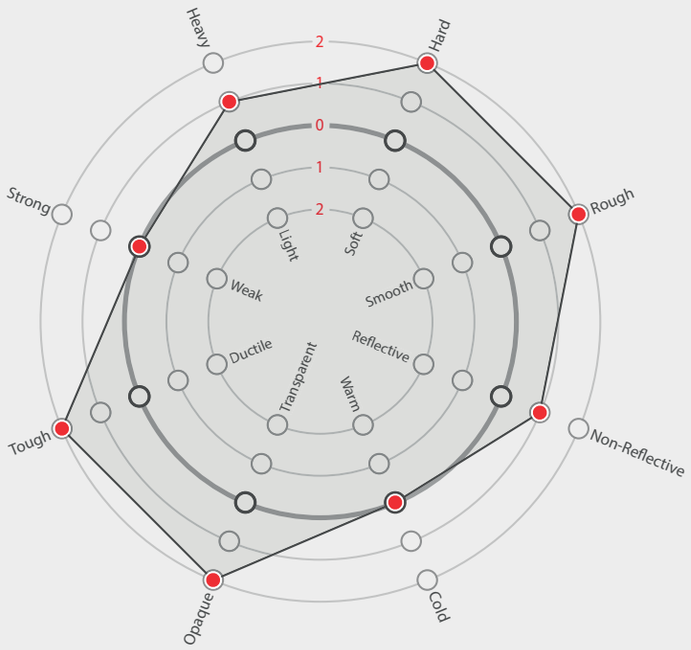
Fig 7.17

PARTICIPANT ASSOCIATIONS

Baches and holiday homes in the woods. Hunting and outdoors.

PARTICIPANT NO.5

	2	1	0	1	2	
Hard	●	○	○	○	○	Soft
Smooth	○	○	○	○	●	Rough
Non-Reflective	○	●	○	○	○	Reflective
Cold	○	○	●	○	○	Warm
Opaque	●	○	○	○	○	Transparent
Tough	●	○	○	○	○	Ductile
Strong	○	○	●	○	○	Weak
Light	○	○	○	●	○	Heavy



RUBBER

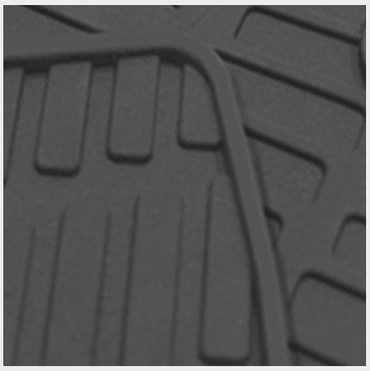


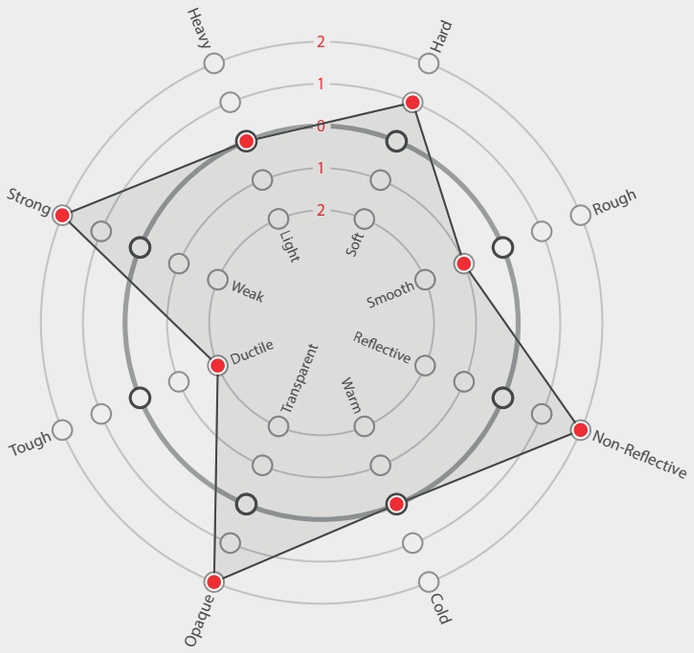
Fig 7.18

PARTICIPANT ASSOCIATIONS

Motorbikes, trucks and gumboots from the farm. Hard wearing, strong material

PARTICIPANT NO.5

	2	1	0	1	2	
Hard	○	●	◎	○	○	Soft
Smooth	○	●	◎	○	○	Rough
Non-Reflective	●	○	◎	○	○	Reflective
Cold	○	○	●	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	○	○	◎	○	●	Ductile
Strong	●	○	◎	○	○	Weak
Light	○	○	●	○	○	Heavy



WOOL

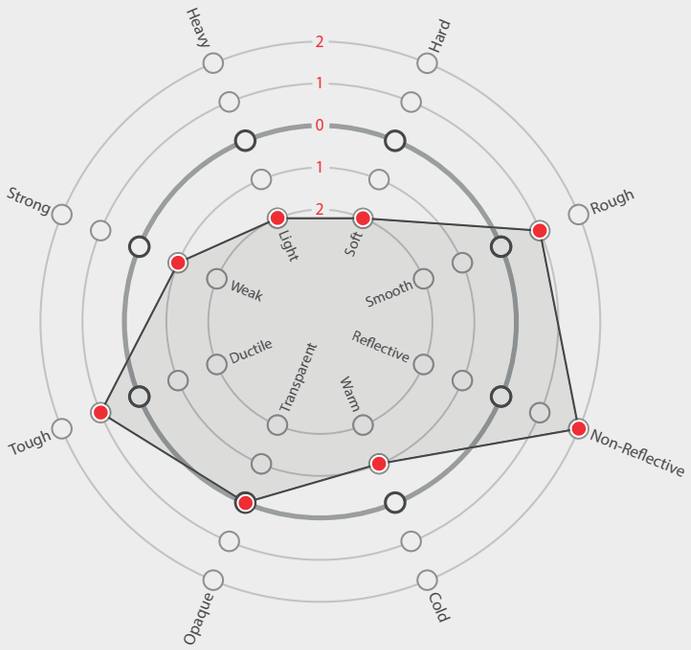
Fig 7.19

PARTICIPANT ASSOCIATIONS

Epitomizes the farming industry. Thick woollen jackets/jumpers and being embraced in them. Comfort.

PARTICIPANT NO.5

	2	1	0	1	2	
Hard	○	○	◎	○	●	Soft
Smooth	○	○	◎	●	○	Rough
Non-Reflective	●	○	◎	○	○	Reflective
Cold	○	○	◎	●	○	Warm
Opaque	○	○	◎	○	○	Transparent
Tough	○	●	◎	○	○	Ductile
Strong	○	○	◎	●	○	Weak
Light	●	○	◎	○	○	Heavy



WOOD

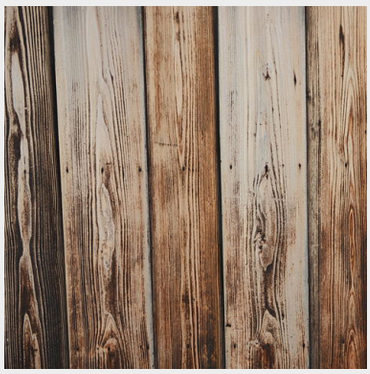


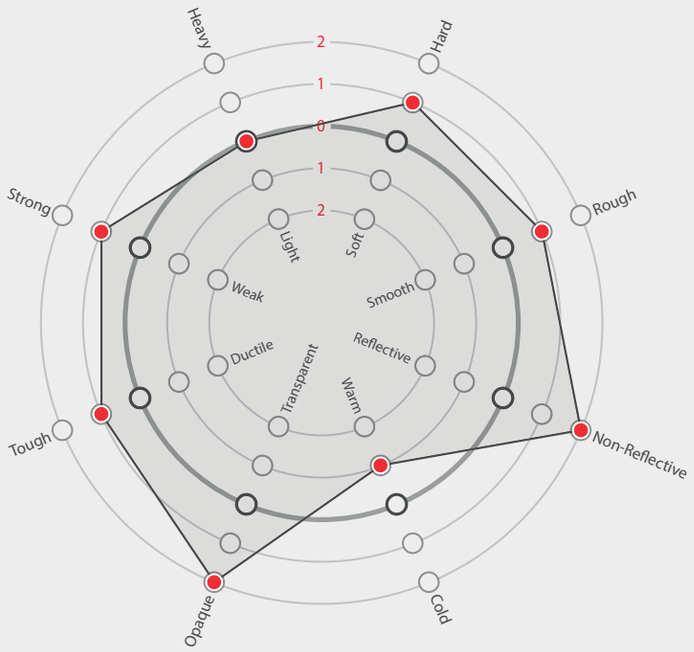
Fig 7.20

PARTICIPANT ASSOCIATIONS

Been through a lot, weathered history. Certain process and treatment to it. Been built for a specific purpose. Functional material.

PARTICIPANT NO.6

	2	1	0	1	2	
Hard	○	◉	◎	○	○	Soft
Smooth	○	○	◎	◉	○	Rough
Non-Reflective	◉	○	◎	○	○	Reflective
Cold	○	○	◎	◉	○	Warm
Opaque	◉	○	◎	○	○	Transparent
Tough	○	◉	◎	○	○	Ductile
Strong	○	◉	◎	○	○	Weak
Light	○	○	◉	○	○	Heavy



CONCRETE

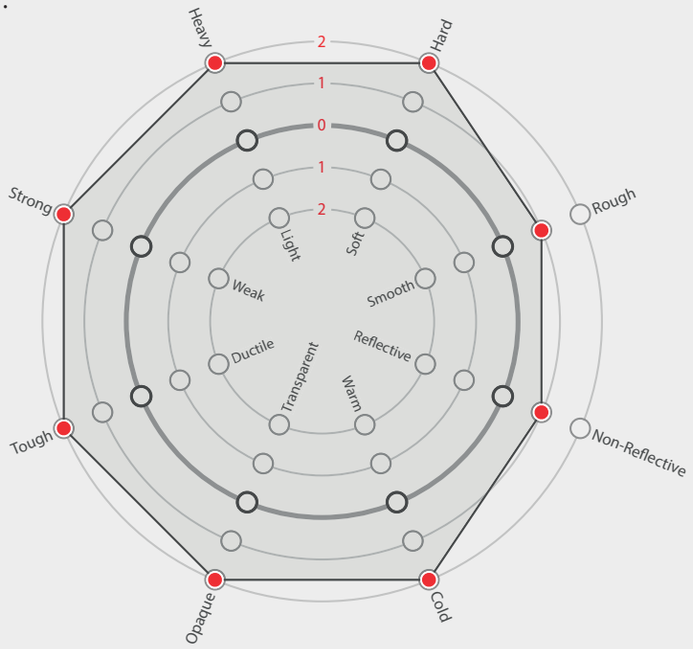
Fig 7.21

PARTICIPANT ASSOCIATIONS

Contains an imprint of the process that formed it. Direct understanding how it was built. Can see the wood grain. Taken on the qualities of the wood that it was cast in.

PARTICIPANT NO.6

	2	1	0	1	2	
Hard	●	○	○	○	○	Soft
Smooth	○	○	○	●	○	Rough
Non-Reflective	○	●	○	○	○	Reflective
Cold	●	○	○	○	○	Warm
Opaque	●	○	○	○	○	Transparent
Tough	●	○	○	○	○	Ductile
Strong	●	○	○	○	○	Weak
Light	○	○	○	○	●	Heavy



STEEL

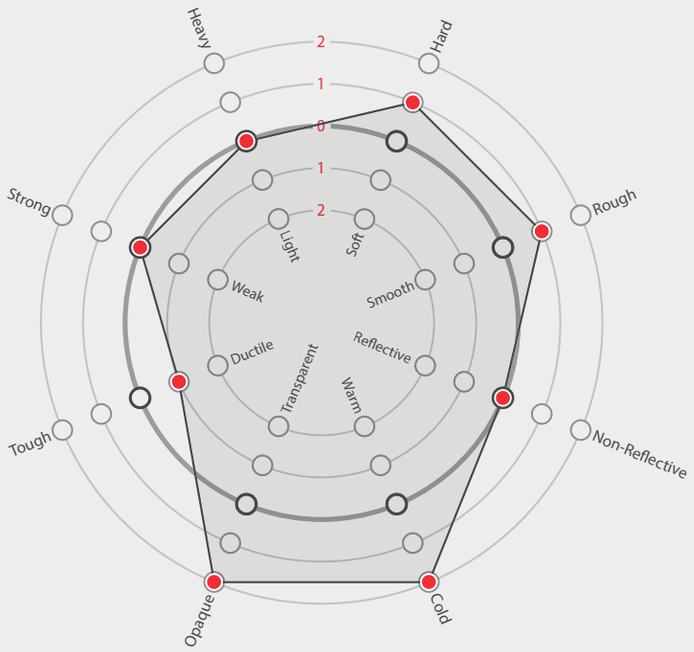
Fig 7.22

PARTICIPANT ASSOCIATIONS

Weathered, more beautiful with age.

