Maintaining the Aesthetic: exploring the process from Surface Design concept to manufactured product

EMMA LINNEY

A thesis submitted to the University of Huddersfield in fulfilment of the requirements for the degree of Master by Research in Art and Design

January 2017

Contents.

Statement of Copyright.

Abstract.

This research will explore the relationship of craft and manufacture, investigating whether these two areas can be connected and whether digital processes of making can be considered a craft or not. This will be conducted by analysing the researchers relationship with manufacturing techniques and assessing the characteristics of a ‘Craft Person’. In addition to this, manufacturing techniques will be tested and compared to discover the most appropriate methods for creating tactile surface designs, looking not only at aesthetic results but exploring the process of preparing a design for manufacturability.

Definition of Terms.

It is important for the reader to understand what is meant by certain terms that will be used throughout this thesis. Below is a selection of commonly used phrases or words that will be used throughout the research.

Computer Numerical Control or CNC:

This is a method of creating a design using numerical values that work like a graph or chart. This form of manufacturing is closely linked with CAD (Computer Aided Design) which is the method of creating the initial design, in order to be processed the design is translated into a set of coordinates that then feed into the CNC routing machine. (cncrouterworks.com, 2004)

Routing:

This is a method of cutting into a surface using a drill-like tool, the router cuts away at a material leaving a path that is the same width as the tool. Routing is to hollow out or furrow. *(Dictionary.com*, 1900)

Manufacture:

This is the method of making something using machinery, this is generally associated with large scale production and fabrication. In relation to this, Industrial Manufacture is the process of making something on a mass-scale, this term is generally associated with large volume production. *("Definition of manufacture in English,"* n.d.)

Process:

In this work the 'process' relates to the method of getting the work done, this is defined as *'a series of actions or operations conducing to an end' (Definition of process,*2017)
This begins with the initial design idea and continues right though to making the final product. 'My Process' Is the way in which the researcher goes about starting and executing projects, this will be introduced and explained during the introductory stages of this thesis.

Aesthetic:

Aesthetic is a term relating to the visual qualities of something, it is defined as '*Giving or designed to give pleasure through beauty' (*"*Definition of aesthetic in English,"* n.d.) In this research the 'desired aesthetic' refers to the way in which the work is supposed to look, incorporating a natural, organic look as well as incorporating texture and 3D effects.

Laser-cutting:

This is a manufacturing process that uses a high-powered beam to cut through materials, similarly to a CNC router, this is based on computer set parameters. The laser guides the beam around the surface, cutting the material as it goes, it will either burn, melt or even vaporise the material which results in a high-quality cut, usually requiring no additional finishing. *(Make Works Ltd,* 2015)

Raster:

This refers to an effect that can be achieved on the laser-cutter, this is a type of high resolution engraving which works by engraving an image in a series of dots, the laser engraves each dot, tracking it along one line at a time. *(Rowmark,* 2005) This process is very good for high resolution imagery and can track the differences in tone within the image.

Part 1. Introduction to the Research.

A common experience for many design graduates, is trying to understand the next step of taking work into manufacture and working on a larger scale. Four years of studying Surface Design helps develop creative skills and expand thinking and learning techniques. However, when thinking about full-scale manufacturing there is limited teaching available and much of this learning and understanding comes from trial and error. Throughout the undergraduate degree, the techniques and materials that have been favoured have been those that are readily available within the University itself. Collaborating with external companies has always been encouraged to widen the knowledge base on manufacturing techniques, however there have always been limitations to properly understanding these processes due to limitations on project time-scales.

This research has investigated the steps required to test a design in the manufacturing industry and decide which processes are appropriate for the style of work that is desired. This has been done by observing the practice and looking to adapt, manage and modify the work to suit the desired aesthetic results. This research is important for better understanding how vital choosing the correct process for a surface design can be. Many people will choose a technique based on cost, convenience or simplicity without necessarily understanding the effects on the final outcome. Ultimately, if this project were to develop into a business opportunity it would be paramount for the success of this process to choose the appropriate manufacturing techniques. In this respect, the manufacturing technique is as important as the material choices and other design decisions.

1.1 Inspiration for the Research.

This section will briefly explain some of the influential factors that have contributed toward this research project. There have been many sources of inspiration for the techniques, designs. As well as the question itself, however the three sections below highlight the key areas that have caused this research.

1.1.1 The CNC Routing Company.

Working with industry has always been an important aspect of the Surface Design curriculum, it is important to understand what a manufacturer expects of a designer in terms of process and material knowledge, as well as the ability to translate a client's ideas into materiality. This factor has played a large influential part in the research question, mainly due to working with a local CNC routing manufacturer. Working with an industry specialist has been incredibly beneficial in learning new design techniques and gaining a good understanding of aspects of creating 3D designs. This company is well established with over 20 years experience in the field of CNC routing and vinyl wrapping, based in Lancashire, the factory takes care of all aspects of the manufacturing process. The company specialises in routing doors and decorative surfaces for both the commercial and general markets.

Working previously on a project with industry has provided the researcher with a brief experience within the world of CNC routing. This initial stage of experimentation allowed a development of new and exciting designs but without much consideration for the adaptation of the design process for this new technique. This initial sampling stage relied on gathering feedback from the manufacturers in order to have a commercially viable design.

1.1.2 The Surface Design Show.

Throughout this research there are references made to the Surface Design Show which is an annual trade show held at the Business Design centre in Islington, London. This show has played a large influential part in both this research question and also in shaping the researchers design style and inspiration. The researcher has had involvement in the University of Huddersfield's exhibition stand for the past four years, not only displaying parts of their own work but also assisting with the building the display and representing the Surface Design course during the show. The exposure that the show has brought in the world of Surface Design as well as the links with industry that it has created has played a massive role in shaping this research and the researchers design collections.

1.1.3 Personal Experience with Craft.

Having worked for a small craft business for a number of years now, there has been much of this research that has been inspired by this experience. Much of the job role has involved preparing work for trade and retail shows including events such as the British Craft Trade Fair and the Country Living Christmas Fair. This exposure to contemporary craft businesses has encouraged the researcher align their work in a similar retail category, providing unique products using a combination of hand and digital techniques.

Within the business itself much of the making processes are still done by hand, however there are elements that have been outsourced to manufacturers. A large portion of the work from this business involves cut-out elements, the designs are incredibly intricate plants, birds and insects which have several layered aspects to them. These designs were originally cut out by hand simply using a scalpel blade to cut into the paper surface, however as the business progressed and expanded, this no longer became a viable option to keep up with demand. The designer sought an alternative method of cutting their designs so that time could be better spent processing orders and creating new work, it was decided that laser cutting would be a good option and would ensure a perfect cut every time. In this instance the process of switching from hand cutting to the digital process of laser cutting provided the designer with the opportunity to cut large quantities that were required for orders as well as freeing up valuable time to focus onto the business instead. This product is still considered a craft product; the designs have all originated from hand drawn images and the designer's personality and style is still evident in each and every product.

1.2 The Research Process.

This research will go through several different stages in order to answer the research question. The research will follow a combination of research techniques, including inductive and action methods for reflection on personal work, as well as conducting two case

studies focused on contributing events for this research question. The methods have been selected in consultation with research method publications including Gray and Malins' '*Visualizing Research'*, Collins' *Creative Research'* and Denscombe's '*The good research guide'.*

The first stage will consist of a Case Study on one of the contributing events for this research question: The Surface Design Show. This study will look at why this show has influenced the researcher and will also look at the 2016 Surface Design Show specifically as a marker for the beginning of this process. The case study will consist of some background information on the show and will then focus on the researchers experience at the 2016 show from the perspective of exhibiting the 'Surface Tactility' collection and a research poster. Finally, there will be an analysis of the show which will look at the shows trends and some of the key exhibitors which have a similar design theme to the work created by the researcher.

The next section will comprise of a case study on a local CNC routing business who have also been a large influential factor in this research. For the purposes of this research, the CNC routing company have been anonymised in line with University's ethics guidelines to protect the identity of the company and prevent any detriment to the business. This section will have an introduction to the business explaining what they do and some of their key successes. Next there will be an analysis of why they are part of this research and how their relationship with the researcher from a previous project has helped influence this research question. This study will also discuss some of initial sampling stages with the company and talk about the challenges faced when working with this manufacturing process. Finally, there will be a comparative analysis of CNC Routing and Laser cutting, looking at which process is best suited for this particular work. This stage is of great importance so highlight the manufacturing benefits and disadvantages of each process.

After the case studies, there will be a detailed look into Craft as a industry including a historical look at origination of Craft as we know it today. During this section there will also be an analysis of the various themes surrounding Craft including defining the term itself, personalisation of a product, e-commerce and the resurgence of the Craft industries.

Finally, there will then be a reflective review that will analyse some key design pieces from past projects, looking at these samples and designs from the perspective of manufacturability and considering whether these could be considered craft. The next stage is a sampling and testing section; this is following the design processes to prepare work for CNC routing and Laser cutting as well as analysing the final results. Throughout this process the methods used to simulate and create designs will be analysed to understand what techniques are best suited for the final desired aesthetic.

The research paper will then be concluded with an overview of the themes discussed and a look into the findings from this research project. Within this section, there will also be a reflection of the successes and failures of the work with a look at how the process could be improved and adjusted for potential future research.

1.3 My Process.

As mentioned during the 'Definitions of Terms' section, the research looks at 'My Process' analysing the way in which the work is conducted. This section will explain how the process usually takes place and steps that are required to achieve certain outcomes.

As a Surface Designer, projects have always followed a specific process in order to create, test and adjust the design pieces, this is referred to throughout the research as 'my process'. The initial design stages in any project begin by drawing, this can be either from still life, using mark-making or creating abstract shapes. From these initial drawings, then comes screen prints and digital designs which are layered up to create depth. It is key at this stage to not commit to one specific design idea, so each of the drawings are tested using several different methods to see what works best. The flexibility in the design outcomes is very important in 'my process' as it ensures that there is room for adjustment is requirements change or imagery is not suitable for the specific material.

Throughout many different projects, there has always been a theme based around the natural environment, this forms the main base of inspiration for all the researchers surface

designs as it is something that is part of everyday life. The imagery and motifs used are usually very organic and created using a variety of drawing techniques which can yield very different results. This type of imagery is very popular throughout the world of design, frequently being used for fashion prints, surface pattern designs and many more, however in the world of CNC routing and Laser-cutting it is much less common. This may be due to the difficulties faced when creating a design that has an irregular shape, however the techniques for creating bold texture would be ideal for creating impacting organic surface designs.

The process of creating a new design often involves many different trials, although much can be simulated on a computer, seeing the physical sample is the only true way to see whether a design has worked or not. Much of this sampling happens due to the types of materials that are being used, MDF has become a favoured material during this process. The material choice of MDF is due to several different factors, first of all it is a great surface to CNC router and laser-cut due to it being an engineered wood, there is no grain and the density is constant throughout. The second factor is the often over-looked quality that MDF is quite sustainable, ensuring that the wood comes from sustainably managed forests the raw ingredients for MDF are in plentiful supply.

1.4 Surface Design explained.

Surface Design is a subject area that has played a massive part in shaping the researchers design identity, mainly due to being the main area of study for their BA Honours degree. This section will explain what is meant by the term Surface Design in the context of this research and also look at terms that it is also frequently associated with.

Surface Design as a genre applies to many different sectors. In general terms, it is the ‘design of surfaces’, this incorporates smart materials, textiles and hard materials such as wood, concrete, cork, plastic and much more. With this in mind, surface design can cover all aspects of design, from exterior cladding to panes of glass and even flooring.

Before the term ‘Surface Design’ was used, the generic industry name was ‘Walls, Floors & Ceilings’ being a very literal explanation for the subject it covers. As the industry evolved, it has changed into what we now know as surface design, incorporating all aspects of the design world. As an example, the Surface Design Show attracts a variety of people to the show each year, from buyers for large companies like John Lewis Partnership to representatives of institutions such as the natural history museum. The show is also a must visit place for architects, interior designers, visual merchandisers and manufacturers. The sheer variety of visitors that the show gets indicates the reach that this industry has with all other aspects of the creative industries. As advancements in technology and smart materials continue to happen, so the surface design industry will continue to expand. The design for surfaces is a subject area that affects each and every human being, it is a subject area that is now becoming more widely recognised as a discipline in its own right. This has been highlighted by the launch of a second Surface Design-related trade show called ‘The Surface and Materials Show’ held at the NEC in Birmingham. This show was launched in 2015 as part of UK Construction Week at the NEC and has already proved to be a big success. In addition to the UK shows there are also a variety of shows internationally such as Surtex in New York, The International Surface Event in Las Vegas and Heimtextil in Frankfurt. The emergence of such internationally renowned shows highlights the importance of surface products globally, not only influencing design decisions but also being at the forefront of new technologies.

In context of this research, surface design is the key theme running throughout the work that ties all other elements together. This work will focus on Surface Design in general, the samples created will have the potential to be used in a wide variety of applications. It is best not to focus on the final positioning of these test surfaces as this may distract from the research aims and objectives.

1.5 Summary.

There have been many contributing factors to this research question and much has been focused around personal experiences within the Surface Design and Craft industries.