PARTICIPANT NO.6

	2	1	0	1	2	
Hard	○	●	◎	○	○	Soft
Smooth	○	○	◎	●	○	Rough
Non-Reflective	○	○	●	○	○	Reflective
Cold	●	○	◎	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	○	○	◎	●	○	Ductile
Strong	○	○	●	○	○	Weak
Light	○	○	●	○	○	Heavy



BONE

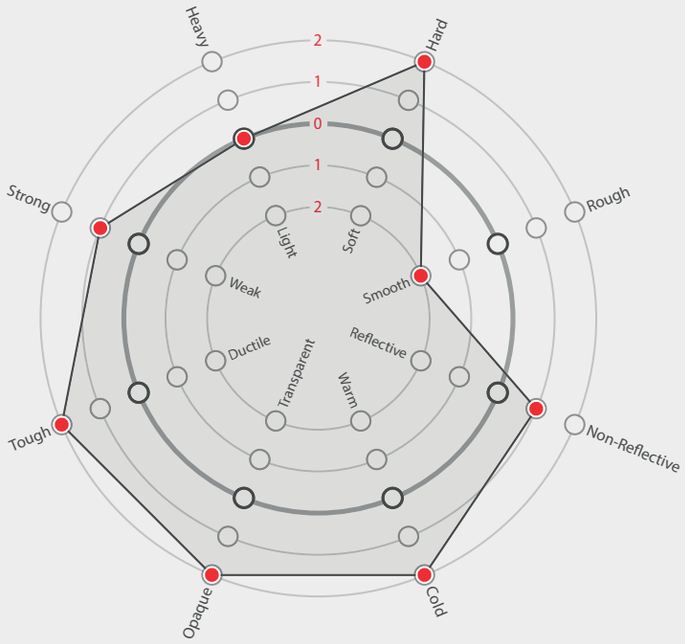
Fig 7.23

PARTICIPANT ASSOCIATIONS

Primal aspect. Associations with hunting. Material has been harvested from an animal.

PARTICIPANT NO.7

	2	1	0	1	2	
Hard	●	○	○	○	○	Soft
Smooth	●	○	○	○	○	Rough
Non-Reflective	○	●	○	○	○	Reflective
Cold	●	○	○	○	○	Warm
Opaque	●	○	○	○	○	Transparent
Tough	●	○	○	○	○	Ductile
Strong	○	●	○	○	○	Weak
Light	○	○	●	○	○	Heavy



OAK BARK

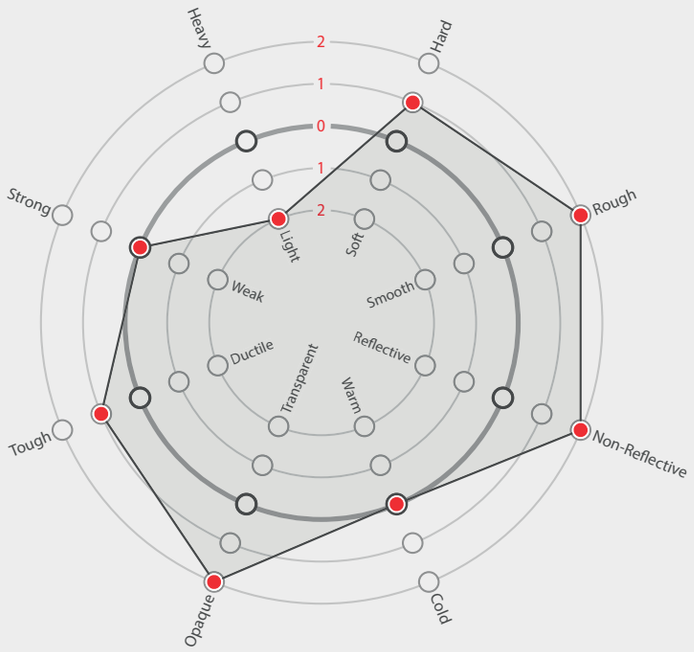
Fig 7.24

PARTICIPANT ASSOCIATIONS

Aged, experience. Developed over time to protect itself. There is wear and damage, but it endures. Rough in surface.

PARTICIPANT NO.7

	2	1	0	1	2	
Hard	○	◉	○	○	○	Soft
Smooth	○	○	○	○	◉	Rough
Non-Reflective	◉	○	○	○	○	Reflective
Cold	○	○	◉	○	○	Warm
Opaque	◉	○	○	○	○	Transparent
Tough	○	◉	○	○	○	Ductile
Strong	○	○	◉	○	○	Weak
Light	◉	○	○	○	○	Heavy



STAINLESS STEEL

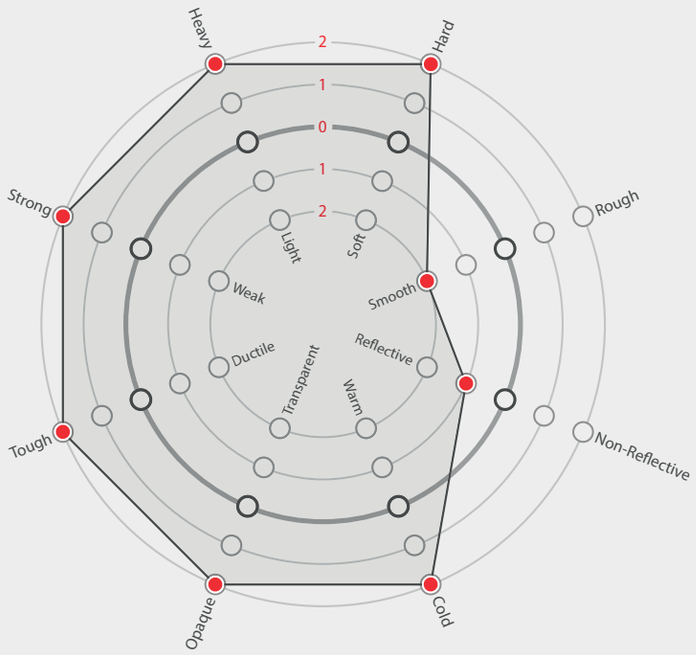
Fig 7.25

PARTICIPANT ASSOCIATIONS

Smooth, refined and solid. Weight and density are reassuring. Enduring material. Impervious to wear. Reflective and catches the light.

PARTICIPANT NO.7

	2	1	0	1	2	
Hard	●	○	◎	○	○	Soft
Smooth	●	○	◎	○	○	Rough
Non-Reflective	○	○	◎	●	○	Reflective
Cold	●	○	◎	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	●	○	◎	○	○	Ductile
Strong	●	○	◎	○	○	Weak
Light	●	○	◎	○	○	Heavy



WOOD

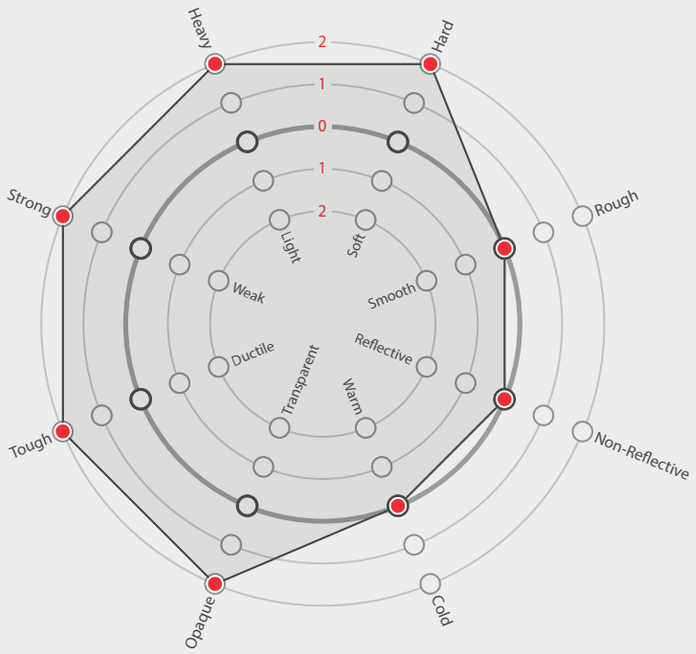
Fig 7.26

PARTICIPANT ASSOCIATIONS

Jobs. Working with wood is a man's role e.g. builders. Physical labour. Wood has a strong history of use by man.

PARTICIPANT NO.8

	2	1	0	1	2	
Hard	●	○	◎	○	○	Soft
Smooth	○	○	●	○	○	Rough
Non-Reflective	○	○	●	○	○	Reflective
Cold	○	○	●	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	●	○	◎	○	○	Ductile
Strong	●	○	◎	○	○	Weak
Light	○	○	◎	○	●	Heavy



MARBLE

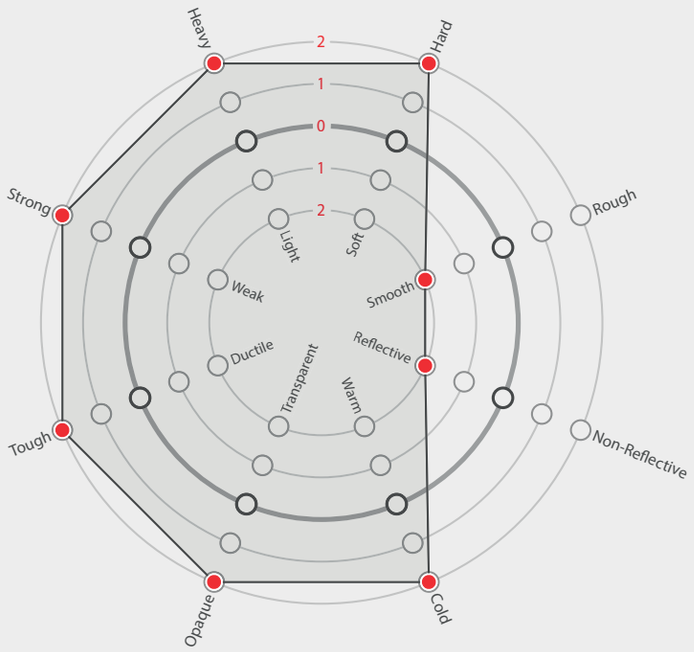
Fig 7.27

PARTICIPANT ASSOCIATIONS

Carved sculptures of great men.
Immortalised

PARTICIPANT NO.8

	2	1	0	1	2	
Hard	●	○	○	○	○	Soft
Smooth	●	○	○	○	○	Rough
Non-Reflective	○	○	○	○	●	Reflective
Cold	●	○	○	○	○	Warm
Opaque	●	○	○	○	○	Transparent
Tough	●	○	○	○	○	Ductile
Strong	●	○	○	○	○	Weak
Light	○	○	○	○	●	Heavy



CEMENT

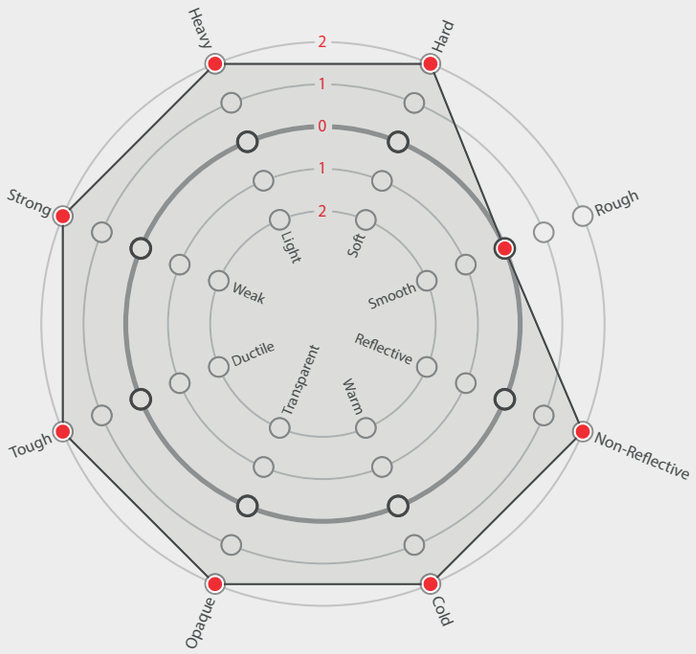
Fig 7.28

PARTICIPANT ASSOCIATIONS

Construction material, man's role. Labour.