In the next section there will be the Aim and Objectives for the research which will then be followed by a contextual review, looking at the key areas supporting this research project.

Part 2. Aim and Objectives

2.1 Aim.

- To investigate the relationship of the Craft process through laser cutting and CNC routed surfaces from design to production. And question if a loss of ‘Craft’ aesthetic is the result of digital manufacturing processes.

2.2 Objectives.

The above aim will be achieved by fulfilling the following research objectives-

- To define what is meant by ‘craft’ in the context of contemporary surface design

- To conduct a reflective study of practice-lead surface design work, analysing the findings of laser-cut and CNC routed wood in terms of viability for large scale manufacturability and question if these processes can be considered ‘Craft’

- To discuss and analyse the test results of a collaborative project with a local CNC routing manufacturer designed to explore the transition from design sample to manufactured product, and to determine whether the process is appropriate for desired aesthetic design outcome

- To analyse the research results in terms of machinability and design outcomes within the parameters of design intricacy, assessing if the designs can be created in the same style as the original drawings.

Part 3. Contextual Review.

As part of this research it is key to highlight the context for this area of design and manufacture. In this section, there will be an introduction to each of the areas that have had an impact on the research question and its findings. This will also incorporate points of view from a variety of sources to support and counteract the overlying themes.

3.1 Surface Design.

Surface Design is a field that has increased in popularity over the past few years however for many, it is still a subject that is closely associated with Textiles. Throughout this research, it is key to distinguish Surface Design as being more related to the built environment and interior architecture than textiles. In his paper '*Surface Design; what is it, how is it changing and what are the ingredients of a successful curriculum?',* Musson discusses the theme of keeping Surface Design and Interior textiles as separate entities, this is key to building the identity of a surface designer. The paper also distinguishes surface design by providing a good description of what the discipline incorporates as shown below:

> *"So what is Surface Design?...I find it helpful to distinguish this pathway as 'image, colour, texture and pattern applied to surfaces within the man-made environment'…One could argue that Surface Design is, first and foremost, a mindset relating to daily experience of one's surroundings; and that understanding materiality is a key to controlling that experience." (Musson,*n.d.)

Although in Musson's paper there is a clear distinction between Textiles and Surface Design, in some organisations view, textiles and surface design are still part of the same subject. This is very clearly shown on the *Surface Design Association's* website and is a clear theme in their quarterly publication. In these publications, they focus around textiles and fibre based Art and Design, this being associated with Surface Design is causing some confusion. What is clear from both perspectives on Surface Design, is that it is many things to lots of different people, as well as being associated with Textiles, there is also some cross over with the Surface Pattern Design industry which is responsible for prints and patterns for stationary, wallpaper and decorative home-wares etc.

3.2 Craft.

The term means many different things to many different people, however in its most basic state 'craft' is defined as *'an activity involving skill in making things by hand'* or *'Work or objects made by hand'* and also *'Skills involved in carrying out one's work'* *("Definition of craft in English,"* n.d.)

Craft is a theme that has seen a resurgence in popularity over the last few years, with the rise in eco-consciousness there has been an increased awareness that working on a small scale is better for the environment. The theme of Craft has been an important area within the world of decorative arts for many years, pioneers of the Arts and Craft movement often discussed craft in the context of being the alternative to industry and manufacture. This is most recognisably seen in the writings of John Ruskin and William Morris, both of whom have had large influence over the Arts and Crafts movement. In many of his lectures, Morris discusses the importance of handicrafts and the decorative arts in opposition to the rising in mass-manufacture. In his series of lectures 'Hopes and Fears for Art' he discusses a variety of themes surrounding the decorative arts, what is a common theme throughout these writings however, is the idea that manufacture is causing the degradation of labour and causing the working man to become less skilled *(Morris*,2012). These themes surrounding craft are something that has continued to following the Craft movement into modern day and much of Morris and Ruskin's romanticised perspectives are echoed in points of view of some modern-day craft practitioners.

Although Craft is often associated with hand-made production and a high level of manual dexterity, there are many new practices now that also involve digital technologies within the craft practice. In a recent article by Grayson Perry in the Guardian, there is a discussion that the future of manufacturing now lies with Modern Craft practices highlighting that the collaborative and experimental nature of modern craft practices have been responsible for large digital breakthroughs such as 3D printing and wearable technologies*(Perry,*2016). This new association with craft highlights the inclusive nature of the subject and the benefits that can be had when modern day technologies are combined with the core themes of craft and making. In the book 'Digital Hand-made' Johnston

endeavours to highlight to evolution of the craftsman from a person using traditional techniques, to someone who can utilise modern techniques in a 'artisanal' way. The showcase of 80 artists and designers from across the globe truly highlights that the sky is the limit when craft comes into the digital age (*Johnston,*2015). This perspective of embracing technology is also echoed by many other key figures in this field including Professor Sir Christopher Frayling, author of '*On Craftsmanship: Towards a New Bauhaus'.* In an essay 'We must all turn to the crafts' he discusses the need for craftsmen to shed their nostalgia and come to terms with modernity, instead of looking back on old traditional methods, craftsmen should find ways to utilise new machinery to create new and exciting pieces. *(Frayling,*2012)

Craft is clearly a divisive subject area; public perception is still undecided on what Craft means and understandably so with confusing advertising harking back to the 'good old days' and the cyclical nature of trends reaffirming the notion that old is best. Macdonald in her essay 'Concepts of Craft' manages to decipher this subject area by simply stating that the meaning of craft is fluid, *(Macdonald,*2005) it can represent many different things to many people. She highlights that craft is inclusive and will continue to evolve and change for the foreseeable future.

3.3 Design and Manufacture.

The decision-making steps leading up to a design going into manufacture is a key component of the whole process, it is these decisions that influence the outcome of the product, and determine in one way or another whether it will be a success. While many believe that reducing these steps will increase productivity and efficiency, there are others that believe this stage should be allowed to take time, to allow the product to truly develop and grow. Swift & Booker discuss the necessary stages of decision making before a product is manufactured, highlighting the key benefits including cost saving and opportunity for refinement.*(Swift & Booker*, 2014) Allowing time for the product evolve during the design stages of the process allows any issues to be resolved with little financial implication, if a design is rushed to manufacture there is more room for error and this also incurs a much higher cost for changing the design again. Much of the issues with manufacturing

processes come from a lack of understanding of the technique itself by the designers and clients. Although there will be designers who have a practical knowledge of the machines they are designing for, there will be some who do not, particularly in the case of smaller designer-makers.

Designing for manufacture can be a simple solution to large scale manufacturing issues, using appropriate machines and methods allows the process to run much smoother. Design for Manufacture or DFM is a widely used term in the world of manufacturing, it is essentially 'optimising design to aid production' *(Plant, Harrison, Griffiths, & De Coster, 2010)* whether this be improving time efficiencies, machining costs or even machine maintenance. It is a largely used term when talking about manufacturing improvements, however in this context it applies to designing specifically for the machine to improve quality and aesthetic results. In relation to manufacturing processes for Surface Design, it is important that the process is fully understood by the designer as the design itself and the actual results can differ quite considerably. This is particularly true in the case of CNC routing, the designer must take into account not only the material that is being machined, but also the shape of the tool and the machines tolerances in terms of angles.

However, design for manufacture is not just a large-scale, mass production method, it can also be applied to the new generation of small manufacturers. These manufacturers are utilizing the new technology that is coming from this next industrial revolution, equipment such as table-top 3D printers and laser cutters are now become more accessible for small businesses. Having a personal interaction with the equipment that is making the products provides the maker with a better working knowledge of how the machine works with certain task. This can in turn inform the makers decisions when creating pieces of work in the design stages, like in handicraft, the maker begins to develop a form of tacit knowledge, one that helps make pieces that work better in the manufacturing process and produce better end results.

Where a direct interaction with the machine is not possible, it is important to build a good relationship with the manufacturers who will be making the pieces on the maker's behalf. In his book *Batch; Craft, Design and Product: The Work of the Designer Maker,* Tanner

interviews Rachel Moses of Design Nation discussing how essential working together with the manufacturer is to smaller designer makers. In this piece, Moses highlights the importance for designers to understand where their products will be made, not only for building a rapport with the manufacturers but also to understand the process itself much better.

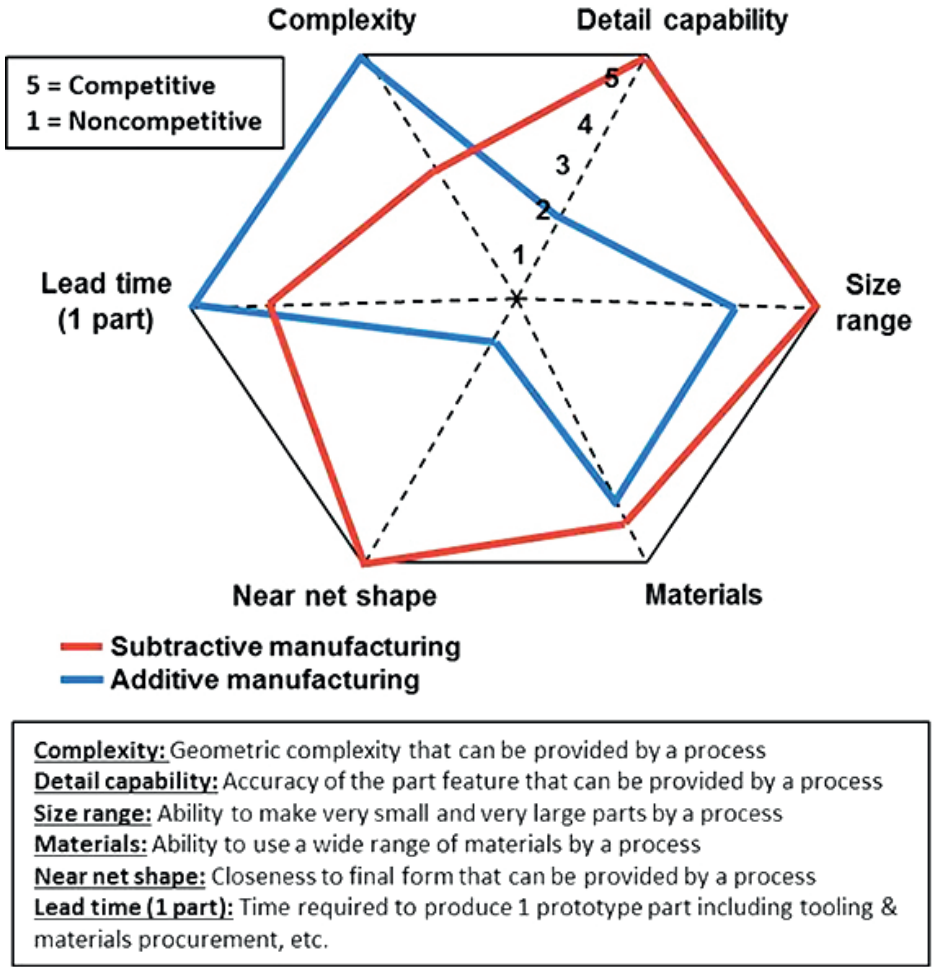


Fig.1. Comparison of Additive and Subtractive manufacturing techniques (Kennametal, 2015)

The manufacturing techniques that have been selected for this research project are just a small selection of the options available when considering creating a textured surface. As the main material being used in this instance is wood, it was felt that CNC routing and Laser cutting would be most appropriate. Both of these techniques are what is called 'Subtractive Manufacturing' which is the process of removing from the surface to create the design, other techniques used particularly for wood include lathing as well as hand carving techniques. These manufacturing methods each have their own strengths and weaknesses for example, although laser cutting comes with a high accuracy level the cost of maintenance for this machine is also very high. In contrast to this CNC routing provides a much more cost effective machining rate especially when producing larger quantities, but

the tolerance for intricate designs is limited by the size of the tool head. Although each manufacturing process is best suited for a particular task, it is always good to assess alternative options. Another manufacturing option for creating textured surfaces could be 'Additive Manufacturing' which mainly encompasses 3D printing, this is a great option for making single items and has a great flexibility in creating complex designs. As shown in Figure 1, both additive and subtractive manufacturing have their merits but for the production of large scale surfaces, subtractive is the best option at the moment.

3.4 Industry 4.0.

Industry 4.0 is defined as *'the next phase in the digitization of the manufacturing sector, driven by four disruptions'* The four factors driving this next manufacturing stage are *'Big data, Advanced analytics, Human-machine interfaces and Digital-to-physical transfer'* (*Baur & Wee,* 2015)

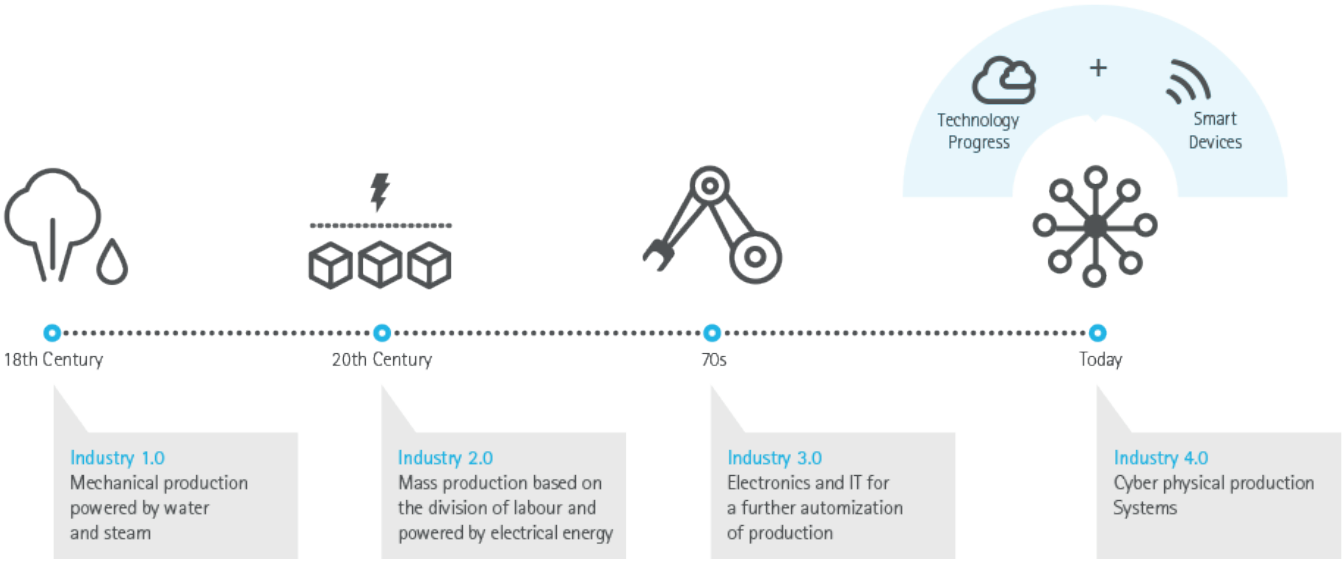


Fig.2. Info-graphic showing the four waves of big manufacturing change (Accenture,2016)

'According to EEF (The manufacturers Organisation) Britain is the 9th largest manufacturer in the world for 2016/17, rising from 10th the previous year. *(EEF,*2016) So despite popular opinion, the UK does continue to holds its own as a manufacturing nation. What also appears to be the case more and more often now is that many businesses are choosing to re-shore back to the UK in pursuit of better quality production and shorter delivery times as well as a variety of other factors. With this increase in British manufacturing

happening, there is also the starting signs of the next industrial revolution **(Industry 4.0)** one that incorporates smaller batch production methods, but with an increased cyber presence. The next revolution will promote a more harmonious relationship between humans and machines, and will also increase manufacturing flexibility, with fully integrated systems allowing production to adopt smaller batch sizes. This is in turn means that larger manufacturing businesses who currently rely on low-cost mass manufacture, will be able to apply these new digitized efficiencies to achieve a make to order production method that incorporates the customers wishes with all aspects of the process *(ISA,*2016).

This next industrial revolution will undoubtedly bring with it new challenges, especially for the smaller business but it is important to invest in future technology in order to remain relevant. In an article published by Forbes, Marr suggests that those who take up the new technology will be rewarded in business, whereas those who do not may risk being left behind. *(Marr,*2016)

3.5 Digitalisation: Technology in Design & Manufacture.

Technology and manufacture have always had a close relationship, often with one area informing the other. With the advancements in technology, there is a new area of manufacturing coming as mentioned above; Industry 4.0. This has large implications for large manufacturing businesses but it is also having an effect on small scale makers too. With the advancements in technology for things such as 3D printing, laser cutting and much more, there is now the capability for individuals to manufacture items from their home allowing much more flexibility and control for the maker.

Incorporating digital technologies into traditional manufacturing techniques can provide big benefits for manufacturers and clients alike. A good example of this is the textile industry, with the innovation that has come from digitalisation, we have seen a more accessible market for personalised textile products. The development of digitally printed textiles has opened up a new manufacturing process that allows products to be made quickly, accurately and with less labour-intensive work required. With very limited set

up costs compared with screen or block printing, digital textile printing has very low minimum orders, and even allows smaller businesses to print their own textiles in house. Digital Textile review suggests that digital technology is enabling a shift from using large manufacturing facilities to much smaller 'cottage' set ups. *(Ingraham,*2013)

3.6 Political Influences on Manufacture.

In light of recent political events within the UK, there is inevitably going to be a change to UK manufacturing. The current manufacturing industry is heavily supported by offshore businesses who can manufacture items at a relatively low cost, however as the UK looks to leave the EU is it time to make change to this? In the wake of the Brexit vote there have been many businesses, experts and concerned citizens who have speculated the impact of Brexit on UK manufacturing. The general consensus currently is that Brexit is having a negative effect on UK manufacturing although perhaps not as drastically as first expected, financially the fall of the Pound is keeping British manufacturing competitive in the global market but with an uncertain future for many skilled foreign workers, Britain may need to look at ways of getting skilled labour from their home turf. In an article first published in the Sunday Times entitled 'Animal spirits: Handmade in Britain - the quiet revolution for craftsmen.' Johnson discusses how Britain needs to come together and invest in what he describes as 'craft knowledge' *(Johnson,*2015) encouraging our population to go back to skilled manufacturing which will otherwise be seriously affected by the loss of skilled foreign workers.

Although the Brexit vote will undoubtedly affect many different industries through the UK an article from Manufacturing Global Carberry suggests that things may not be as bad as it seems. Like with Industry 4.0, it is very much down to how business is conducted after the vote, this may end up being an opportunity for the UK to invest into home grown technologies and help recreate the UK as a manufacturing giant once again. *(Carberry,*2016)

3.7 Summary.

As shown in the above sections there are many different areas that affect the considerations for taking a surface design product into manufacture. The variety of opinions displayed in this chapter have shown the many different options available in manufacturing, craft and surface design.

In the next chapter there will be a methodology which will explain the rationale for using certain research techniques as well as providing an outline of the thesis to come. Finally there will be a brief discussion on the ethical considerations required for this research.

Part 4. Methodology.

In this section there will be an evaluation of the research methods used throughout this research project looking at the benefits and limitations of the chosen methods. There will also then be an outline of the research structure, detailing the areas covered in each chapter.

4.1 Choosing Research Methods.

This research will follow a participatory action research methodology mainly through observation of practice. Due to the researcher's personal involvement with this project it was felt that this approach was the most suitable, this is mainly due to the evolving nature of the project and emphasis on qualitative outcomes rather than quantitative data. *(Collins,* 2010, pp42-43) This research will analyse sample outcomes and reflect on points for improvement and alteration based on a framework of 'ideal' outcomes such as aesthetic quality and machinability. The samples will be created and evaluated using practice, observation and visualization methods *(Gray & Malins, 2004,* pp. 104–107) A comparison of techniques will be done to assess which method for creating 3D surfaces is most suitable for the imagery used. It is this analysis that will determine the final outcome pieces and future manufacturing techniques.

In addition to this, there will also be a review of literature used for contextualising the theme of 'Craft', the conclusions of which will be used to analyse the samples positioning within the craft market.

Although the methods selected are the most appropriate for this research it is important to understand the limitations with using these research methods, which include a lack of scientific rigour, meaning that conclusions drawn from these research findings cannot necessarily be applied to other cases. In addition to this, the combination of practice, observation and visualization research methods means that results will be unpredictable and tests will be designed based on personal experiences rather than proven methods.

(Gray & Malins, 2004, pp. 105).

A case study has also been selected as a form of qualitative research this is to highlight two of the influencing factors for this research. Although other methods were considered for presenting this part of the research, it was felt that due to the two subject areas being single instances that a case study using personal constructs would provide the best format for detail and breadth of information (Gray & Malins, 2004, p. 117) Conducting a case study is being used to show context for this research by highlighting the two influencing factors for this research question, the format is also best suited to this style of research which is very reflective and relies on personal conclusions.

4.2 Order of Research.

The first of the two case studies will be an introduction to the Surface Design Show which has played a large part in the researchers University education and was the facilitator to several collaborations. This section will form part of the contextual settings for this research, highlighting how the research question came about and what the contributing factors were for this particular show experience. This section will be comprised of an introduction to the show and what it represents, it will then go on to look at how the show has informed the researcher. Finally, there will be an analysis of the most recent visit to the show at the beginning of this research discussing the themes of the show and how relevant this practice is to the current market.

At the beginning of this research process, a research poster was presented at the Surface Design show to support the Surface Tactility collection and introduce research aims to the visitors of the show. The poster was themed around the initial aims and objectives for the research which have since been adapted and changed as the project has evolved. Initially this research project was to improve and develop a way of designing for CNC routing using a 3D design software to aid the process. However, during this initial testing stage it was apparent that this would not be possible and the aims of the research were changed. The focus has now changed toward comparing Laser Cutting with CNC routing, the former

is a process that is very familiar to the researcher, whereas CNC routing is still a relatively new concept.

The next case study will be a profile on a CNC routing company, for the purposes of this research the company has been anonymised to protect their identity. The profile will discuss their relationship to the research and how this has evolved to be a collaborative project support this research. The relationship with the CNC routing company has been an integral aspect of the research practice and inspired the initial investigation into CNC routing and exploring other tactile processes. This section will also include a comparison between laser-cutting and CNC routing techniques to discuss which method is best suited for the aesthetic requirements of this project. One of the main reasons for working with this company was to develop new design styles, it was felt that a collaborative project would benefit both parties and would enhance the designers manufacturing knowledge. It was also felt that due to the manufacturers extensive material knowledge from their suppliers that they would provide the researcher with a good material base to work from and develop in future work. After previously working on collaborative project with this CNC routing company it was taken into consideration that perhaps an alternative business could offer a similar service and produce better routing results. However, it was decided that building on the existing relationship with the CNC routing company would be best and would allow for better developments in the design stages and due to their local positioning it would be better for visiting the factory.

The main body of this research focuses around observation of practice, for this there will be several different ways in which this is recorded. The initial stages for this process will be reflecting on pieces of work that have explored a variety of digital manufacturing techniques. By using these examples for points of reference, it is possible to then take these reflections and apply them to new design ideas. The reflective study will analyse not only the visual outcomes for the samples used, but will also discuss the possibility of these pieces being a 'Crafted' item.

After the reflective study, there will then be a testing and sampling stage for refined CNC routing and laser-cutting techniques. For this stage of research, the design imagery will be

taken from an existing file, this is to allow for full focus on the techniques and process. As a designer, it can sometimes be too easy to focus on the 'potential' of the aesthetic without considering its practicality first of all. It is for this reason that the design used has been taken from a previous project, for the purposes of the research it will be re-evaluated to create a slightly edited piece suitable for full scale manufacture. Once suitable steps and techniques have been implemented to create designs suitable for manufacture and processing, it will then be possible to alter the imagery and begin designing for the process. However, this work will be part of future endeavours, and not part of this initial research project. The outcomes of these tests will be illustrated in visualisations and comparisons as well as using the overall results and findings for the conclusion of this research stage.

In the final section of the research, there will be a contextual analysis of a variety of themes surrounding Craft and Manufacture. This section will discuss some key arguments surrounding what is craft and how it is affected by modern manufacturing techniques. This section will finalise the research thesis and will be concluded with a summary of the themes and arguments discussed, including a review of points for further research as well as analysing whether the work created can be described as a craft product.

4.3 Ethical Considerations.

As an ethical consideration for this research it was advised that the companies involved in this process would remain anonymous to protect their business identities. The company supporting this research by producing samples as well as being part of a case study will be given a pseudonym of 'The CNC Routing Company'. Other companies referenced within this research will either be directly quoted from their websites. In the case of the Surface Design show, companies that are mentioned are being referenced as a source of visual research, any analysis made by the researcher is a personal opinion and does not represent anybody else's view.

Part 5. Case Study: The Surface Design Show

5.1 Introduction.

This section will look at the Surface Design show, this is a trade show that has had incredible importance throughout the researchers' university education, providing new material and processing inspiration for many projects. The show has also been the trigger point for this research study, inspiring a line of questioning focused around scaling up work and using alternative manufacturing techniques.

Fig.3. The Surface Design Show at the Business Design Centre (Surface Design Show,n.d.)

5.2 Background.

First launched in 2005, the Surface Design show is one of the leading trade shows for surface materials, products and lighting systems. Held in London at the Business Design Centre, this show is a highlight in the calendar for professionals from many different areas, including builders, interior designers, architects and many more. The show incorporates all

aspects of the Surface Design industry and aims to show potential clients a wide variety of surfaces and products in their many different applications. Below is an example from the Surface Design show website of the many different opportunities provided by the show.

Fig.4. Surface Design Show, Looking for Inspiration and Innovation within Surface Design?

(Surface Design Show,2016)

In addition to being a retail opportunity for exhibitors at the show, the programme of events throughout the show provides a variety of professional perspectives from the world of design, sustainability, future materials and many more. There are a variety of different talks and presentations available for visitors of the show to go to, these talks will usually run along a theme that is incorporated in the whole show. In the past there have been themes centred around 'sustainability' and 'health and well-being'. These presentations provide insights into variety of subject areas that affect the industry and can be used by visitors and exhibitors to improve their operations. This show is very important for bringing together a variety of different industries, it is also a great opportunity for businesses to learn from each other and evolve. The show is also a great educational opportunity for Art and Design students who are able to see a cross-section of the Surface Design Industry all in one concentrated format.