PARTICIPANT NO.8

	2	1	0	1	2	
Hard	●	○	◎	○	○	Soft
Smooth	○	○	●	○	○	Rough
Non-Reflective	●	○	◎	○	○	Reflective
Cold	●	○	◎	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	●	○	◎	○	○	Ductile
Strong	●	○	◎	○	○	Weak
Light	○	○	◎	○	●	Heavy



SLATE

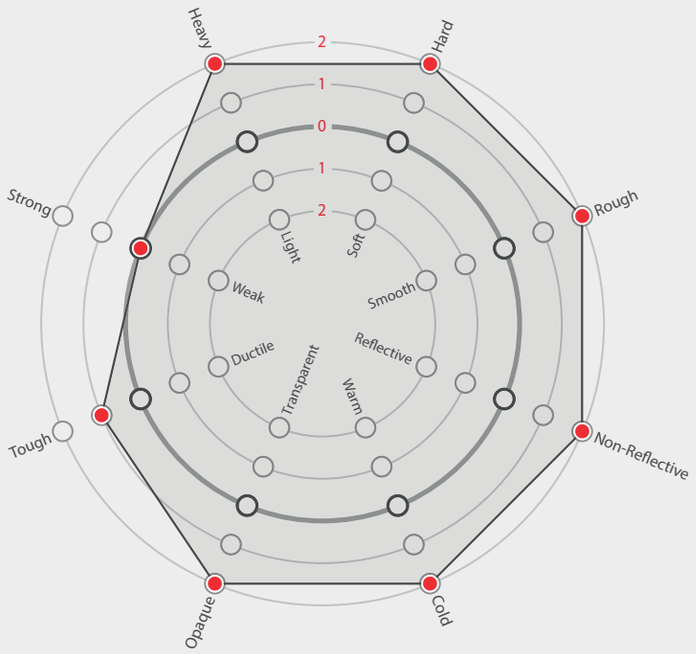
Fig 7.29

PARTICIPANT ASSOCIATIONS

Pulled out of the ground. Links to mining which was traditionally a man's role. Linear material. Non fluid in form. Sharp and rugged

PARTICIPANT NO.9

	2	1	0	1	2	
Hard	●	○	◎	○	○	Soft
Smooth	○	○	◎	○	●	Rough
Non-Reflective	●	○	◎	○	○	Reflective
Cold	○	○	●	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	○	●	◎	○	○	Ductile
Strong	○	○	●	○	○	Weak
Light	○	○	◎	○	●	Heavy



RIMU

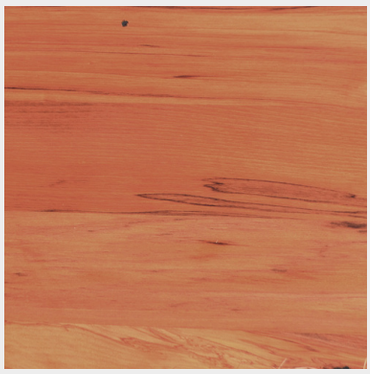


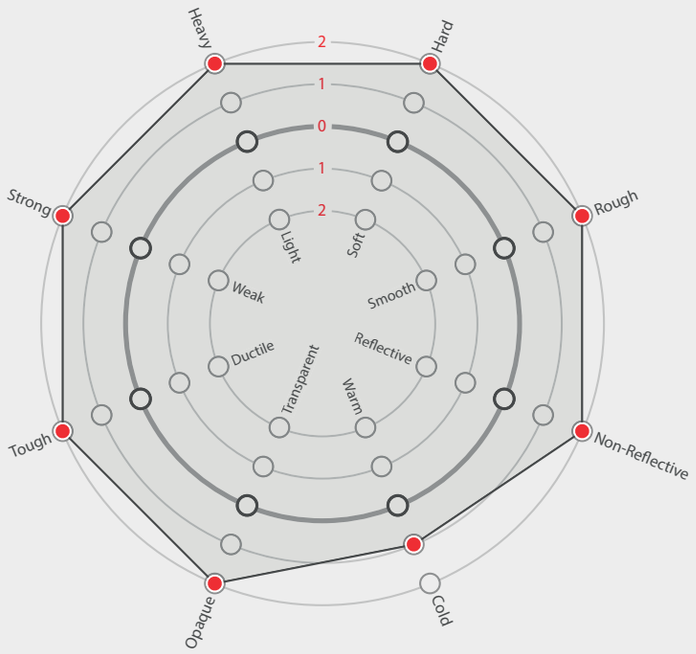
Fig 7.30

PARTICIPANT NO.9

	2	1	0	1	2	
Hard	●	○	○	○	○	Soft
Smooth	○	○	○	○	●	Rough
Non-Reflective	●	○	○	○	○	Reflective
Cold	○	●	○	○	○	Warm
Opaque	●	○	○	○	○	Transparent
Tough	●	○	○	○	○	Ductile
Strong	●	○	○	○	○	Weak
Light	○	○	○	○	●	Heavy

PARTICIPANT ASSOCIATIONS

Used in housing and furniture. Dense and heavy so generally required a male to work it. Structural but still retains aesthetic qualities.



STEEL

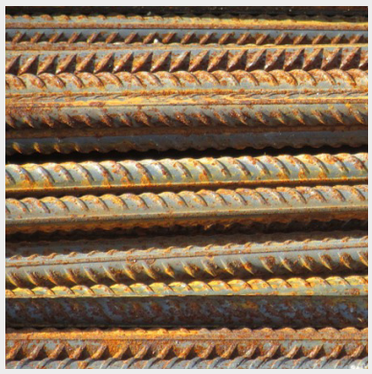


Fig 7.31

PARTICIPANT ASSOCIATIONS

Functional and structural. Coarse material. Changes over time. Oxidises and reacts to the environment. Resilient.

PARTICIPANT NO.9

	2	1	0	1	2	
Hard	●	○	◎	○	○	Soft
Smooth	○	○	◎	○	●	Rough
Non-Reflective	○	●	◎	○	○	Reflective
Cold	○	○	●	○	○	Warm
Opaque	●	○	◎	○	○	Transparent
Tough	●	○	◎	○	○	Ductile
Strong	●	○	◎	○	○	Weak
Light	○	○	◎	○	●	Heavy

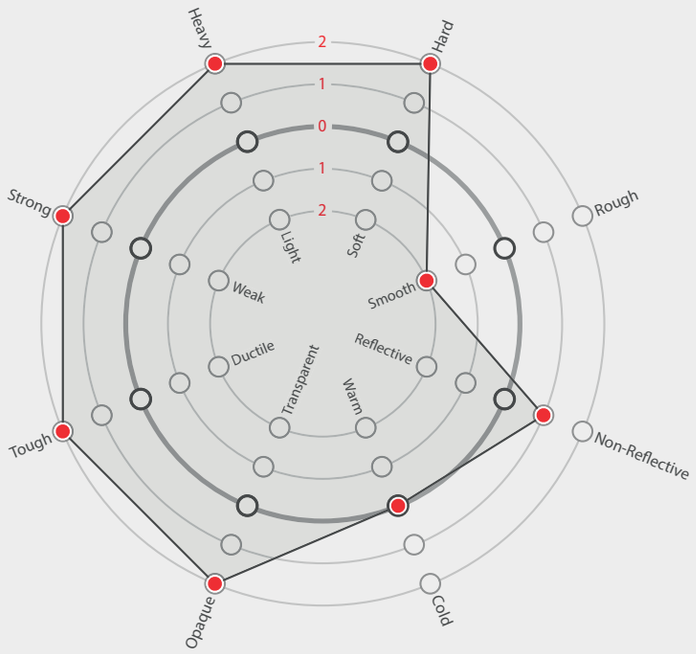


PHOTO STUDIES

8

From the images supplied by participants, four material categories were constructed: wood, metal, stone, and leather. The participant descriptions of the materials were collated for each category and used to generate word clouds. These word clouds visualise the words used to describe the materials within each category. Words that were used more than once by the nine participants when describing the materials appear larger than others. This gives a visual representation of the shared/ similar views of the expression of contemporary masculinity within material.

WOOD

Fig 8.01 - Oak

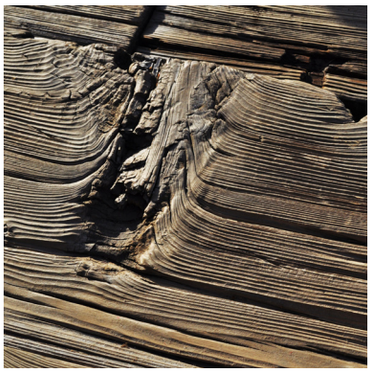


Fig 8.02 - Wood

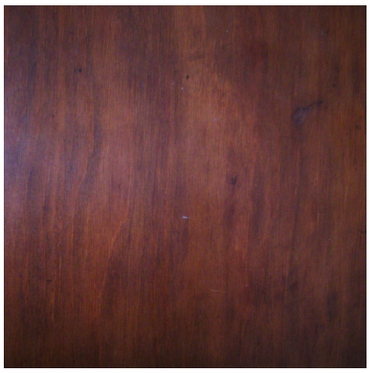


Fig 8.03 - Mahogany

Fig 8.04 - Cedar

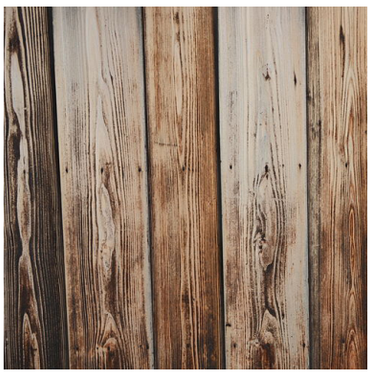


Fig 8.05 - Wood

Fig 8.06 - Oak Bark

Fig 8.07 - Wood

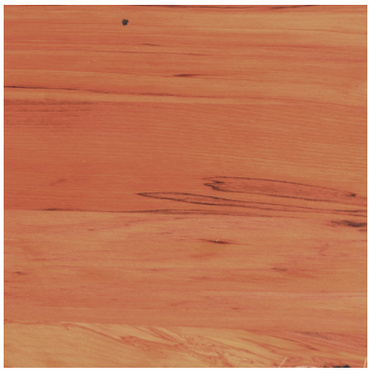


Fig 8.08 - Rimu

Fig 8.09 - Wood material category word cloud

METAL

Fig 8.10 - Iron

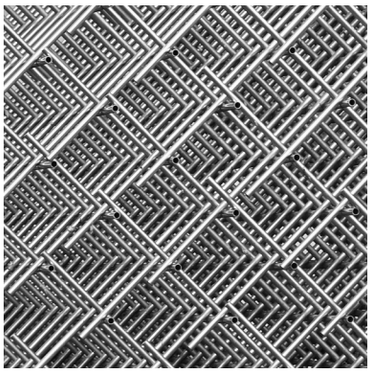


Fig 8.11 - Steel

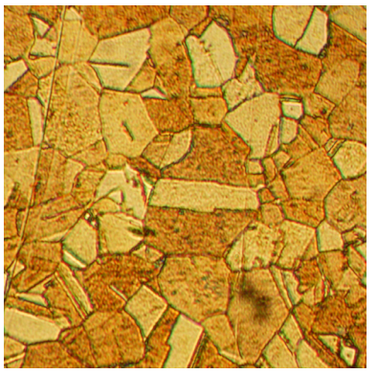


Fig 8.12 - Brass

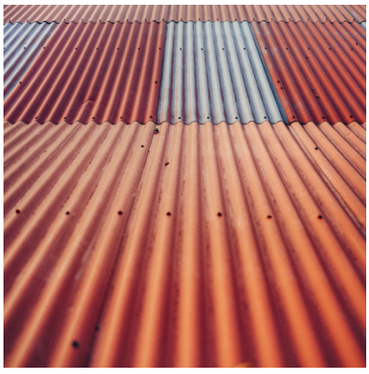


Fig 8.13 - Steel

Fig 8.14 - Steel

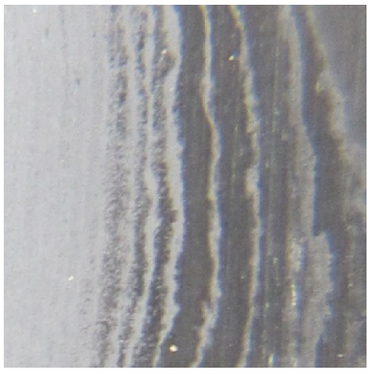


Fig 8.15 - Steel

Fig 8.16 - Steel

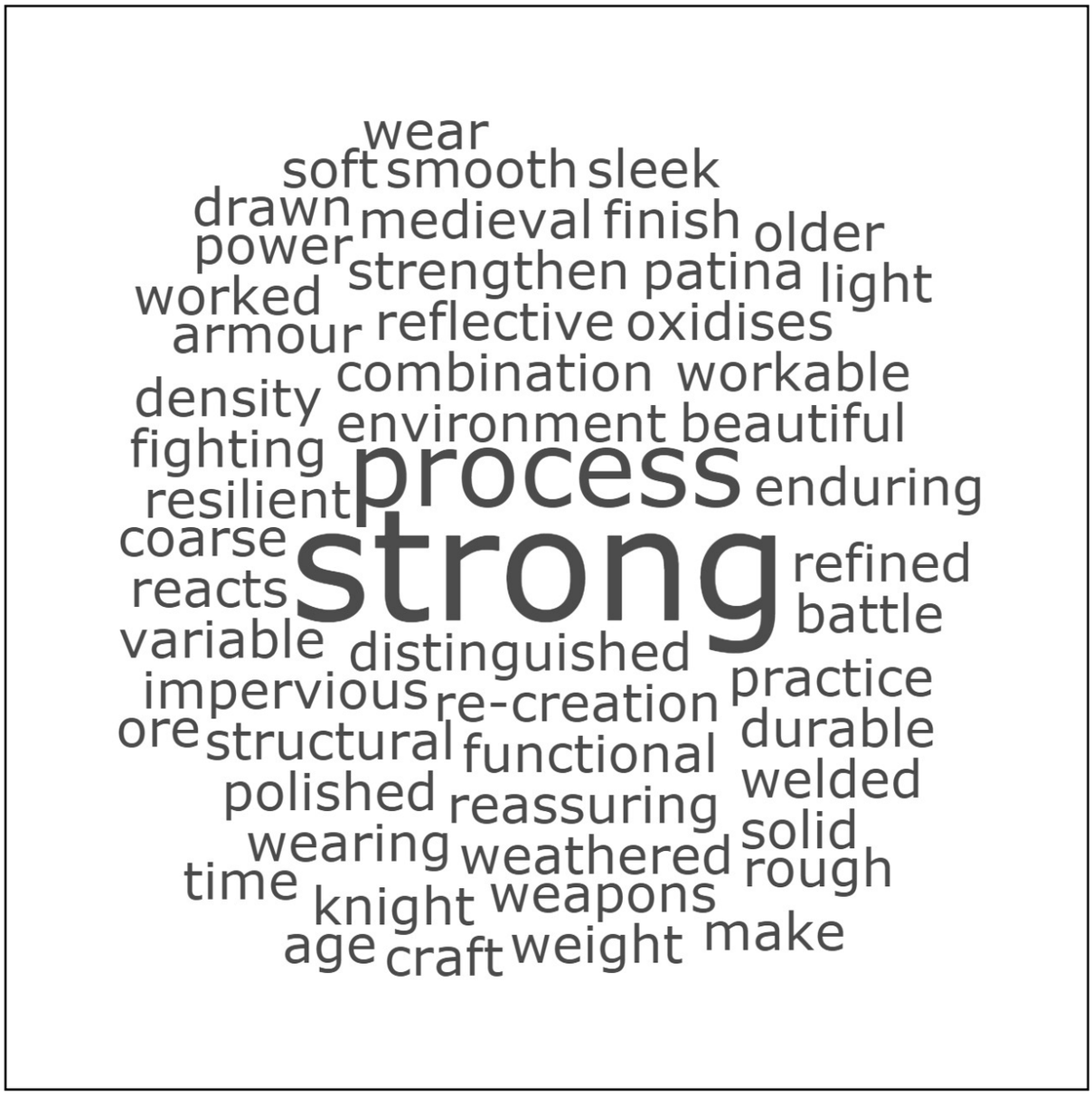


Fig 8.17 - Metal material catergory word cloud

STONE

Fig 8.18 - Clay Dirt

Fig 8.19 - Slate

Fig 8.20 - Concrete

Fig 8.21 - Concrete

Fig 8.22 - Marble

Fig 8.23 - Slate

Fig 8.24 - Stone material catergory word cloud

LEATHER

Fig 8.25 - Leather

Fig 8.26 - Leather

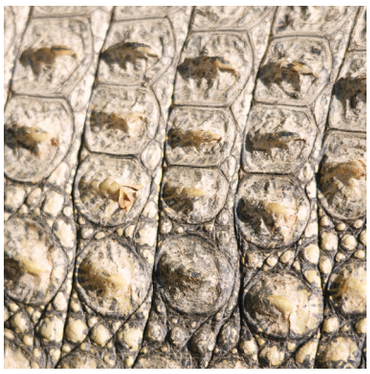


Fig 8.27 - Leather

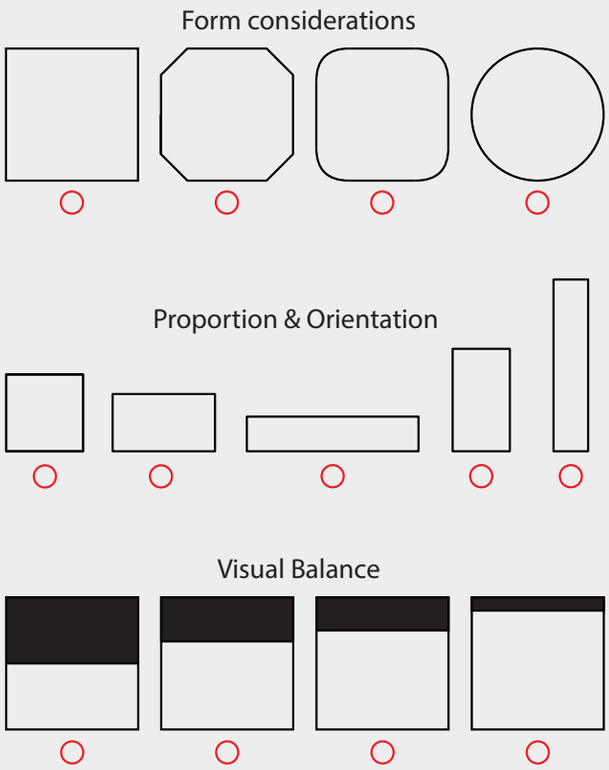
Fig 8.7 - Leather material catergory word cloud

PARAMETRIC DESIGN

9

Form & Proportion:

*Per row indicate form/proportion/visual balance expresses the highest masculinty



Participant no: ____

Fig 9.1 - Form/ proportion questionnaire

The from and proportion survey (Fig 9.1) was used in the development of the parametric definition. Participants were asked to choose which form, proportion, and visual balance image best expressed contemporary masculinity. Participants were asked to indicate one from each section, but were informed that they were able choose two if they felt they both equally expressed masculinity.

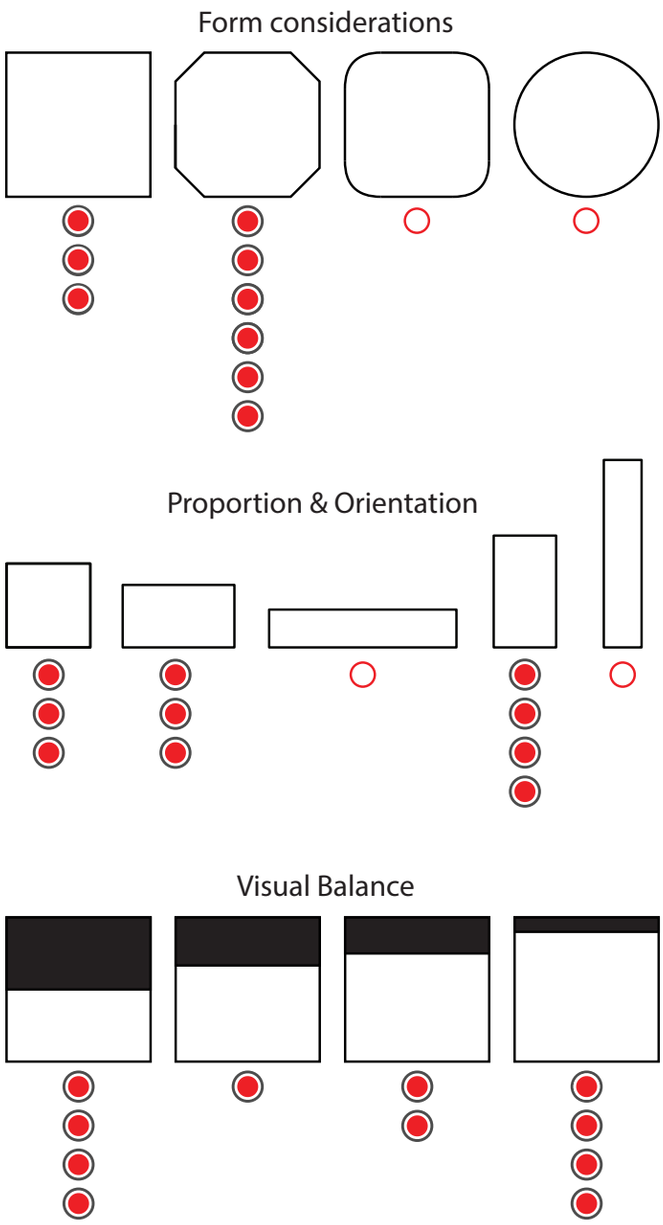
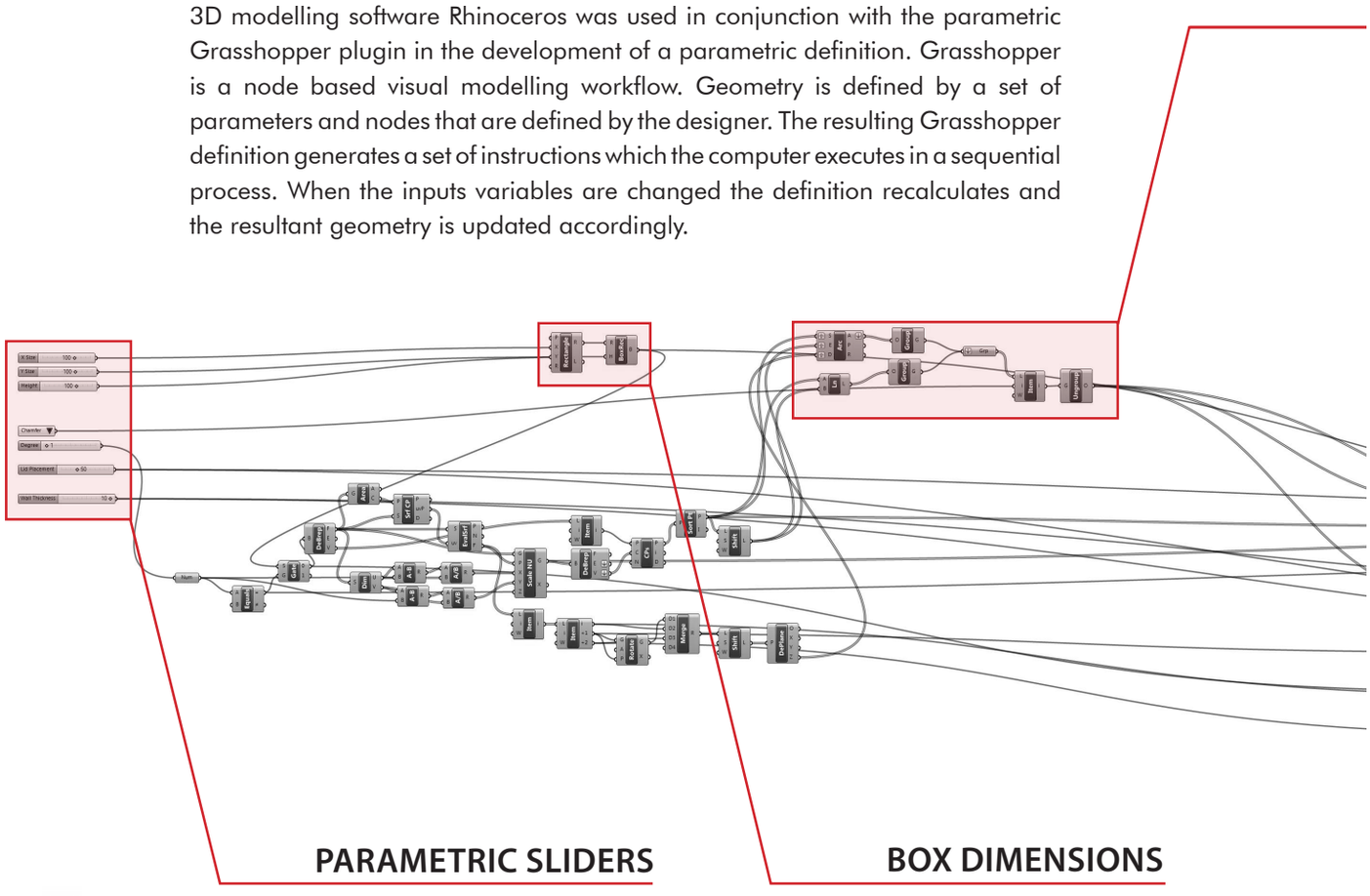


Fig 9.2 - Form/ proportion survey

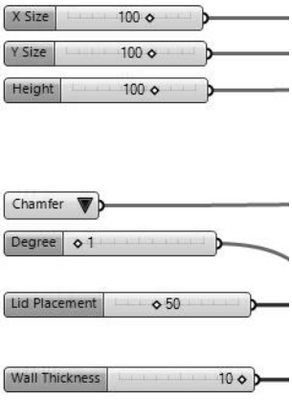
Fig 9.2 visualizes the results of the nine participant responses to the form and proportion survey. Each red marker res presents a participant response. Apart form the form considerations, the overall participant results show a range of perspectives and it was decided to include the whole range of potential form, proportion, and visual balance considerations within the parametric definition.