5.3 Exhibiting at the Show.

The University of Huddersfield's Surface Design BA course has had a close relationship with the show, with some of the students getting the opportunity to exhibit their own work in a professional format. The work shown is usually a wide variety of pieces from many students, it has always been very popular with visitors and other exhibitors at the show, giving them a fresh perspective on surface design potential from up and coming young designers.

Fig.5. The 'Surface Tactility' Collection displayed at the 2016 Surface Design Show. (Own Image,2016a)

Over the past 4 years, the researcher has had the opportunity to exhibit some design work several times, in 2015 the opportunity arose to display a selection of pieces from the 'Reclaimed by Nature' project *(see appendix A for collection images)*. This project incorporated

up-cycling and re-purposing with natural imagery, this created a unique body of work that had individualism as well as an eco-friendly theme. This particular project showcased a variety of design techniques, including a wide selection of hand printing processes, laser cutting and UV printing. One of the samples on display attracted the attention of a local CNC routing business; a reclaimed MDF board which was sublimation printed and then laser cut in a beech leaf design. The visitor explained that there may be a way to potentially enlarge the design to a full-scale piece using a CNC router and using this method would bring it in for cheaper than it would cost to laser-cut on the same scale.

This initial interaction was the first step to working with the CNC routing company, it was a great opportunity to hear someone from the Surface Design industry offer their professional opinion on the work. The company was very interested in the future aims for the 'Reclaimed by Nature' project including evolving the work to include sustainably sourced materials. Without this initial interaction at the Surface Design show, it is doubtable that this research would be happening, the platform that the show provided to enhancing the work and allowing to expand and develop has been incredibly beneficial. This initial meeting lead to a collaborative project 'Surface Tactility' which focused around creating tactile surfaces using a variety of additive and subtractive manufacturing techniques.

At the beginning of this research, the opportunity arose once again to exhibit at the show, this time it was part of a post-graduate group. The theme of the stand was IdeasHaus which is a collaborative concept to create a new design thinking formula that would improve the method of students within the university working with businesses. The work that was displayed showed a variety of different design techniques from a selection of post graduate students. As part of the researcher's exhibition pieces, a research poster was displayed introducing it to the visitors of the show *(see appendix B for details).* The poster displayed the initial themes and aims of the research giving visitors an insight into what the research was going to focus on. This poster provided a good talking point for visitors and encourage further conversation with regard to the feasibility of the design ideas. The general consensus was that the concept for a tactile surface design would be a well-received product, many of the visitors were intrigued by the process of making this type of

product. Generally, the feedback for the 'Surface Tactility' project and the research poster were very positive and it was clear that there is a need for this type of product in the Surface Design industry.

As well as a selection of designers, buyers and architects visiting the show, there were a number of bloggers, researchers and trend forecasters visiting to see the latest products in the industry. One of these visitors was from the trend forecasting company 'Scarlet Opus', this company provides Consumer and Design trend insights for professional and residential interiors. They later published a blog post about the show in which there were reviews of each of the Postgraduate exhibitor's collections, the Surface Tactility collection was very well received.

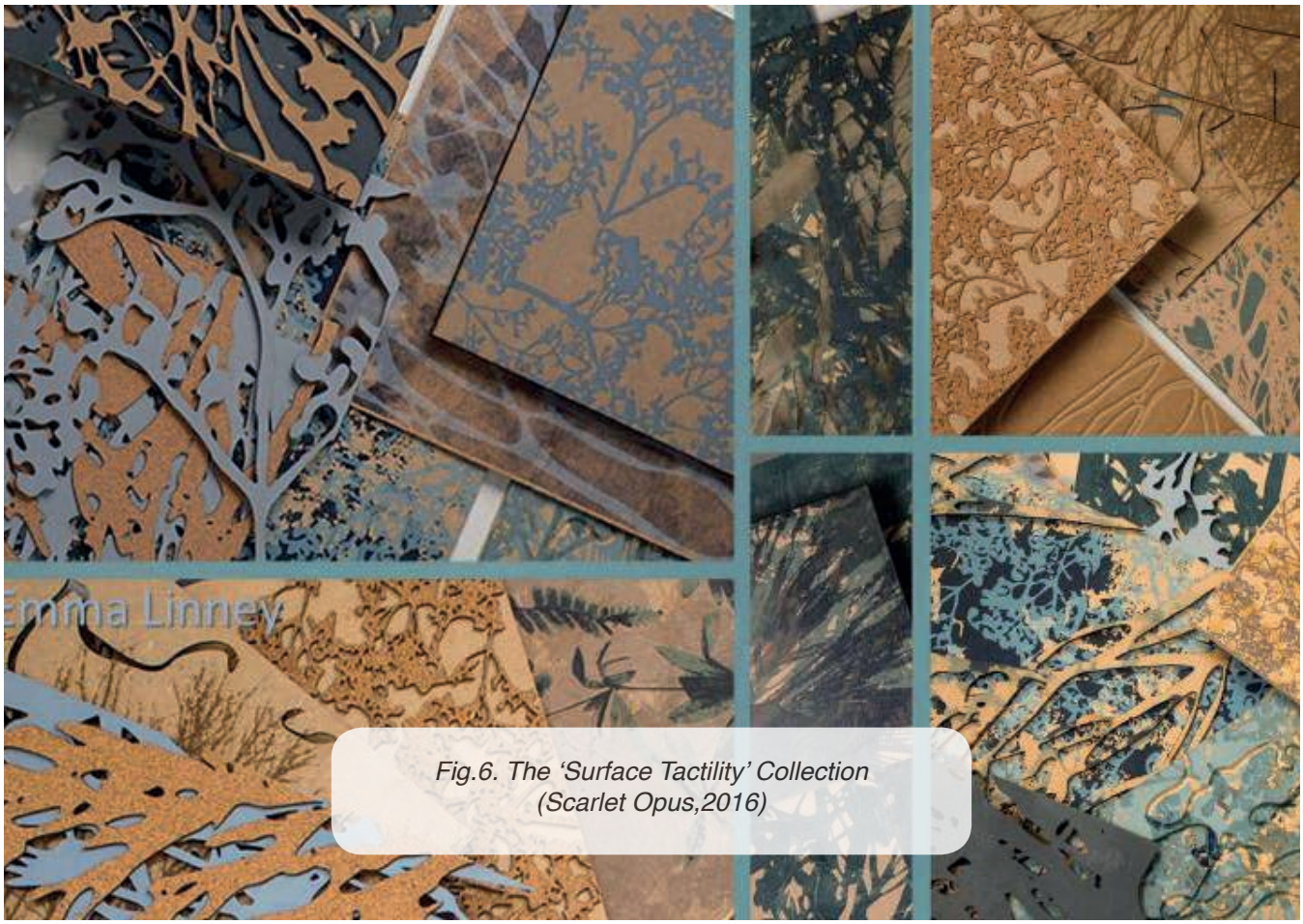


Fig.6. The 'Surface Tactility' Collection (Scarlet Opus,2016)

'Emma's work is ideal for large wall panels and I'd love to see her commissioned to create pieces for a hotel lobby, a fashion accessories or jewelry store, or even an independent coffee shop.'

(Redshaw.V, 2016)

5.4 Show Analysis.

Overall the Surface Design show has always provided a great source of inspiration, from the amazing curated 'Trend Wall' to their 'Surface Spotlight' displays, the show provides a wide variety of surface solutions for all visitors. The 2016 Surface Design show offered a large selection of surfaces including many options looking at the theme of multi-sensory solution. This theme further reinforced the notion that tactile surfaces would be a good potential product for this type of market.

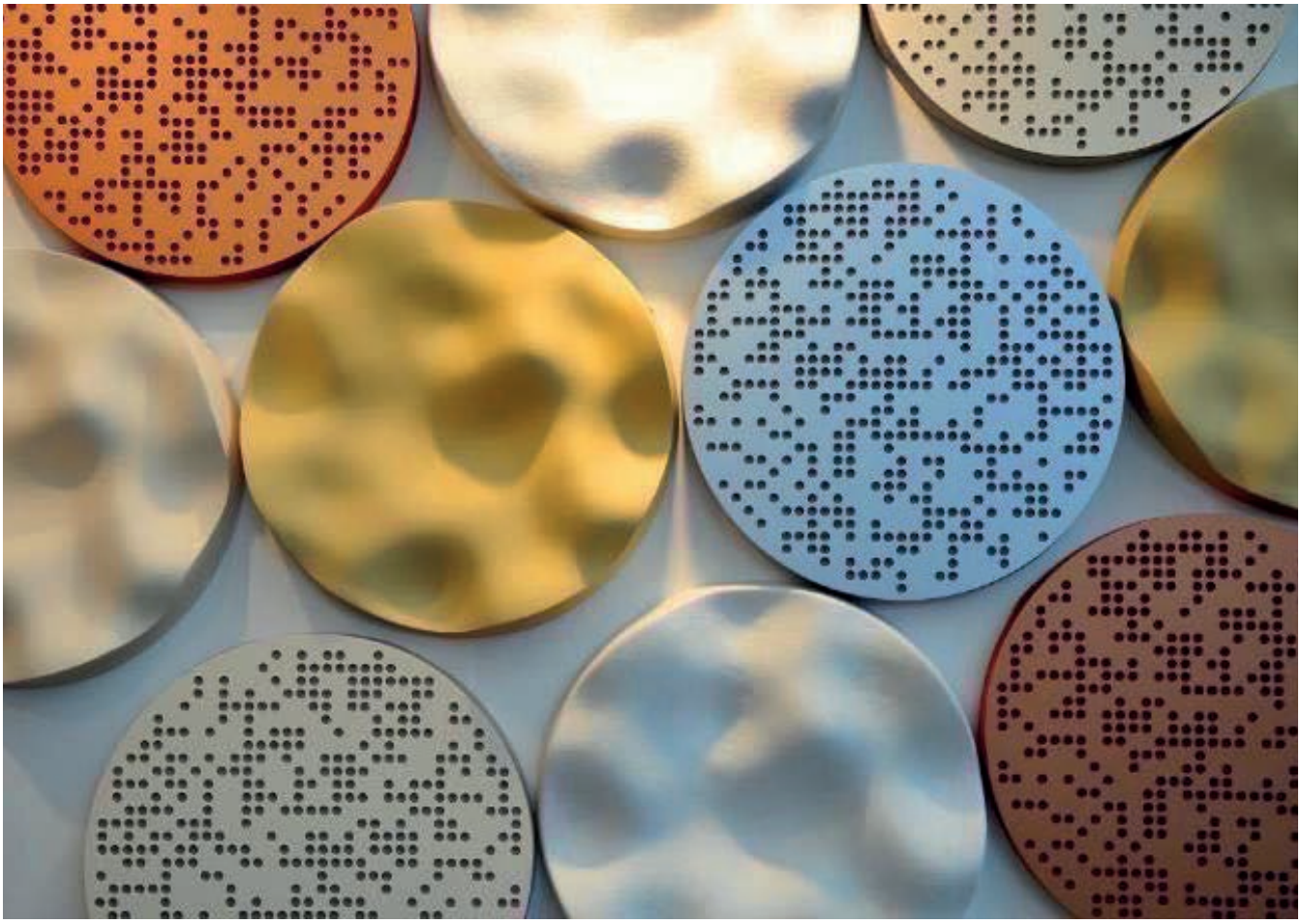


Fig.7. (GRG Acoustic's panelling display from the Surface Design Show (Surface Design Show & GRG Acoustics,2016)

One of the stand-out exhibitors at the show was GRG Acoustics, their stand (shown in Fig.6) consisted of a selection of acoustic panelling solutions, designed to either diffuse, absorb or enhance the acoustics in many different environments. What was really striking about this display was their intelligent use of tactility and 3D structures for sound manipulation purposes, although designed for a specific acoustic function the 3D quality made this also a very impressive aesthetic. GRG Acoustics successfully showed how

the multi-functional nature of a surface can enhance its appeal and that 3-dimensional surfaces have many uses other that just for a general aesthetic appeal.

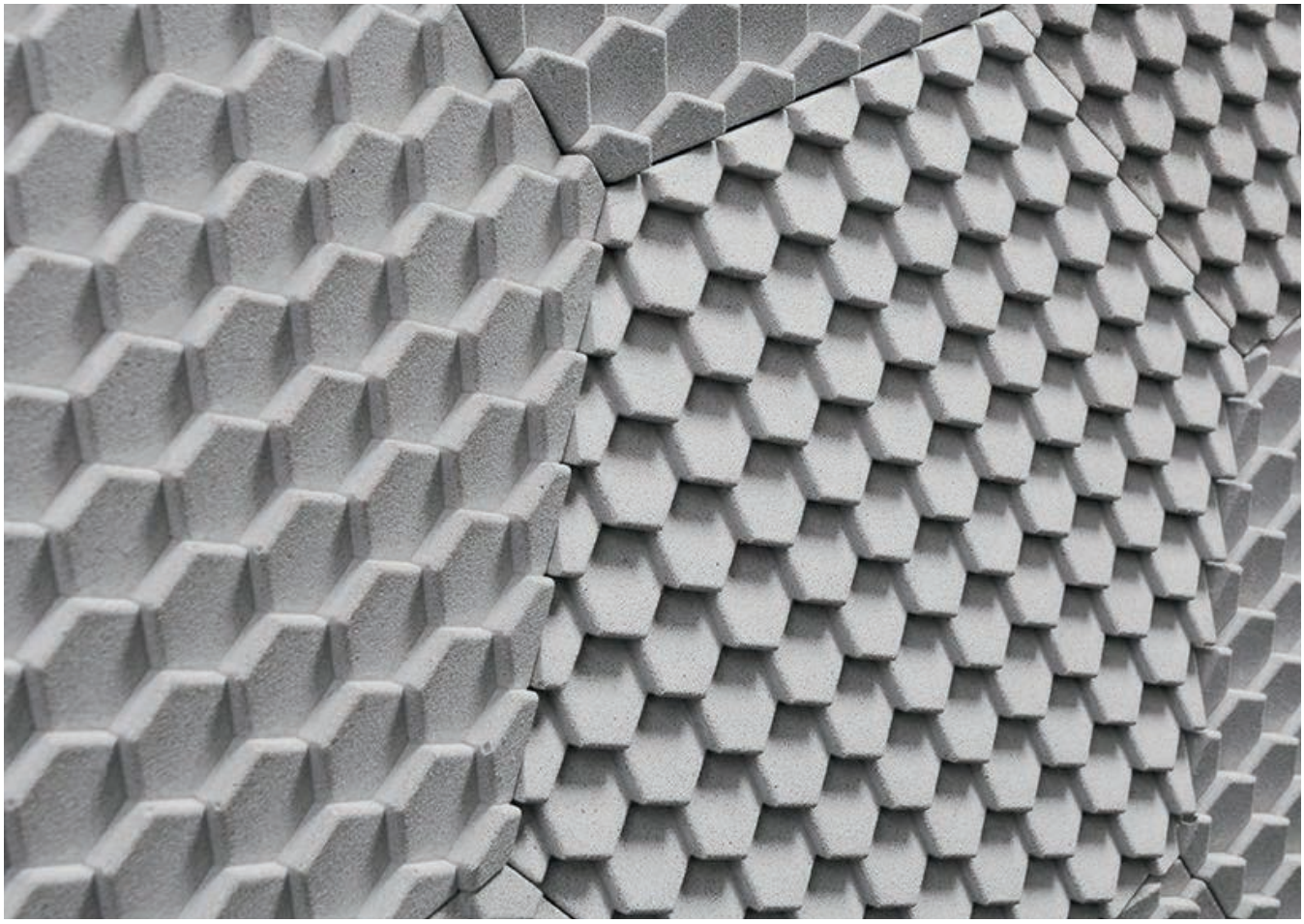


Fig.8.Jesmonite Hex Textured Stone Tiles,
(Heliot and Co,n.d.)

In addition to there being acoustic surfaces, there were also a variety of textured surfaces created for a visual and tactile impact such as Heliot & co 's HEX collection. These tiles have followed a recent trend toward different shaped tiles for the home to add a more contemporary twist. This particular example show in Fig.7. Shows a great example of creating a striking design without the use of colour, creating a textural surface creates enough tonal differences to have a product that is interesting and unique. This characteristic is one that is very important to the researchers 'ideal aesthetic' the importance of an honest surface, showing the consumer the material as it is rather than disguising it is not only environmentally friendly as there is less processing required but also enhances the strength of the design.

Fig.9. 3D Effects: Carving Techniques Inspire Textural Patterns within Surfaces: Amarestone CNC Carved Limestone
(Surface Design Show & Amarestone, 2016)

There were also some good examples of CNC routing at the show, including this display created by Amarestone. The display is a great example of the types of materials that can be machined on a CNC router. The simplicity of the designs shows how much can be developed to create truly unique pieces of art and design that have not been seen before at the Surface Design show. The strength in the design is once again coming from their conscious lack of colour, allowing the stone to be the feature in the product. This type of surface would look great in any bold and contemporary environment.

5.5 Summary.

What is clear from the 2016 Surface Design show, is that tactile surfaces are becoming more and more popular within the built environment. These types of features are being created to provide clients with something unique that makes a bold statement. As discussed later on in this research, this is very reflective of the evolving nature of the

consumer who now demands unique products as part of expressing their unique identity. This observational exercise also proved that there is a need for the type of designed product being created during this research project, this can be seen in some ways as a ‘proof of concept’ and highlights the move toward 3D surface designs.

The next section will be another case study, this time based around The CNC Routing Company, who have inspired and supported this research project.

Part 6. Case Study: The CNC Routing Company

6.1 Introduction

This case study will look at a local CNC routing company who have contributed towards this research. The first section covers why they are part of the research including a brief background into their business. The next part will look at how the relationship with the CNC routing business has formed, including discussing the first collaborative project during the 'Surface Tactility' final major project. Finally, there will be a small comparison looking at Laser Cutting vs CNC routing and the benefits and disadvantages of each.

6.2 Research Participation

Working with the CNC routing company during the 'Surface Tactility' (See appendix C for collection book) project brief developed a line of questioning that lead to this research question. In order to pursue the research appropriately, it was felt that building on the relationship with the company would be very important. The company have once again offered to create samples from this project, testing out the ideas created and also testing out their newer CNC routing machines.

The company are locally based, specialising in CNC routing of wood and finishing these surfaces using methods such as vinyl wrapping and painting. The business is well established with 20 years' experience in this manufacturing field. They have a long-standing relationship with their raw material suppliers which has meant an excellent overall outcome of service for their clients. The company's dedication to providing the best quality and service for their customers has made them extremely competitive in the CNC routing market.

As with many other manufacturing companies, they have also conscientiously made an effort to create a business that considers the environmental impact of the products they produce. They have strived to ensure that the product and service they are providing is as environmentally friendly as it can be, this includes recycling all of their waste cardboard,

plastic and biomass as well as ensuring that the wood they are using is FSC and PEFC certified. This level of commitment to the environment shows an excellent long term view for the company and its employees, they have shown they are adaptable in times of change and will continue to evolve as the environmental and manufacturing climate demands.

6.3 Building links with the company

The relationship with the company all stemmed from the 2015 Surface Design show, in which a selection of samples, along with concept boards were exhibited on the University of Huddersfield stand. The work exhibited sparked an interest with the Managing Director of the company, who offered insight into scaling designs up for feature walls. They also advised that laser cutting on the scale of a full wall can come in extremely expensive in comparison to CNC routing. The samples being shown were laser cut wood pieces from the 'reclaimed by nature' collection as shown in Fig.10.

Fig.10.Cutout Leaves sample from the Reclaimed by Nature collection, (Own Image,2014a)

After the initial conversation, a visit to the factory was then scheduled to provide a bit more insight into the process of CNC routing in general and also to highlight what the business specialises in. The factory visit was incredibly beneficial, giving a better picture of what is required for a CNC routed product and its various applications afterwards. The business was very keen to develop their product range further and show their machine capabilities for future clients, however with no specific design department this was limited to creating simple geometric patterns or using imagery that was not specifically for this purpose. This proved challenging throughout the process but in terms of a collaborative project, this was a learning experience that benefited both parties.

6.4 Initial sampling processes

After following up from discussions at the Surface Design show via email and the first factory visit, the opportunity then arose to collaborate on work for the project “Surface Tactility” and to test some of the original laser cut designs on a CNC router. The results initially were very mixed as although in principle a laser cutter and a router work in the same way (both by CNC programming) the consideration of the size of the cutting tool differed so much between the pieces. This meant that pieces that would be OK for laser cutting would be far too complex and in the incorrect scale for CNC routing. It was also found that during this experimentation that MDF *(Medium Density Fibreboard)* would be the most suitable material for further experiments, this is due to a few key points. First of all, MDF is an engineered panel-board meaning that the density and consistency of the material is uniform throughout, this makes CNC routing and laser-cutting much simpler as there is less chance of splintering and splitting of the wood during the cutting process. Secondly, MDF is manufactured using a variety of softwood fibres and can be considered a sustainable material providing that fibres are sourced from FSC certified forests. It is for these two main reasons that MDF was the material choice to provide comparable samples and due to its affordability, to keep costs down.

After many amendments and tests, it was possible to get somewhat simplified designs

to work on the CNC router. Although the results were mixed, some samples were used for the final major project degree show. The feedback from CNC routed pieces in particular was very positive, in the setting of a design degree show, there were not many people who had seen work in this style before. The routing proved to be an effective way of getting bold texture onto surfaces, and with further research could be scaled up successfully with the right steps and programming put in place.

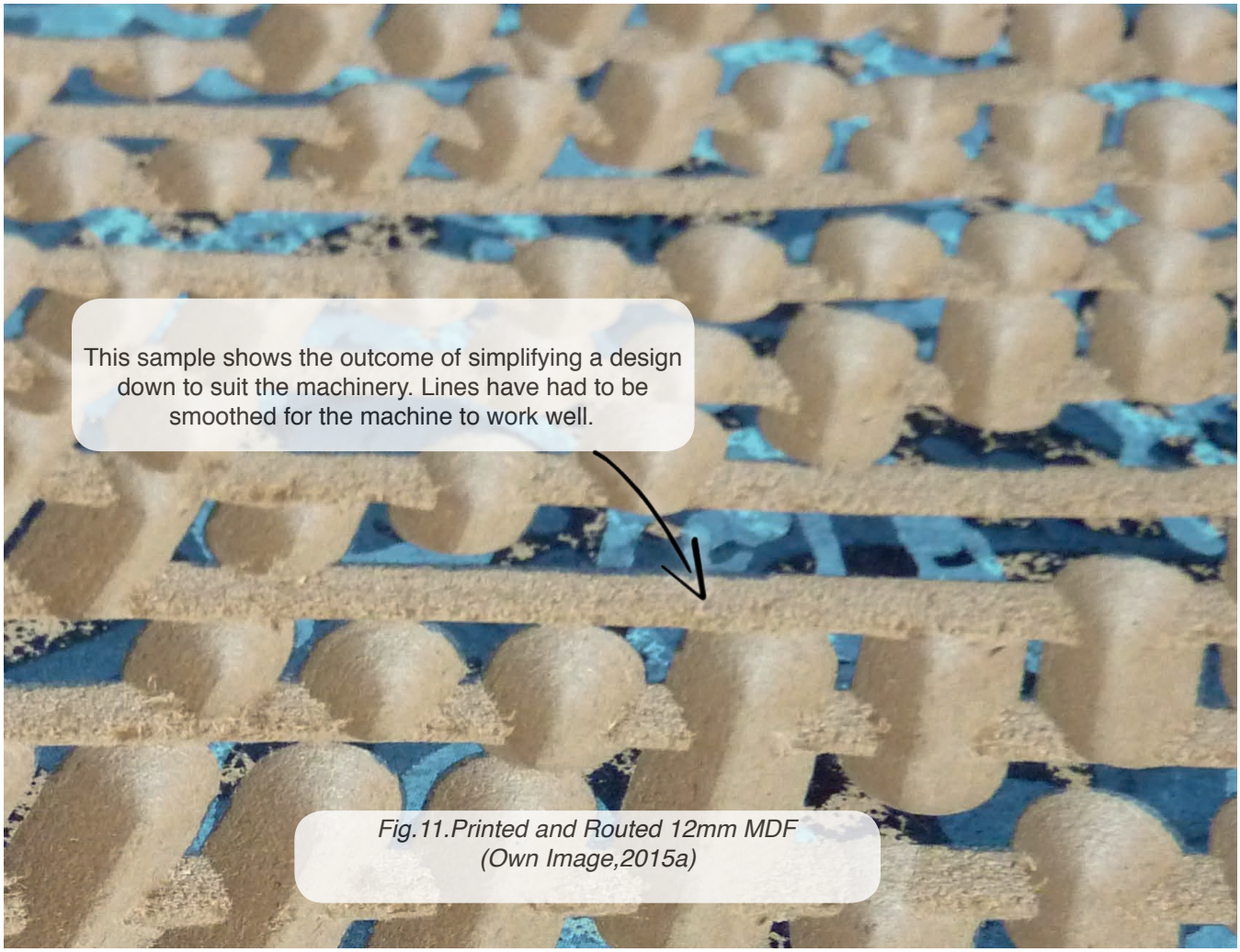


Fig.11.Printed and Routed 12mm MDF (Own Image,2015a)

The results of these tests ultimately lead to this research question, as a designer, it was important to understand why the results were not as expected and what could be done to resolve this problem. What became very apparent was that further testing on design software would be required initially before testing on the CNC router.

Shown in Fig.11. Is an example of the CNC routed samples created during the project, this work was created by working around the limitations of the machine. It was clear

that the router was not designed to work easily with very organic shapes so as a final attempt, designs were created from the initial hand drawn images, but this time by using the negative space, or joining together several smaller shapes to one larger, easier to cut piece.

6.5 CNC Routing vs Laser-cutting.

Personal experience has dictated a preference toward laser cutting as a manufacturing process, this is mainly due to the availability of the machinery within the university and also due to working on a ‘sample’ scale. However, many discussions about taking the work to the next stage of ‘full scale’ manufacture have suggested that CNC routing could be a far more effective method. One of the key reasons for this is cost, CNC routers are much cheaper to maintain than laser cutters when considering large scale manufacture. The tools used on a CNC router are much cheaper to replace than that of a laser cutter.