PARAMETRIC DEFINITION

3D modelling software Rhinoceros was used in conjunction with the parametric Grasshopper plugin in the development of a parametric definition. Grasshopper is a node based visual modelling workflow. Geometry is defined by a set of parameters and nodes that are defined by the designer. The resulting Grasshopper definition generates a set of instructions which the computer executes in a sequential process. When the inputs variables are changed the definition recalculates and the resultant geometry is updated accordingly.



PARAMETRIC SLIDERS



Consists of variable numerical values and edge treatment toggle button which govern the following features in the generation of the product container

BOX DIMENSIONS

Builds a box from the X, Y, and Z parameters

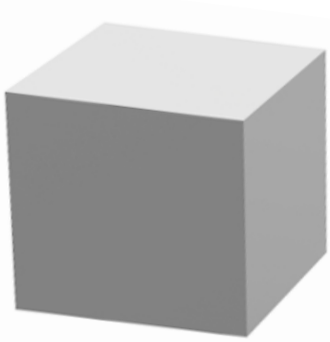
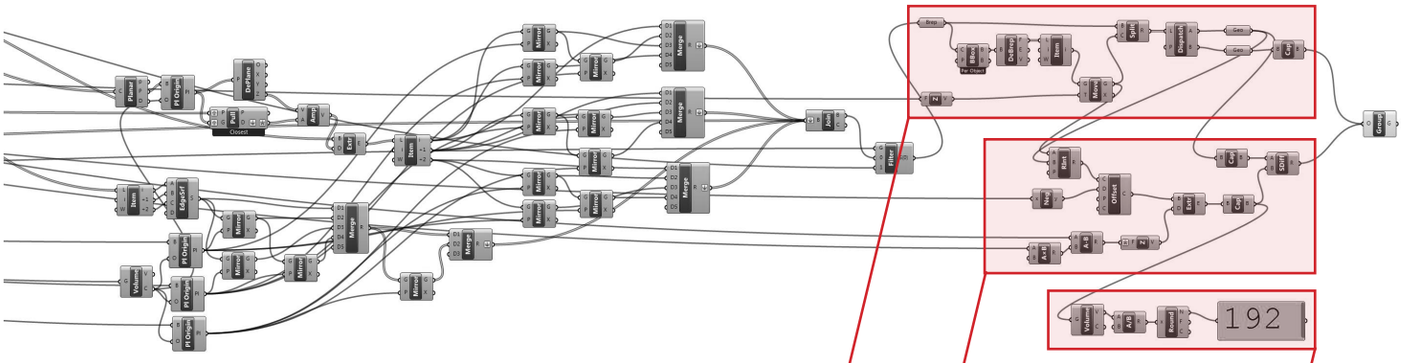


Fig 9.3 - Grasshopper 3D parametric definition

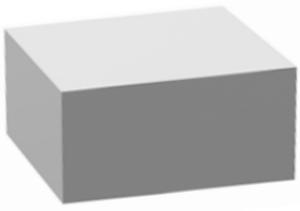
EDGE TREATMENT

Enables the choice between a radius chamfer and straight edge to be applied to the container



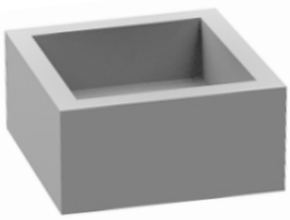
CONTAINER LID

Splits the container into two halves based on the lid placement parameter



CONTAINER VESSEL

Builds the cavity based of the wall thickness parameter



VESSEL VOLUME

Calculates the internal container volume

PARTICIPANT PROTOTYPES

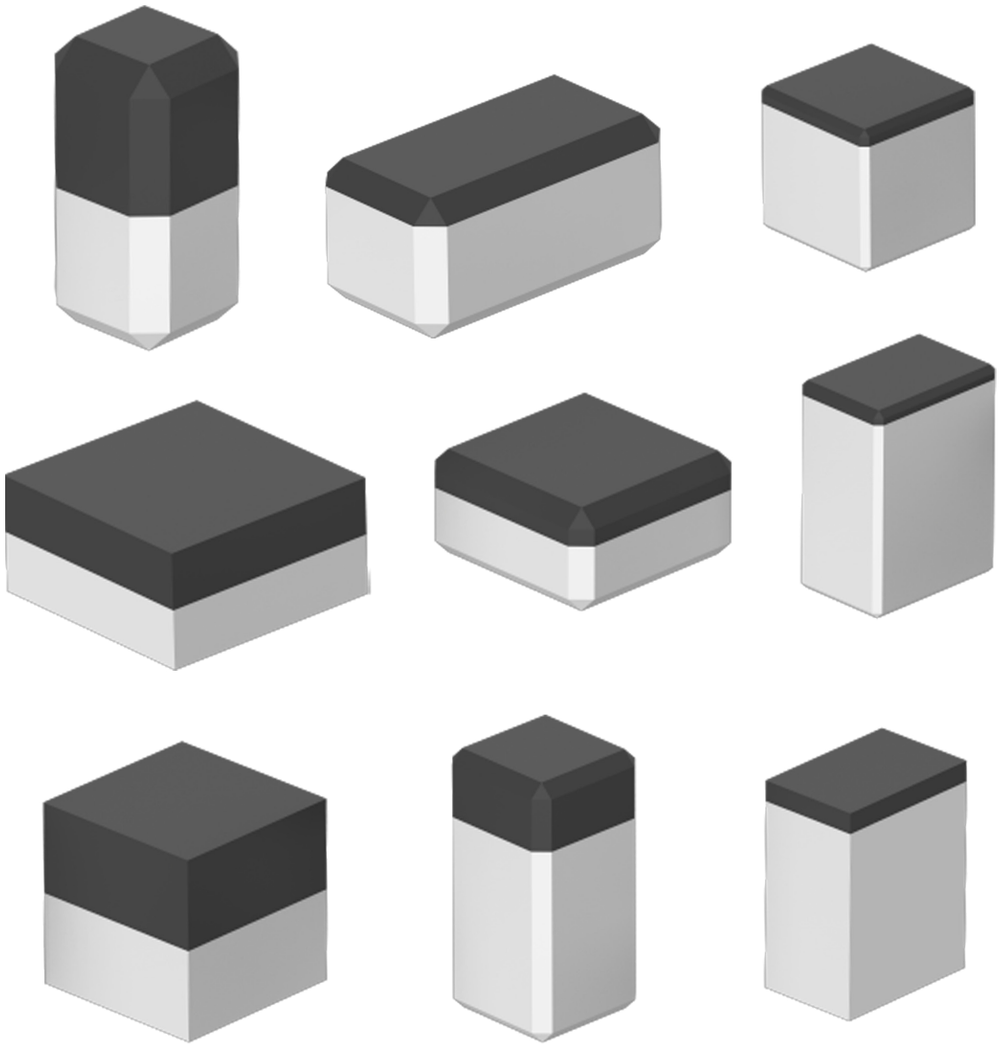
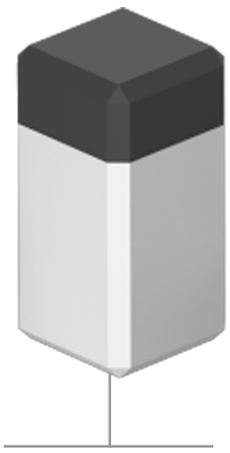


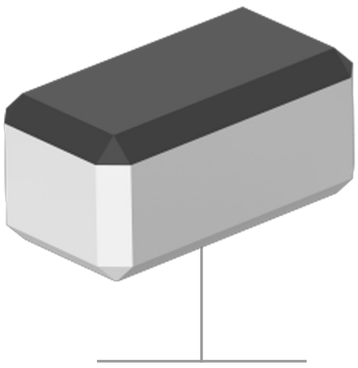
Fig 9.4 - Nine participant form/ proportion prototypes

Using the results from the form and proportion questionnaires, nine digital product containers were generated that represented each of the participant's interpretations of the expression of masculinity in regards to form, proportion, and visual balance. They were generated by the researcher through the use of the parametric definition.



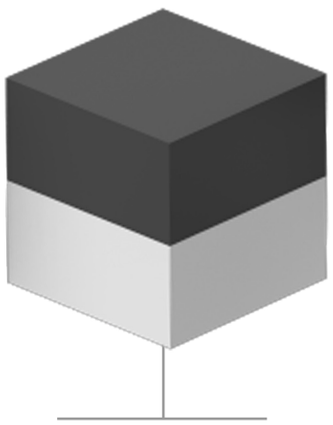
PARAMETERS

X: 45
Y: 45
Z: 135
Chamfer: 15
Lid placement: 90
Wall thickness: 10



PARAMETERS

X: 100
Y: 100
Z: 100
Chamfer Degree: 0
Lid placement: 50
Wall thickness: 10



PARAMETERS

X: 70
Y: 135
Z: 60
Chamfer Degree: 25
Lid placement: 45
Wall thickness: 10

Fig 9.5 - Three digital chosen participant form/ proportion digital and physical prototypes

Three prototypes were chosen from the nine generated product containers that represented the range of forms, proportions, and ratios between the lid and container (Fig 9.5). The supplied material images from the participant interviews and resulting categories informed which materials the product containers would be constructed with.

The researcher chose the employed materials and combinations that led to the construction of the physical prototypes. As many of the participants described materials in vague terms such as wood, metal, leather, and concrete, the specific 'type' of material was chosen by the designer, which led to the construction of physical containers that matched the proportions of the three chosen digital prototypes. The physical containers in Fig 9.5 employed;

- Concrete/ steel
- Leather/ oak
- Oak/ concrete.

For the duration of the research these materials were referred to as concrete and metal, leather and wood, and wood and concrete.

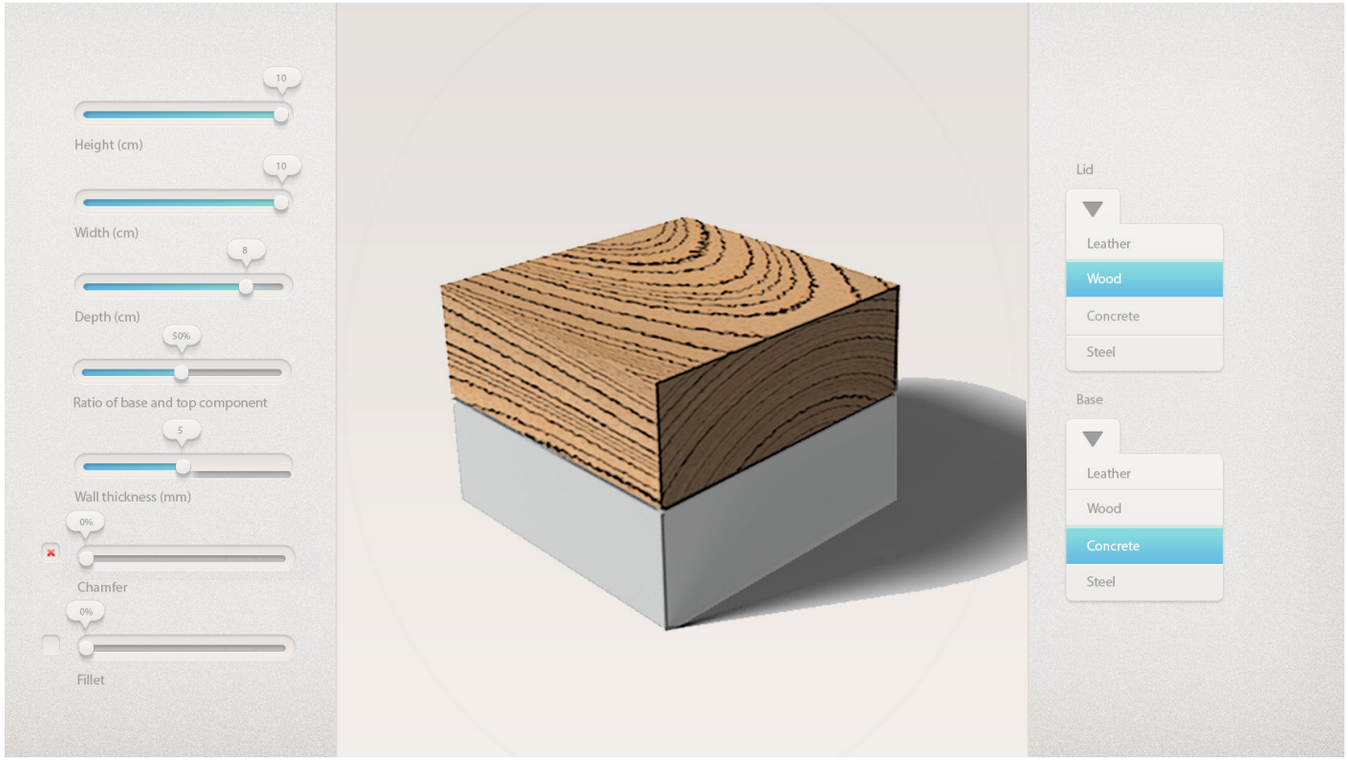


Fig 9.6 - Mock interface

MOCK INTERFACE

Based on the material selection and form/ proportion questionnaires, Fig 9.6 was constructed to visualise a mock web-based interface for the expression of contemporary masculinity through the customisation of material, form, and design detail considerations. The mock interface seeks to reflect the material and form/ proportion questionnaires and it uses a slider based system similar to Fab Forms and Shapeshifter in addressing the following considerations:

- Height (cm)
- Width (cm)
- Depth (cm)
- Ratio of base and top component

- Degree of chamfer
- Degree of fillet

The mock interface also enables materials to be selected for the top and bottom components. The materials available were informed by the material images supplied by the participants and the resulting material categories. If taken further, the interface would contain a range of material categories to choose from rather than being limited to a selection of four. The current research project seeks to develop a system to better address and cater to complex ideas through the incorporation of a parametric design approach. The research seeks to determine if a parametric design approach can effectively enable the expression of contemporary masculine qualities in the customisation and design of product containers. The development of a web-based interface for customisation falls outside the scope of the research, but if this approach is successful, future studies could seek to develop such a tool.

PROTOTYPE ASSESSMENT

10

Fig 10.1 - Physical containers

A final interview was conducted with participants, where they verbally assessed the three physical product prototypes:

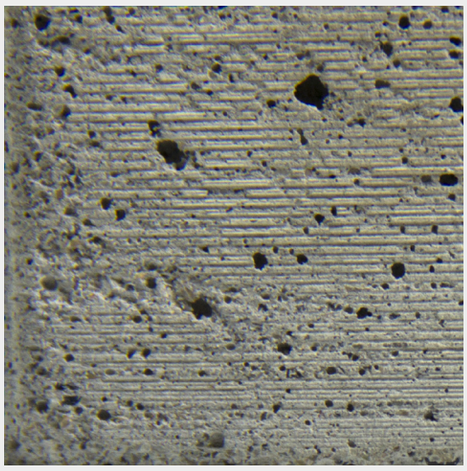
Concrete and Metal
Leather and Wood
Wood and Concrete.

Participants were asked:

Do you feel these containers express contemporary masculine qualities through the employed material and form considerations?	**What would you alter/ change about these containers in regards to the materials and forms employed?**

Participant comments were documented and were paired with an image of each physical prototype along with close up texture images (Fig 10.1-10.3). These helped inform the alterations needed to be made within the

CONCRETE AND STEEL



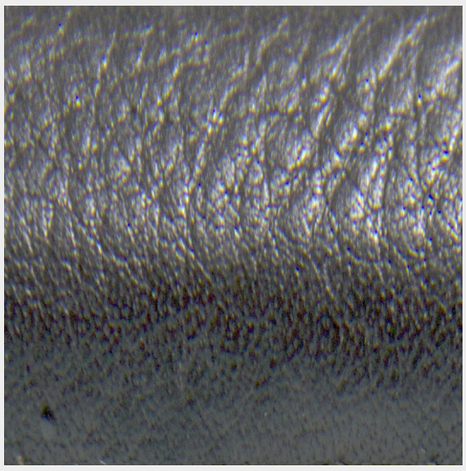
PARAMETERS

X: 45
Y: 45
Z: 135
Chamfer: 15
Lid placement: 90
Wall thickness: 10

Fig 10.2 - Metal and Concrete physical container

Do you feel these containers express contemporary masculine qualities through the employed material and form considerations?	**What would you alter/ change about these containers in regards to the materials and forms employed?**
Most masculine container because of shape and size. Tall, length. The use of metal and concrete paired together feels more masculine. Represents male dominant professions such as building, scaffolding.	Feels too organic.
	Grey and matte.
	The materials blend together while the others contrast.
Feels like a modern perfume bottle. The smaller chamfers work better. Rough gritty texture feels good. Smooth steel is a good juxtaposition.	Concrete feels fragile. Prefer if it were polished.
Feels industrial. Chamfers allow it to be held comfortably	Too heavy. Concrete too rough, needs coating
Good weight, texture. It fulfils the role of a perfume bottle. It's good as it is.	Smoother concrete texture. Too contrasting.
Chamfered edges is more masculine than the sharp edges. Easier to hold due to chamfers. Catches the light. Reflective qualities. More aesthetic	Sealed concrete would be better.
Very heavy. Rough. Sharp lines	
Concrete is industrial and contemporary. Balanced. Thirds ratio.	

LEATHER AND WOOD



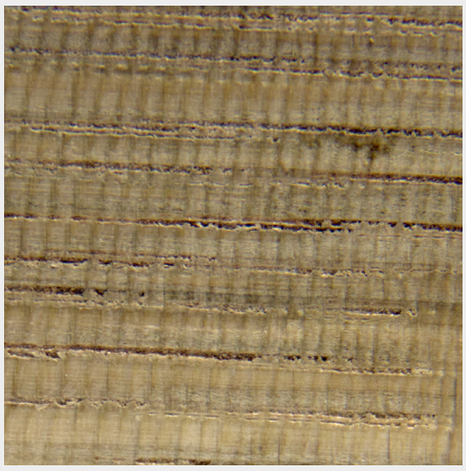
PARAMETERS

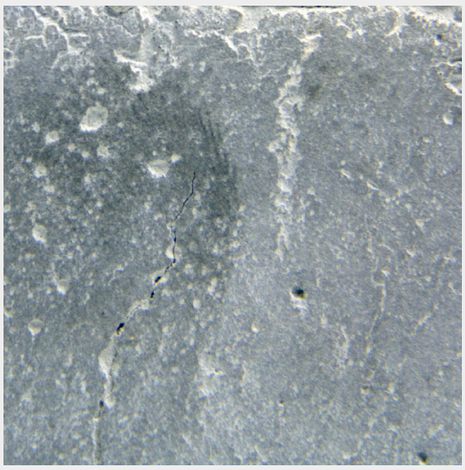
X: 70
Y: 135
Z: 60
Chamfer Degree: 25
Lid placement: 45
Wall thickness: 10

Fig 10.3 - Leather and Wood physical container

Do you feel these containers express contemporary masculine qualities through the employed material and form considerations?	**What would you alter/ change about these containers in regards to the materials and forms employed?**
Feels like a sarcophagus. The proportions are not masculine. Could be more extreme. The leather a wood do work together.	Try patterning, variation in texture in materials.
Angular nature. Tactility in the leather	Chamfer is too extreme. Lesser degree is needed.
The combination of leather and wood feels masculine.	Prefer if the wood was varnished. Wood is too light, use a more dense wood.
Soft surface. Textured. Leather has a practical feel to it. Reliable.	Higher level of craft for leather. Possibly change the shape to accommodate the leather.
Leather is warm. Rough rugged edged. Not clean	Lacking in leather. Lid needs to be bigger compared to the base.
Speaks of traditional masculinity	Proportions don't feel masculine. Better craft with leather

WOOD AND CONCRETE





PARAMETERS

X: 100
Y: 100
Z: 100
Chamfer Degree: 0
Lid placement: 50
Wall thickness: 10

Fig 10.4 -Wood and Concrete physical container

Do you feel these containers express contemporary masculine qualities through the employed material and form considerations?	**What would you alter/ change about these containers in regards to the materials and forms employed?**
Wood can be shaped and cut. Concrete feels bold and rugged with sharp edges. Worn. The wood is the same shape and smooth just like the concrete.	Too bulky and heavy
Nice and big. Feels chunky. Masculine proportions	Concrete feels fragile. Prefer if it were polished.
Clean lines are appealing. Combination of the wood grain feels natural, organic	Hard corners are too aggressive. Too much container and not enough storage.
Rugged. Corners and edges are masculine.	Too many sharp edges
Good weight. Feels sturdy and durable.	
Good weight and size. Nice smooth concrete finish	
Contrast between the warm wood and cold concrete material. Balance. Weight	
Equal balanced proportions. Concrete is industrial and contemporary	

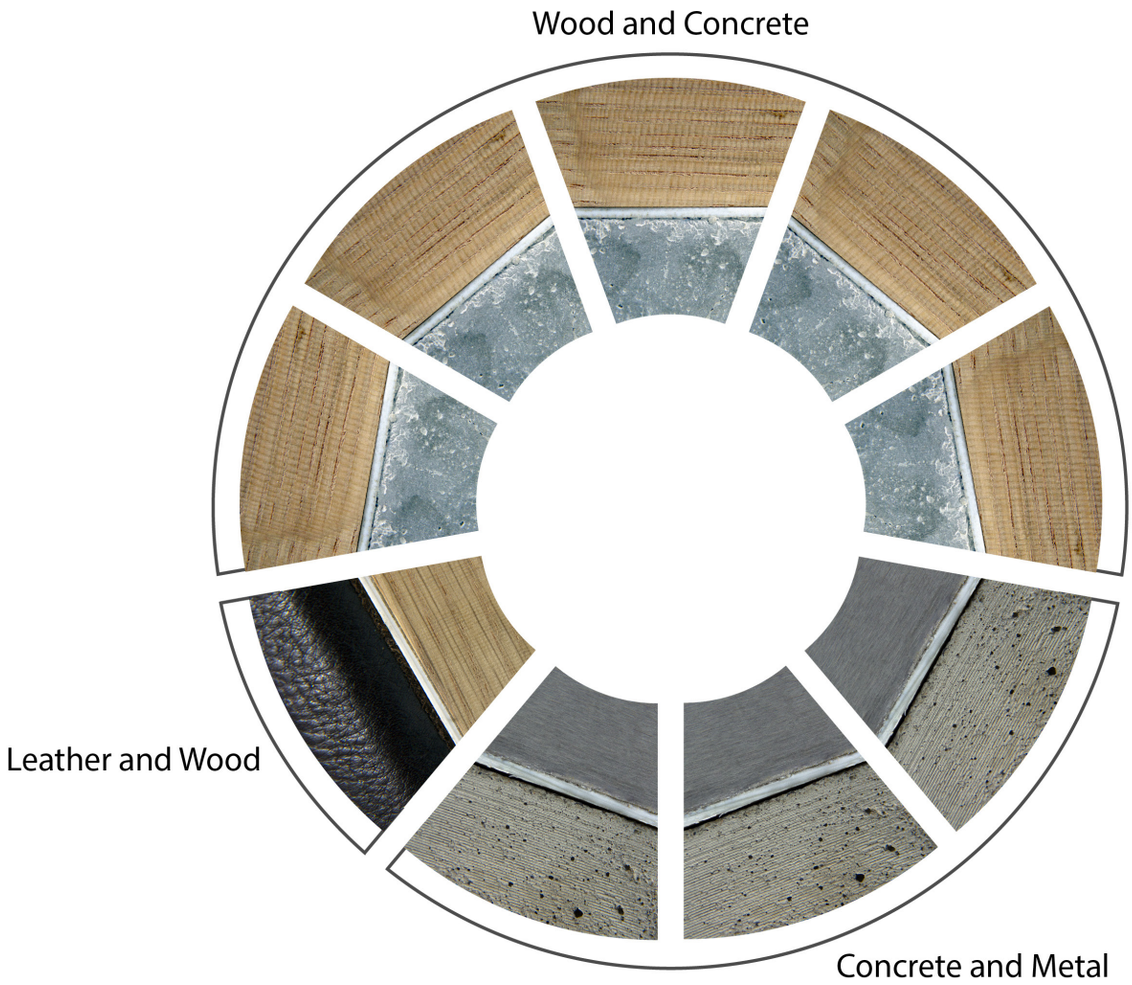


Fig 10.5 - Most potential physical prototype visualisation

MASCULINITY CONTAINER POTENTIAL

During the final interview, participant's were asked the question:

> "Which product container has the most potential for the expression of contemporary masculine qualities?"

Below is a graphic displaying the results of each participants response to the question in regards to their preferred prototype. Each segment, represents a response and each image within the segments corresponds to either the concrete and steel, leather and wood, or wood and cement container. Fig 10.4 reiterates the responses from participants in regards to the question:

> "What would you alter/ change about these containers in regards to the materials and forms employed?"