Fig.12. CNC Machined Plywood, sample showing during the machining process (Visual News & Anderson, 2015a)

There is also the argument for variety when using a CNC router, pieces can be altered by

using a different shaped tool, altering the depth of the cut and even changing the angle of the cut. The developments in CNC routing mean that 3D carvings can be created using a machine, this in turn means that pieces can be made with similar results to that of a 3D printer or hand sculpting.

> *"When choosing between laser and mechanical cutting, it may be helpful to remember that the processes are not exclusive of one another…weighing the benefits of one type of cutting versus the other are essentially balancing laser cutting's precision and reliability against its cost and energy usage, and mechanical cutting's ease of use and cost efficiency against its risk of damaging or deforming a given material"*
> *(Thomas Publishing Company, 2017)*

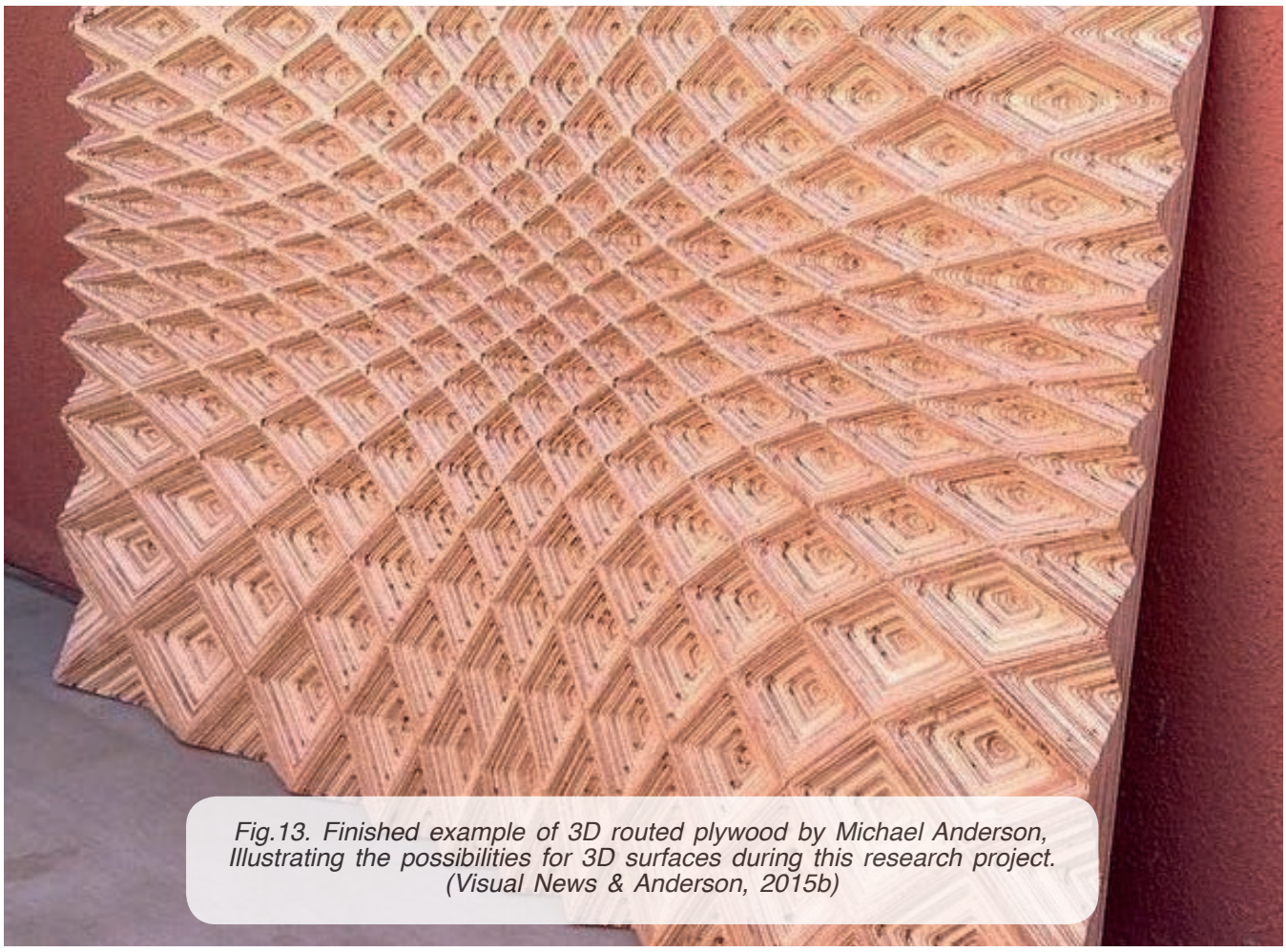


Fig.13. Finished example of 3D routed plywood by Michael Anderson, Illustrating the possibilities for 3D surfaces during this research project. (Visual News & Anderson, 2015b)

When comparing the router effects with that of a laser cutter, there are many more different styles that can be achieved with a CNC router, this is mainly due diversity with tool heads. A laser cutter only has one head shape and size as the tool is made to cut or etch fine details, in relation to this work it is advisable to focus on the CNC aspect due to the variety that can be achieved. However, it is still important to understand and

appreciate that there is a place for both machines in the same manufacturing market.

This assessment of the two techniques shows how both processes have validity in certain areas of manufacturing. It is generally personal preference and scale which determines which cutting method will be used to create the desired surface. As a surface designer, this decision-making process for choosing a manufacturing method will effect the final aesthetic and also the final cost. The correct decision must be made ultimately on how well the design works in each process, costs and other factors can be worked out at a later stage.

6.6 Summary.

Working with the CNC routing company has created a new avenue for exploration in creating tactile surfaces. This experience has inspired further research explorations into improving the designing process, it is important to refine the design-manufacture process first before creating new design pieces. The importance of truly understanding the machinery and how best to work with it will ultimately yield the best results. The comparison of Laser cutting and CNC routing has shown that both techniques have validity as a method for creating a cut-out surface, it is just down to preference as to which method is most suitable.

Part 7. The Context of Craft.

7.1 Introduction.

This section will look into what it means when the term ‘Craft’ is used, looking at the historical use of the term as well as its modern day connotations. This will be broken down into 4 main areas, first of all looking at the definition of craft, analysing the meaning of the word in the literal sense and how this is reflected in general perceptions of the subject. Next will be a look into the history of craft which will investigates how the craft we know today came into fruition and what this means for the perceptions of the subject that so many have. Then there will be an investigation into the resurgence of craft, looking at the contributing factors to its increased popularity in recent years and how this has expanded the reach of this subject area. Finally, there will be a look into one of the manifestations of modern day craft, looking at the popularity of personalisation in the making industry and how this affects the craft world.

7.2 Definitions of Craft.

The term ‘craft’ has seen many manifestations over the last few centuries. From the practical connotations before the industrial revolution, to a romanticised view of craft during time of great mechanical development, ‘Craft’ has always been in a state of flux.

The dictionary definitions used in section 3.2 refer mainly to craft as a skill that comes from working with your hands or creating something that requires great skill. It can be argued that in some instances of manufacture, a great amount of skill is required to create products and surfaces, yet manufacture is generally classed as separate industry. What is apparent in the ever evolving culture of craft is that these presumptions of craft are being challenged by a new wave of designer-makers, crafts people and artists. Where once there were negative ideas of combining craft with machines, there are now positive contributions being made to the craft movement with people utilising machines for their

own craft practices. This is reflected in several exhibitions, books and articles including a previous exhibition at the V&A in London, called The Power of Making, this exhibition is predominately a celebration of craft and human ingenuity, displaying objects that make the observers question how was this made? What this exhibition and the book of the same name managed to do, is open the viewer's eyes to alternative methods of craft, outside of the perceived 'traditional' techniques. In his essay, 'The Power of Making' Daniel Miller talks about the evolution of making and craft as we step forward into the next manufacturing age, one that incorporates digital technologies. The main message for this exhibition is to show that the definition of Craft has changed from just 'handicraft' to incorporating fine art and manufacture equally, Craft is simply a creative expression of great skill whether this be using a paintbrush, chisel or 3D printer.

7.3 Historical Craft.

Craft as we know it today did not even exist as a concept until the late 18th century, in its earliest form during the medieval period it was a generalized term to mean *'intelligence, skill and strength, a set of connotations retained in the cognate term "crafty"* (*MacDonald.J, 2005*). Craft as an actual 'thing' is a fairly modern one, pioneers of the Arts and Crafts movement are largely responsible for the modern day meaning of Craft, associating it with decorative arts, and handmade. The Arts and Craft movement began in Britain in the late 19th century, pioneered by John Ruskin and William Morris, it embodied the antithesis to the industrial revolution. There was a great deal of concern amongst many intellectuals for the changing face of industry, no longer were objects being created using manual techniques, but instead were being produced on a mass scale using machines. For many it was felt that the beginning of industrialization marked the end of craft and the handmade skills that had been used for many centuries, it was also felt that the machine-based manufacture encouraged exploitation of workers and the destruction of beauty. As a result of these feelings the Arts and Crafts movement began to represent a 'anti-industrialisation' concept that stood for wholesome living, joy in labor and the celebration of the craftsman, amongst many others.

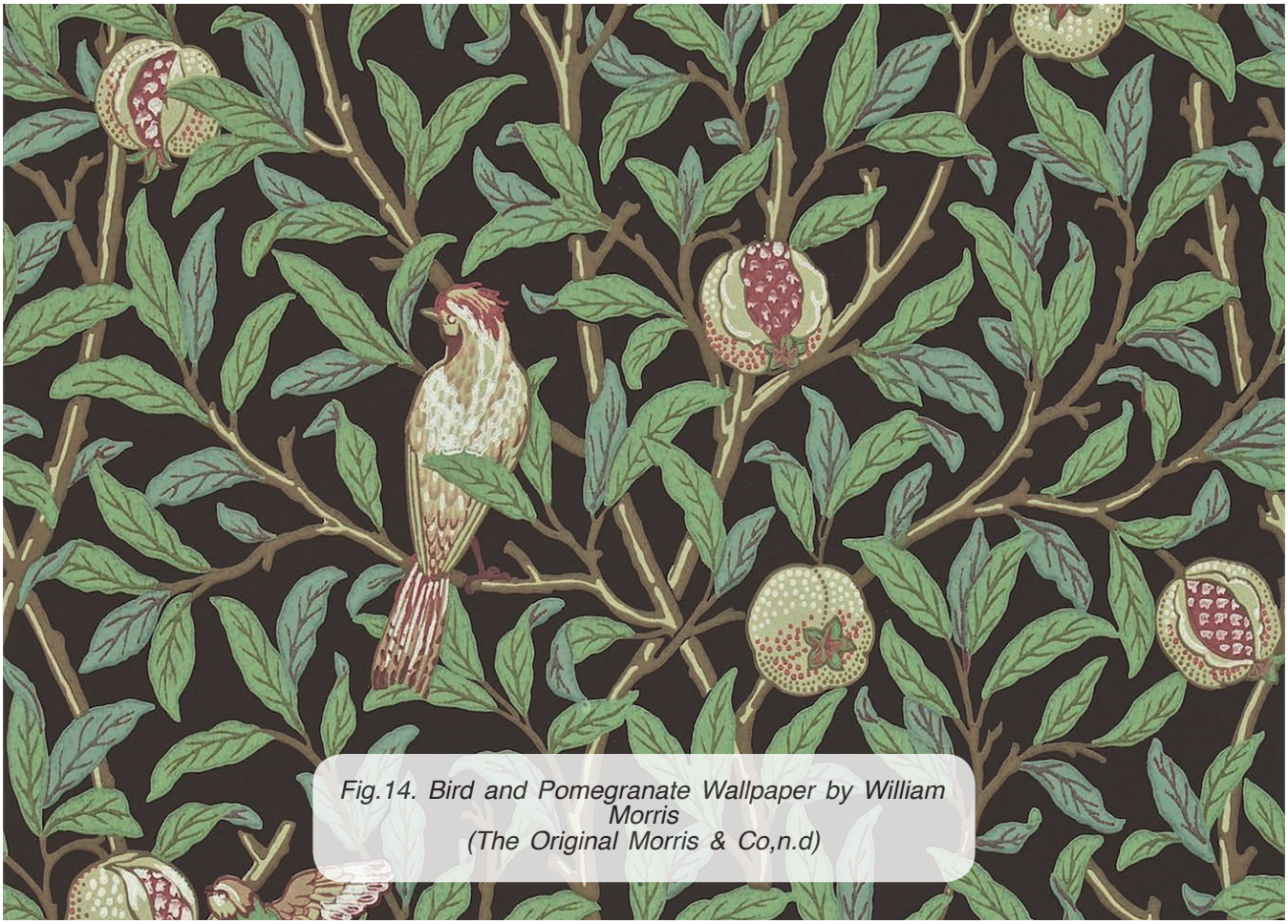


Fig.14. Bird and Pomegranate Wallpaper by William Morris
(The Original Morris & Co,n.d)

The Arts and Crafts movement often referred back to rural working, using the countryside as the idyllic setting for the Arts and Crafts movement and the origin of the happy craftsman, this in reality was incorrect as MacDonald discusses in *Concepts of Craft* describing rural working conditions in many cases as being in 'dreadful squalor'. This was largely overlooked by Ruskin who's perceived view of rural England provided the ideal tonic for the ever changing industrial towns and cities. Although it cannot be argued against that the Arts and Crafts movement did a lot for the modern day meaning and status of Craft, there are many who believe that the 'Romantic' views of ideal Arts and Crafts have caused prejudices that are still apparent today amongst many people. What is apparent is the term 'retrospective regret' comes into play here, and is the foundations for many of the opinions toward manufacture and the machine.