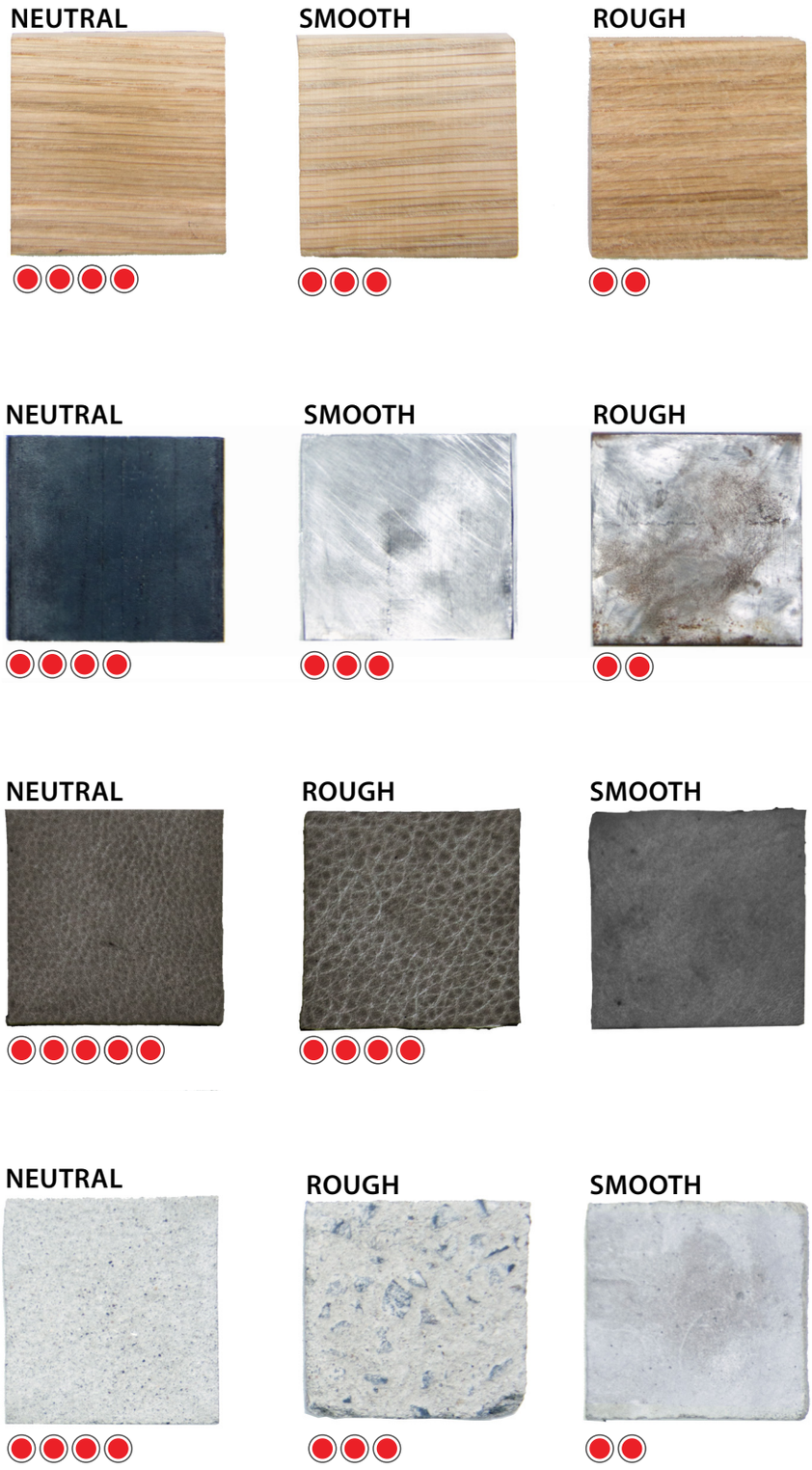


Fig 10.6 - Combined material swatches sorting responses

MATERIAL SWATCHES

Physical material swatches were constructed based on the four identified material categories: wood, metal, leather, and stone. The swatches were produced using the materials of oak, steel, leather, and concrete that were employed within the physical prototypes. Three material swatches were produced for each material, ranging in surface qualities/ texture from one extreme, neutral, and the opposite extreme.

Wood	Smooth to rough
Metal	Smooth and polished to rough and rusted
Concrete	Smooth and polished to rough with aggregate
Leather	Smooth and texture-less to rough and heavy texture

Participants were asked to sort the swatches from left to right. Left being the swatch that best expressed contemporary masculinity. Fig 10.5 shows the swatches in order from the most indicated to the least from the sorting by the nine participants. The red markers indicate how many times each material swatch was indicated. From the overall results, the majority of participants chose the neutral swatches. The remaining swatches apart from the smooth leather were all indicated at least twice. Even though the neutral swatches were indicated the most, the results from the sorting shows that the expression of masculinity in regards to surface quality/ texture varies between the nine participants.

REFINED DIGITAL PROTOTYPES

11

Based upon the suggestions of participants in the assessment of the physical product containers, a series of digital variations were generated through the use of the parametric definition. Because these containers were digital representations of the participant feedback, only the suggestions affecting the material, form, and design details were taken into consideration. The parametric definition was used to make the alterations in regards to the form and design details and then the models were processed in Keyshot, a 3D rendering software. Keyshot enabled materials to be applied to the models in addressing the materials suggestions. These models were then rendered and displayed with the participant suggestions.

CONCRETE AND METAL

Fig 11.1 - Concrete and Metal physical container

WHAT WOULD YOU ALTER/ CHANGE ABOUT THESE CONTAINERS IN REGARDS TO THE MATERIALS AND FORMS EMPLOYED?

PARTICIPANT SUGGESTIONS

Concrete feels fragile. Prefer if it were polished.

Too heavy. Concrete too rough, needs coating

Smoother concrete texture. Too contrasting.

Sealed concrete would be better.

Feels too organic. Grey and matte.

The materials blend together while the others contrast.

MODIFIED DIGITAL CONTAINERS

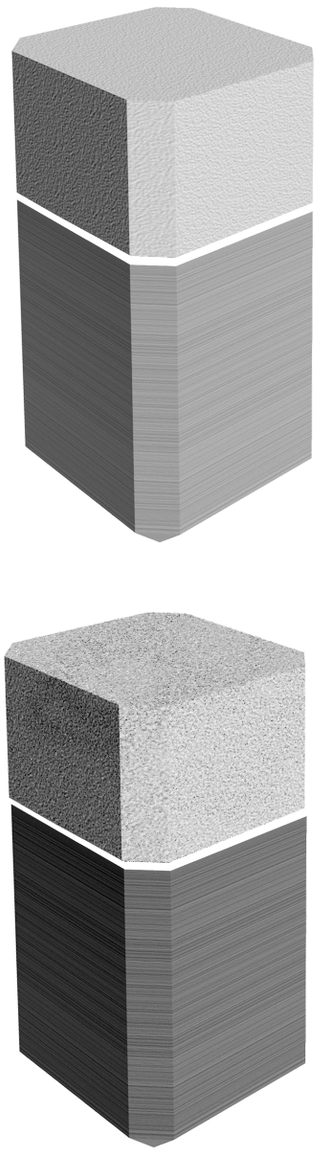


Fig 11.2 - Concrete and Metal digital containers refined

LEATHER AND WOOD

Fig 11.3 - Leather and Wood physical container

WHAT WOULD YOU ALTER/ CHANGE ABOUT THESE CONTAINERS IN REGARDS TO THE MATERIALS AND FORMS EMPLOYED?

PARTICIPANT SUGGESTIONS

Lacking in leather. Lid needs to be bigger compared to the base.

Higher level of craft for leather. Possibly change the shape to accommodate the leather.

Chamfer is too extreme. Lesser degree is needed.

Try patterning, variation in texture in materials.

Prefer if the wood was varnished. Wood is too light, use a more dense wood.

MODIFIED DIGITAL CONTAINERS

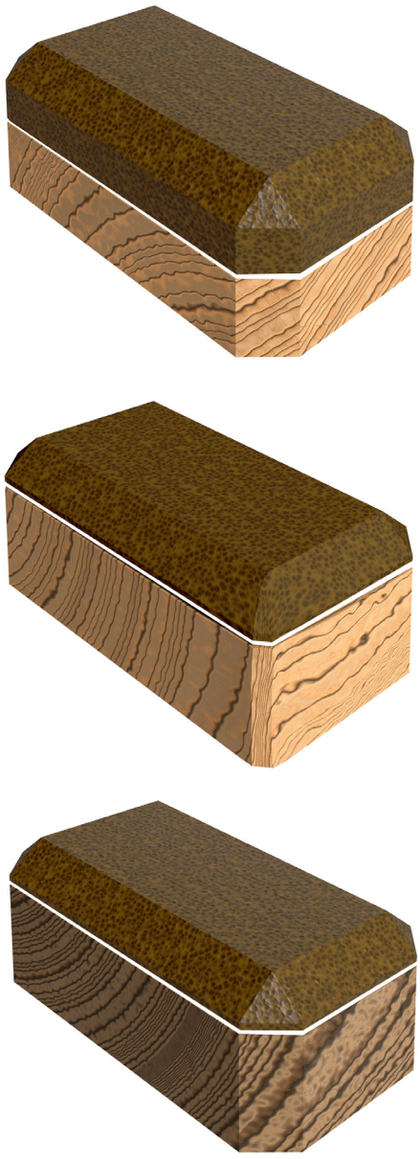


Fig 11.2 - Concrete and Metal refined digital containers

WOOD AND CONCRETE

Fig 11.5 - Wood and Concrete physical container

WHAT WOULD YOU ALTER/ CHANGE ABOUT THESE CONTAINERS IN REGARDS TO THE MATERIALS AND FORMS EMPLOYED?

PARTICIPANT SUGGESTIONS

Too many sharp edges

Hard corners are too aggressive.
Too much container and not enough storage.

Concrete feels fragile. Prefer if it were polished.

MODIFIED DIGITAL CONTAINERS

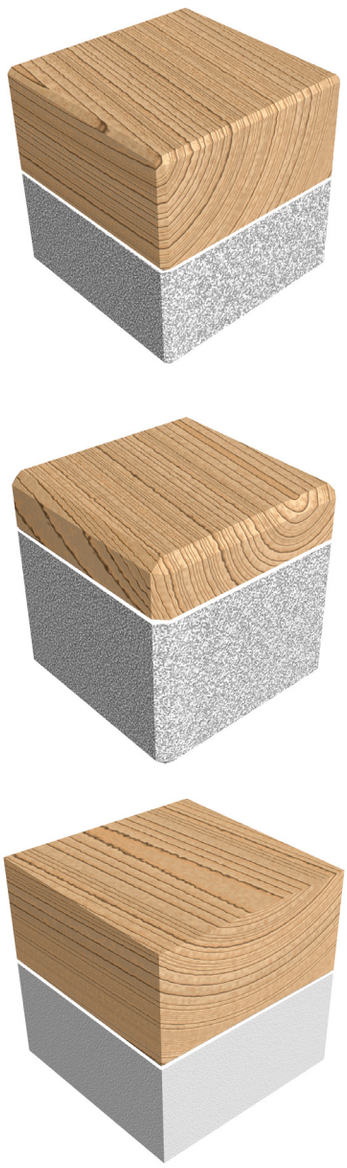


Fig 11.6 - Wood and Concrete refined digital containers

DISCUSSION & CONCLUSIONS

12

The primary goal of the research was to develop a system to better address and cater to complex ideas through the incorporation of a parametric design approach. A parametric definition was produced informed by the inclusion of interviews and questionnaire, which allowed New Zealand men to express their interpretation of contemporary masculinity. This was achieved through identifying the expression of contemporary masculine qualities in material, form, and design details, and resulting in the customisation of product containers. The 'Meanings of Materials' (MOM) selection tool (2010), was adapted to include form and proportion considerations, where interviews and questionnaires played a key role. The data was collated to create visualisations and material photo studies/ palettes for the analysis and communication of the expression of contemporary masculinity. Nine digital product prototypes were generated within the parametric definition. Three physical prototypes that captured the range of solutions were built alongside a series of material swatches which participants assessed. Adjustments were made to the three prototypes based upon each participant's assessment and resulted in the generation of a series of digital prototypes that embodied each participant's interpretation of contemporary masculinity.

Due to the qualitative nature of the research, the participant group of nine needs to be recognised as a limitation. The participant were New Zealand males with an age range from 20-28. Some had prior design knowledge and all had experience in working with a range of materials. The responses from each participant reflect their individual perspectives on the expression of contemporary masculinity in material, form, and design detail, and as such results can only be used to understand masculinity within this context. The participants were not given access to and unable to interact directly with the parametric definition as it was built in CAD software and not as a web-based interface. The researcher acted as a mediator between the participants and the parametric definition. The researcher was responsible for the translation of participant data in the formation of the container prototypes, which also must be recognised as a limitation.

This research highlights the necessity of the reciprocal relationship between the designer and the consumer. When attempting to tackle larger issues/ ideas such as identity, it becomes the responsibility of the designer to best understand and represent the ranging perspectives and needs of consumers. This research argues that a parametric design approach is able to bridge the gap between the designer and the consumer. Instead of prescribing qualities or trying to cater to each consumer at an individual level, a web-based parametric interface is able to offer a range of customisable options. Designers can't and should not attempt to define such dynamic and evolving identities, and a parametric approach enables them to avoid doing so by allowing consumers to decide for themselves. This is an opportunity for complex ideas such as masculine identity to be better represented and articulated. It was identified the customisation through parametric design o ffered the best conditions for effectively catering to this complex ideas.