Retrospective regret, a term used in Frayling's *Craftsmanship toward a new Bauhaus* is best summarised as feeling that the past was somehow better than modern day. When discussing craft, retrospective regret is often a perspective used by those wishing to return to a simpler time before industrialisation, which is often seen as a reaction to the mass-

materialistic culture that has been created over the past few decades. Although can be some positive outcomes of looking back on a bygone era for inspiration in craft, it can in some ways be seen as a hindrance to progress, why should we not try to develop ways of making things faster and better? Why should we insist on doing things the way they have always been done? If this were the case in everyday life we would not have the continuing developments in medicine, architecture and politics to name a few, why should craft remain a shrine to the past. There is definitely need for an admiration of old craft methods and processes, there also is definitely value in preserving the skills from traditional crafts. However, to stand in the way of technological advancements to preserve old techniques, seems to me to be a little irresponsible.

In Craftsmanship toward a new Bauhaus Frayling's analysis of historical accounts of Craft shows how ill-informed these accounts actually were in terms of modern day applications of a medieval work system. In the chapter *'Skill- a word to start an argument'* he discusses how the history that forms the foundations of the 'Crafts Revival' is actually '*nostalgia masquerading as history' (Frayling,2011)* meaning these retrospective accounts of historical crafts by people such as Morris and Ruskin, are merely nothing more than fiction in many cases.

One perspective to consider is that without the technological advancements of the industrial revolution, would there be the craft industry that we have today? The perspectives of Ruskin and Morris against industry are precisely the reason that craft saw a revival. What they viewed as the 'dehumanising effects of modern mass production' were actually a way for the craftsman to develop and grow. In 'The Power of Making' Daniel Miller discusses the development of the maker, and explains how beneficial industry actually is for the craftsman:

> *'It is precisely because we now have industry, where machines take over so many boring and repetitive tasks, that those who have emerged from impoverishment can afford to celebrate craft as something we do for pleasure and leisures. Ideals of creativity and self-fulfilment grew with the machine age'*
> *(Miller,2011)*

For some crafts-people there is a reluctance to embrace new technology even if it

is designed to make a job easier because it can be seen as 'selling out'. In reality, embracing techniques that save time actually allows the maker to spend their time being more creative, experimenting with new ideas. In his introduction to the exhibition 'Real Craft', designer and curator Chris Eckersley briefly discusses the impact that Morris has had on modern craft prejudices observing that Morris's perspective '*blamed the machine for the decline in standards'* (Eckersley, 2014). His reactionary view to the development of machinery has undoubtedly had a large part to play in the view that 'Mass-Manufacture' and 'Manufacture' are the same thing, when in actual fact the machine is '*simply a useful tool'* (Eckersley, 2014), how people use the machines is what defines its place in craft (or its absence).

7.4 The Resurgence of Craft.

Craft is a word so frequently used in the creative industries today, the market has evolved from the culture of wanting objects that are cheap, functional and throw away, to products that are reliable, timeless and come with a story. 'Craft' as a culture embodies the 'made to last' ethos in many ways, this is very desirable to many consumers are now looking for this type of product. Taking this desire for quality over quantity, coupled with the boom in Social Media, it is now easier than ever for craftspeople to share their stories and processes engaging their customers. In a recent report by the Crafts Council, it was shown that in 2013 there were 11,620 craft businesses in the UK, with an overall value to the economy of £3.4bn *(Crafts Council, 2013)*. Since this report, there has been a steady increase, this is noticeable by the number of small craft businesses appearing online.

The increased popularity of accessible, easy to use selling platforms such as Etsy and Folksy have definitely encouraged this increase in small craft businesses, allowing people to transform their hobby into an income with relative ease. In a blog article *'How The Craft Trend Happened: Three Moments' O'Reilly*.J' he talks of three key stages in the resurgence of craft, one of these being the development of eCommerce and Retail, namely Etsy. This post not only analyzes the sellers in terms of gender, age and ethnicity, but also touches on the consumer too, discussing the purchasing power of the consumer

today and their desire to understand the provenance of the objects they buy. This desire to understand how, where and why a product is made, and to have a shared experience with the person making the product can be seen as a reaction to mass produced, impersonal products that have dominated the retail markets for the past few decades.

> *"People are getting tired of the same old big-box retail products…young adults in particular are attracted by the life stories of the sellers whose products they buy"*
> *(The Economist, 2014)*

In addition to this, there is an increased awareness of sustainability and well-being, 'Craft' is often perceived as a more sustainable option for the eco-conscious consumer, who is choosing to buy a product that is traceable in terms of process and materials, leaving its maker, accountable and responsible for its environmental effects.

7.5 Personalization of a product: *(understanding your customer)*

Personalisation of products is a key theme not only in craft industry, but also in the wider world of design. The consumer has much more control over the products they buy, and with many businesses offering personalisation as a standard practice one must question why?

In a recent study by Crafts Council it was found that Craft was considered the most personal category when compared with Art, Design and Luxury goods highlighting the evolution of the craft buyer. It could be said that the recent resurgence in the Craft culture is due to the consumer demanding more for their money, where once the buyer was happy with mass produced items, they are now craving an aspect of individuality, a way to show their personality with the products they purchase.

Craft has always incorporated an element of personalization, the notion of the 'Craftsman' itself creates an image of an individual that is much more approachable and open to personal touches in the work for their client, than the large corporations that dominate

the creative markets. In terms of this research, it is important to consider that the personalisation is one of the main reasons for considering a digitally fabricated product craft as it is made specifically for its user/clients needs. In Woolley's paper 'The Making: value and values in the craft object' he discusses crafts influence on material culture as a whole, showing how craft influences have encouraged mainstream areas such as interior design and fashion to *'personalise and humanise designs' (Woolley, 2011)*

What must be understood, is that personalisation is not a characteristic exclusive to craft products, with the new wave of industrial change comes a changing in manufacturing strategies for large corporations. Deloitte have released several reports predicting the evolution toward wider personalisation, not just product personalisation but also personalised internet browsing and holiday services to name a few. One statistic from the report states that *"1 in 5 consumers who expressed an interest in personalised products or services are willing to pay a 20% premium" (Deliotte,2015)* This shows the change in the consumer shopping habits, away from wanting mass produced goods, the consumer is now willing to pay for an item that is unique to them. Large businesses will evolve to offer personalised products for their customers through a variety of manufacturing and design methods. A great example of larger corporations offering a personalisation service is well known footwear brand 'Converse' they have the facility on their website to offer a personalisation service whereby customers can choose their own style and design of their trainer. This service comes at a premium cost but means that consumers who were craving an item unique to them can go to a mainstream retailer for this service. This service is something that will continue to become more commonplace in the fashion industry as well as in other areas such as holidays, furniture and many other consumer products. What is clear is that those who do not embrace the personalisation aspect of manufacture, may end up being left behind, as Perkins states 'businesses risk losing revenue and customer loyalty over the longer term as customers increasingly demand personalisation'.

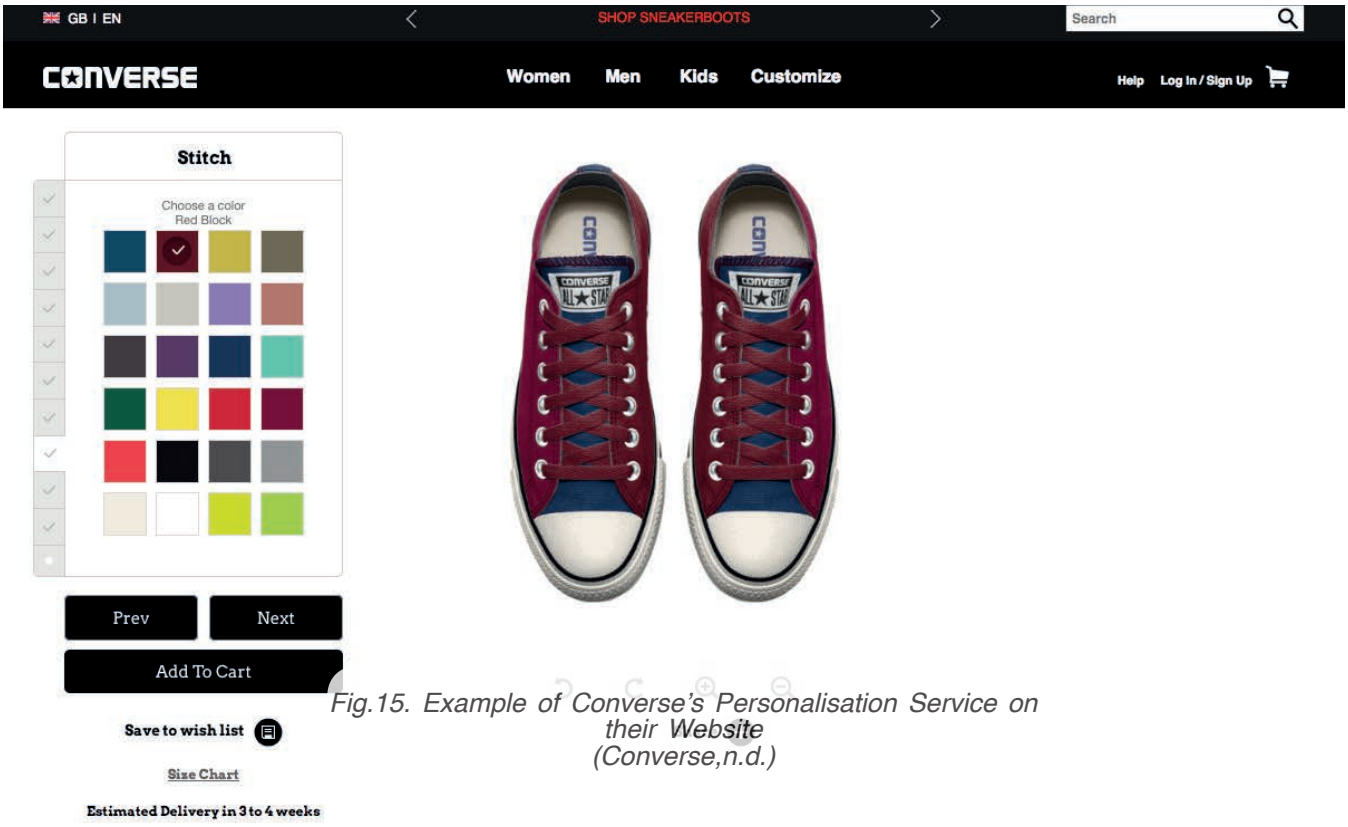


Fig.15. Example of Converse's Personalisation Service on their Website (Converse,n.d.)

There is an aspect of personalisation that can be offered by a craftsperson, that a large manufacturing company cannot, which is the 'human' element behind the work. Personalisation is not just about tailoring the work to the client, but also about expressing the maker's identity through their work. In a blog article by from the British Museum, Lloyd-Jones discusses the value of crafts today highlighting that it is a *'language of material, provenance and making' (Lloyd-Jones.T, 2011*) the key thing to focus on here is *provenance* this is the maker's ability to show exactly where their product has come from, telling the story of the item as part of its value. The story of the product has as much value as the item itself and provides the customer with added emotional value in their item, in Crafts Councils report 'Consuming Craft' they discuss the stories behind craft products, observing that from their research "45% of craft buyers agree that 'I like my possessions to be talking points, to be able to tell other the stories behind the objects I have." This strong sense of identity through craft objects is becoming more important as consumers change their shopping habits back to using local businesses and steering clear of mainstream retailers.

Undoubtedly the personal aspect of craft objects is one of the main features that makes it something 'against the norm', incorporating a personal aspect of an item can be done

using machinery or by hand providing that the maker has a strong involvment in the process.

7.6 Summary.

Craft is clearly still a subject area that offers many different opinions, those who follow the beliefs of Morris and Ruskin will always be of the mindset that technology hinders the development of skilled craftsmanship. However, for those who embrace developments in digitalisation and manufacture, there are always new methods for creating craft items, with more accuracy and with the ability to totally personalise items for their customers.

What must be understood is that neither the ‘digital craft’ or the ‘traditional crafts’ makers are better than the other, difference of opinion is what keeps this industry interesting and unique in so many ways. From this analysis of Craft, it is clear that there are some characteristics of a crafts-person that are instilled in both the traditionalists and the modernists. These characteristics are based around having great skill in what they are doing, whether this be using a specific hand tool or designing an object on a computer. In addition to this, crafts-people are selling ‘their story’ as part of their product, their identity is part of the item that they make and the pride inwhich they make their products makes them undoubtedly a crafts-person. There will always be a need for traditionally made products, just as there is a requirement for new and innovative items, as long as the values of the craft maker are instilled in both methods, craft will continue to flourish.