In reflecting on the success of this thesis, future studies would benefit from seeking additional user testing in order to develop a parametric definition for a web-based interface applicable to the customisation of products and the expression of increasingly complex ideas and identities. Due to the limitations endured in this 90-point thesis, the parametric definition applied in the case study outlined in this thesis was constructed solely to translate the data applicable to 3D product container forms. While the initial physical prototypes constructed to support this case study were handmade, if this research were to be expanded these would have been developed through a parametric digital interface and actually produced using digital manufacturing technologies. As the focus of the research focused on the testing of the parametric system rather than the manufacture of the products, the author notes that the realization of the final prototypes would have benefitted from more accurately reflecting the process outlined had the time allowed.

WORKS CITED

Adamson, G. (2010). *The Craft Reader*. Oxford: Berg Publishers, (3rd ed., pp. 321-332)

Alexander, S. (2003). Stylish Hard Bodies: Branded Masculinity in Men's Health Magazine. *Sociological Perspectives, 46*(4), 535-554. http://dx.doi.org/10.1525/sop.2003.46.4.535

Ashby, M. F. (2005) *Materials Selection in Mechanical Design*. Amsterdam: Butterworth-Heinemann, 2005.

Berman, B. (2002). "Should Your Firm Adopt A Mass Customization Strategy?". *Business Horizons, 45*(4), 51-60.

Camba, J., Contero, M., & Company, P. (2016). Parametric CAD modelling: An analysis of strategies for design reusability. *Computer-Aided Design*, 74, 18-31. http://dx.doi.org/10.1016/j.cad.2016.01.003

Chryssolouris, G., Mavrikios, D., Papakostas, N., Mourtzis, D., Michalos, G., & Georgoulias, K. (2009). *Digital manufacturing: history, perspectives, and outlook.* Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture, 223(5), 451-462. http://dx.doi.org/10.1243/09544054jem1241

Doordan, D. (2003). "On Materials". *Design Issues 19*(4) 3-8.

Farag, M. (2013) *Selection of Materials and Manufacturing Processes for Engineering Design*. New York: Prentice Hall, 1989.

Flocker, M. (2003). *The metrosexual guide to style*. Cambridge, MA: Da Capo Press.

Franke, N. & Schreier, M. (2007). Product uniqueness as a driver of customer utility in mass customization. *Marketing Letters, 19*(2), 93-107. http://dx.doi.org/10.1007/s11002-007-9029-7

Franke, N., Schreier, M., & Kaiser, U. (2010). The "I Designed It Myself" Effect in Mass Customization. *Management Science, 56*(1), 125-140. http://dx.doi.org/10.1287/mnsc.1090.1077

Gant, N. (2005). Plastics design - The unlikely pioneer of product relationships. In *Proceedings of the 1st International Conference on The Art of Plastics Design* (Paper No. 6), Shrewsbury: Rapra Technology

Hardesty, L. (2015, September 3). MIT – Customizing 3-D Printing. Retrieved from http://additivemanufacturing.com/2015/09/10/mit-customizing-3-d-printing/

Karana, E., Hekkert, P., & Kandachar, P. (2010). A tool for meaning driven materials selection. *Materials & Design, 31*(6), 2932-2941. http://dx.doi.org/10.1016/j.matdes.2009.12.021

Karana, E., Pedgley, O., & Rognoli, V. (2015). On Materials Experience. *Design Issues, 31*(3), 16-27. http://dx.doi.org/10.1162/desi_a_00335

Karana, E., Pedgley, O., & Rognoli, V. (2013). *Materials experience: Fundamentals of Materials and Design*. Butterworth-Heinemann

Kimmel, M. & Aronson, A. (2003). *Men and masculinities*. Santa Barbara, Calif.: ABC-CLIO.

Lennard, C. (2010, December 12). Masculine Dynamism – Men's Care Growing Fast. *Market Report: Men's Care. 78*(12), 34-36

McNeill, L. & Douglas, K. (2011). Retailing masculinity: Gender expectations and social image of male grooming products in New Zealand. *Journal of Retailing and Consumer Services, 18*(5), 448-454. http://dx.doi.org/10.1016/j.jretconser.2011.06.009

Piller, F. & Müller, M. (2004). A new marketing approach to mass customisation. *International Journal of Computer Integrated Manufacturing, 17*(7), 583-593. http://dx.doi.org/10.1080/0951192042000273140

Pompper, D. (2010). Masculinities, the Metrosexual, and Media Images: Across Dimensions of Age and Ethnicity. *Sex Roles, 63*(9-10), 682-696. http://dx.doi.org/10.1007/s11199-010-9870-7

Pope, H., Katharine, P., & Olivardia, R. *The Adonis Complex*. New York: Free Press, 2000.

Sennett, R. (1968). *The craftsman*. New Haven: Yale University Press.

Simpson, M. (2002, July 22). *Meet the metrosexual: He's well dressed, narcissistic and obsessed with butts. But don't call him gay*. Salon, Retrieved from http://archive.salon.com/ent/feature/2002/07/22/metrosexual/.

Stoetzel, M. (2012). Engaging Mass Customization Customers beyond Product Configuration: Opportunities from the Open Innovation Field. *International Journal of Industrial Engineering and Management, 3*(4), 241-251.

Tan, Y., Shaw, P., Cheng, H., & Kim, K. (2013). The Construction of Masculinity: A Cross-Cultural Analysis of Men's Lifestyle Magazine Advertisements. *Sex Roles, 69*(5-6), 237-249. http://dx.doi.org/10.1007/s11199-013-0300-5

Tedeschi, A. (2014). Foreword. Wirz, F. *AAD - Algorithms-aided design*. (pp. 9-11). Le Penseur.

Wong, D. (2011). *NikeID Makes $100M+: Co-Creation Isn't Just a Trend*. . Retrieved from http://www.huffingtonpost.com/danny-wong/nikeid-makes-100m-co-crea_b_652214.html

FIGURE LIST

FIG NO.	IMAGE NAME	SOURCE
5.1 - 5.6	All images and figures made by author.	
6.1	NIKEiD Interface	Nike. (2016) NIKEiD Interface. Retrieved from http://store.nike.com/us/en_us/product/free-rn-id-shoe/?piid=42709&pbid=206240054#?pbid=206240054
6.2	Project Shapeshifter Interface	Autodesk. (2016). Project Shapeshifter Interface. Retrieved from http://shapeshifter.io/
6.3	Ocean Box Interface	Shugrina, M., Shamir, A., & Matusik, W. (2015). Ocean Box Inter-face. Retrieved from http://cfg.mit.edu/content/fab-forms-customizable-objects-fabrication-validity-and-geometry-caching
6.4-7.04	All images and figures made by author.	
7.05 8.01	Oak Wood Cross-Section	Somma, R. (2012, May, 24). Oak Wood Cross-Section. Retrieved from https://www.flickr.com/photos/ideonexus/7318623882
7.06 8.10	Old dirty dusty rusty scratched metal iron	Tscharntke, T. (2013, March, 1). Old dirty dusty rusty scratched metal iron. Retrieved from https://commons.wikimedia.org/wiki/File:Old_dirty_dusty_rusty_scratched_metal_iron.jpg

7.07 8.25	Leather, brown, struc-ture	Winkler, F. (2014, November, 22). Leather, brown, struc-ture. Retrieved from https://pixabay.com/p-540142/?no_redirect
7.08 8.02	Wood, texture, wood-en	Shah, M. (2014, October, 22). Wood, texture, wooden. Retireved from https://pixabay.com/en/wood-texture-wooden-design-nature-497667/
7.09 8.11	Grid, wire mesh, stainless rods	Cocoparisienne. (2015, July, 2). Grid, wire mesh, stainless rods. Retrieved from https://pixabay.com/en/grid-wire-mesh-stainless-rods-826831/
7.10 8.18	A depiction of a clay for pot making	Maari, T. (2012, January, 18). A depiction of a clay for pot mak-ing. Retrieved from https://commons.wikimedia.org/wiki/File:A_depiction_of_clay_for_pot_making.JPG
7.11 8.03	Wood texture II	ResurgidaResources. (2008, October, 17). Wood texture II. Retrieved from http://resurgidaresources.deviantart.com/art/Wood-texture-II-101021711
7.12 8.12	Microstructure of rolled and annealed brass; magnification 400X	Strangerhahaha. (2008, October, 28). Microstructure of rolled and annealed brass; magnification 400X. Retrieved from https://commons.wikimedia.org/wiki/File:Microstructure_of_rolled_and_annealed_brass;_magnification_400X.jpg
7.13 8.26	Skin, leather, material	LalouBLue. (2013, May, 3). Skin, leather, material. Retrieved from https://pixabay.com/en/skin-leather-material-bag-grey-271953/
7.14 8.27	Skin of a juvenile Nile crocodile near Chilanga, Zambia	Hillewaert, H. (2010, July, 26). Skin of a juvenile Nile crocodile near Chilanga, Zambia. Retrieved from https://commons.wikimedia.org/wiki/File:Crocodylus_niloticus_(skin).jpg
7.15 8.13	A katana of the ko-buse type	Zaereth. (2011, May, 3). A katana of the kobuse type. Retrieved from https://commons.wikimedia.org/wiki/File:Katana_hardened_edge_pic_with_inset_of_nioi.JPG
7.16 8.04	Scribe-fit logwork	Chambers, W. (2009, February, 19). Scribe-fit logwork. Retrieved from https://commons.wikimedia.org/wiki/File:Handcrafted_Scribe-Fit_Log_Home_Closeup.jpg

7.17 8.19	Mountains, slate, grey slate	flyupmike. (2012, July, 7). Mountains, slate, grey slate. Retrieved from https://pixabay.com/en/mountains-slate-grey-slate-51699/
7.18	Tailored rubber mat	Keystones. (2013, Febuary, 6). Tailored rubber mat. Retrieved from https://commons.wikimedia.org/wiki/File:Tailored-rubber-mats-moulded-car-mats.jpg
7.19	Crossbred wool	Goodwin, C. (2008, February, 25). Crossbred wool. Retrieved from https://commons.wikimedia.org/wiki/File:Crossbred_wool.JPG
7.20 8.05	Wood Wall 004	The.Firebottle, (2011, April, 29). Wood Wall 004. Retrieved from https://commons.wikimedia.org/wiki/File:Wood_wall_004.jpg
7.21 8.20	Wood grain German occupation bunker concrete 1	Man vyi. (2008, July, 28). Wood grain German occupation bunker concrete 1. Retrieved from https://commons.wikimedia.org/wiki/File:Wood_grain_German_Occupation_bunker_concrete_1.jpg
7.22 8.14	Red-grey-shingles	Upsplash. Red-grey-shingles. Retrieved from https://www.pexels.com/photo/red-grey-shingles-30344/
7.23	Images and figures made by author.	
7.24 8.06	Swamp White Oak	MONGO. (2009, May, 9). Swamp White Oak (Quercus bicolor) bark detail. Retrieved from https://commons.wikimedia.org/wiki/File:Swamp_White_Oak_(Quercus_bicolor)_bark_detail.jpg
7.25 8.15	Brushed metal texture polished wall surface	TextureX. Aluminum Brushed metal texture polished wall surface. Retrieved from http://www.texturex.com/Metal-Tex-tures/aluminum+brushed+metal+texture+polished+wall+surface+stock+photo.jpg.php
7.26 8.07	The Texture Of The Backgrounds Wood Rough Desk Boards	Wallpaper Zone. The Texture Of The Backgrounds Wood Rough Desk Boards. Retrieved from http://wallpaper.zone/wallpaper/550921

7.27 8.21	Marble background	Totravelandbeyond. (2015, October, 14) Marble background. Re-trieved from https://pixabay.com/en/marble-background-backdrop-1006628/
7.28 8.22	Granite new	Hatlen, H. (2006). Granite new. Retrieved from https://commons.wikimedia.org/wiki/File:Granite-new-iddefjord-norwa.jpg
7.29 8.23	Slate roof	Zureks. (2007, August, 1). Slate roof. Retrieved from https://en.wikipedia.org/wiki/Slate#/media/File:St_Fagans_Tannery_7.jpg
7.30 8.08	Chopping board	Boards of Origin. Chopping board. Retrieved from http://boards-of-origin.myshopify.com/products/chopping-board-large
7.31 8.16	Steel reinforcement iron stainless.	Rkit. (2015, July, 22). Steel reinforcement iron stainless. Retrieved from https://pixabay.com/en/steel-reinforcement-iron-stainless-856074/
8.1-11.6	All images and figures made by author.	