The next section in this research will be a reflective study, looking back at previous samples from the researcher’s collections. These samples will be analysed in terms of effectiveness of the techniques and also how certain pieces have been created with a combination of digital and hand techniques.

8. Working with Machines to Create Surface Designs: *A Reflective Study.*

8.1 Introduction.

As a surface designer, machinery has provided ways of testing design ideas on new materials quickly and efficiently. The ability to test an idea quickly using the accuracy of something such as a laser cutter has enabled a better final outcome for design collections. Utilizing facilities available at the University and collaborating with other businesses has created a style of work that is a hybrid of machine and hand-made work. As part of the researchers design style, it has always been important to create work that does not look too 'digital', part of the signature of the work is that the pieces still feel like they are unique. Much of the process has involved creating work using hand techniques first and then enhancing these using CAD software such as Photoshop and Illustrator.

In this section, a selection of pieces will be analysed that have been created through the combination of hand and digital techniques, evaluating not only the aesthetic qualities but also discussing the process itself and how the personal involvement has influenced the design outcomes.

8.2 Surface Design Samples.

8.2.1 Creating Sample 22: *from the Reclaimed by Nature Collection*

The first piece is Sample 22, from the Reclaimed by Nature project, this project was based around up-cycling and re-purposing old materials with a particular focus on wood. This project was an exploration of methods to improve the visual and tactile nature of a discarded surface, with the view to using these products in commercial environments such as restaurants and hotels. One of the main themes for this project was a focus on sustainability, using materials in their found state rather than recycling was very important,

not only to show that it is possible to make something beautiful out of an unwanted object, but to also show that items to not need to be broken down and reformed to make something new. This project took much of its inspiration from reading McDonough and Braungart's *Cradle to Cradle*, a book which discusses the process of having products with an endless lifespan, rather than throwing them away once their use has expired. This particular sample combined a selection of different techniques to create the finished look, heavily relying on a combination of digital and hand made techniques.

Fig.16. Sample 22 from the 'Reclaimed by Nature Collection
(Own Image,2014b)

Throughout this degree course, we as Surface Designers were encouraged to always express our initial ideas by hand first of all, using mark making, printing and drawing. The first step toward creating this sample was using screen printing in a slightly unconventional way. Initially a layer of disperse dyes were put down in a scattered manner, next a layer of petals were sprinkled over the top to act as a resist, this would in theory leave blank spaces where the petals have been. This was then allowed to dry before putting into a heat press, *(the heat reacts with the disperse dyes to create vivid prints onto synthetic materials).* The results of the heat transfer not only imprinted a colourful ink pattern onto the other sheet of paper, but also caused the flower petals themselves to leave a natural

print as well (see fig.17). These initial print tests were very promising as the colours and textures created by the flowers created an interesting colour palette that would compliment the natural colour of wood.

Fig.17. Petal and Leaf print (Own Image,2014c)

The next stage in creating this sample was to develop the original print into a digital image that could be UV printed onto a piece of reclaimed wood. The original images were scanned into Photoshop and modified using a variety of techniques including altering the colours so that they would stand out on the medium brown piece of wood. This stage of the work was key in creating the end aesthetic of the sample as it was important to create a print that would be sympathetic to the surface it was going on to. Although at this stage there were interactions with digital technology, it was still a personal piece of work, it still had the desired style and there was still ultimate control over the sample end result. The use of digital design software in this sample and in many others is an essential part of the process and something that cannot be done by hand alone, the use of digital software is paramount in improving, enhancing and modifying designs. In reality, much of the initial print pieces would not be suitable as final designs as the process uses very experimental techniques, the ability to go back into a design digitally and re-work it allows something to be produced that shows the true design style.

Fig.18. Digitally Modified Petal Print for UV Printing (Own Image,2014d)

The next stage involved in creating the sample was to print the digital image using the *Mimaki UJF-3042 Desktop Size UV LED Flat-bed Printer* this machine allows you to print images onto hard surfaces. The machine works in a similar way to an ink-jet printer but instead of just putting down ink that would normally be absorbed by the paper, the ink is hardened using UV LED lights, sitting on top of the material rather than soaking in. This piece of equipment is something that is widely used in the world of manufacturing, particularly for things such as signage and stationary. UV printing can be seen, much like digital design software, as a method for enhancing the work as well as being a means to transferring the design from digital to physical. This printing techniques allows a large amount of control to be given to the designer, as it can be programmed to print in a variety of different ways. For this particular design the print was done in several stages, an initial print was done but at -50% opacity, which would leave a faded effect. The next stage was to print isolated parts of the design again, but this time at 100% which would leave a much stronger print, and then finally the same was done over the top using another design. This layer of prints at different opacity strengths created a multi-textural surface that had depth and intrigue and simulated a more ‘organic’ surface to tie in with the project themes.

After the UV print had been done, the sample was then finally laser cut using a line drawing that had been scanned in (see fig.19) modified to fit the sample size (see fig.20.)

Fig.19. Hand Drawn Floral Pattern (Own Image,2014e)

Fig.20. Modified Design Ready for Laser-Cutting (Own Image,2014f)

The laser cutting process is one that has always been favoured by the researcher as a method of translating hand drawings into textural surfaces, the laser cutter allows designs to be created that have a great level of delicacy, something that simply could not be done by hand. This method is also suitable specifically for sampling as it is a relatively quick process, it is ideal for rapid prototyping and allows me to create a physical object that can then be analysed by not only its aesthetic qualities but also its tactile ones.

The interactions with each of these digital processes were necessary to create the final sample, each digital step allowed the design to be enhanced, manipulated and altered to suit the end result. The final outcome of this piece was simply not achievable by other hand methods and in this stage of the work it was important to create samples quickly. Although much of the sample was created using digital techniques, there is still an element of manual 'Craft' in it and with such an personal involvement in each stage the researcher had the ultimate control over the design rather than the machine.

Fig.21. Close-up image of the Finished Sample (Own Image.2014g)

The pieces of equipment and techniques used to create these samples were selected due to their accuracy in terms of the desired aesthetic. The UV printer does have some limitations in terms of colour results, however with a good understanding of this it is possible to create pieces of work that take this into account and still create the desired visual effect. In these initial sample stages, there was not much consideration for scaling up these pieces of work however, bother the laser cutter and UV printer are available in commercial dimensions, although undoubtedly with larger cost implications. With this particular project each sample being individual was very important as each piece would be made from a separate reclaimed surface.

8.2.2 Using Machines to Generate Design Ideas

Machines have not only supported the development and sampling stages in previous work but have also been a fundamental part of the initial preliminary design stages. The use of

digital equipment to facilitate the initial design process is a good way to develop design imagery. With much of the design pieces from the 'Surface Tactility' collection the initial design drawings were done using technology abstract the natural objects. A particular technique which was favoured was projecting the small natural items that were found onto a wall and enlarging them, these were then traced onto a large sheet of paper and used to create outlines that could be laser cut, made into screens for printing or manipulated digitally into designs.

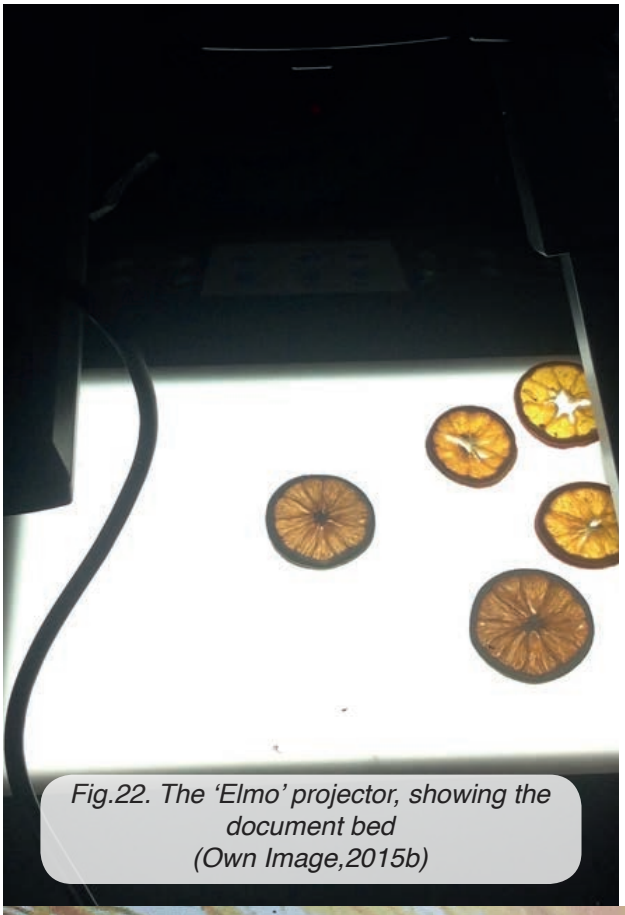


Fig.22. The 'Elmo' projector, showing the document bed
(Own Image,2015b)

Fig.23. Example of the P10HD 'Elmo' document camera which can be connected to an projector.(ELMO, 2016)

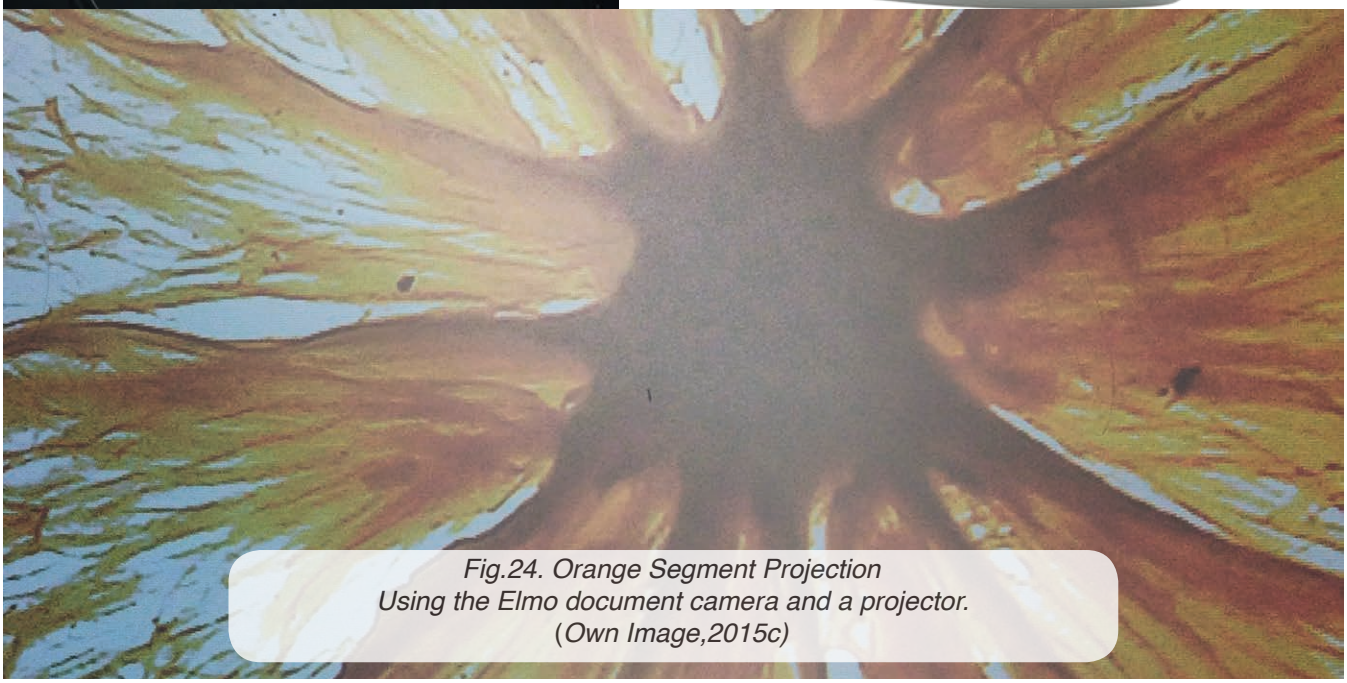


Fig.24. Orange Segment Projection
Using the Elmo document camera and a projector.
(Own Image,2015c)

In this instance, the machinery used to make these images is an ‘Elmo’ projector, this works by creating a live feed like a video, which can then be connected to a projector. This piece of equipment is particularly useful as it has the option of pausing the feed so that objects can be arranged in a certain way, paused, and then projected on the wall without any movement. This function created the opportunity to take care over the drawings without the arrangement moving which was particularly useful for some of the more intricate floral pieces. Although this could have been created using a standard projector, the risk of the pieces moving was too great and in this instance, the ‘Elmo’ projector facilitated greater care and attention. This technique was also a good method for scaling up physically so that images could be assessed to see how images would look on a larger wall surface as they would be intended in the real market.

This drawing technique was used through the ‘Surface Tactility’ project, using the images in a wide variety of ways. The most frequently used method for interpreting these drawings was through the laser cutter, Fig 25 and 26 shows an example of the drawings being translated into a physical sample, the continuous line on these images, along with the abstraction would not have been possible without the use of the projector.

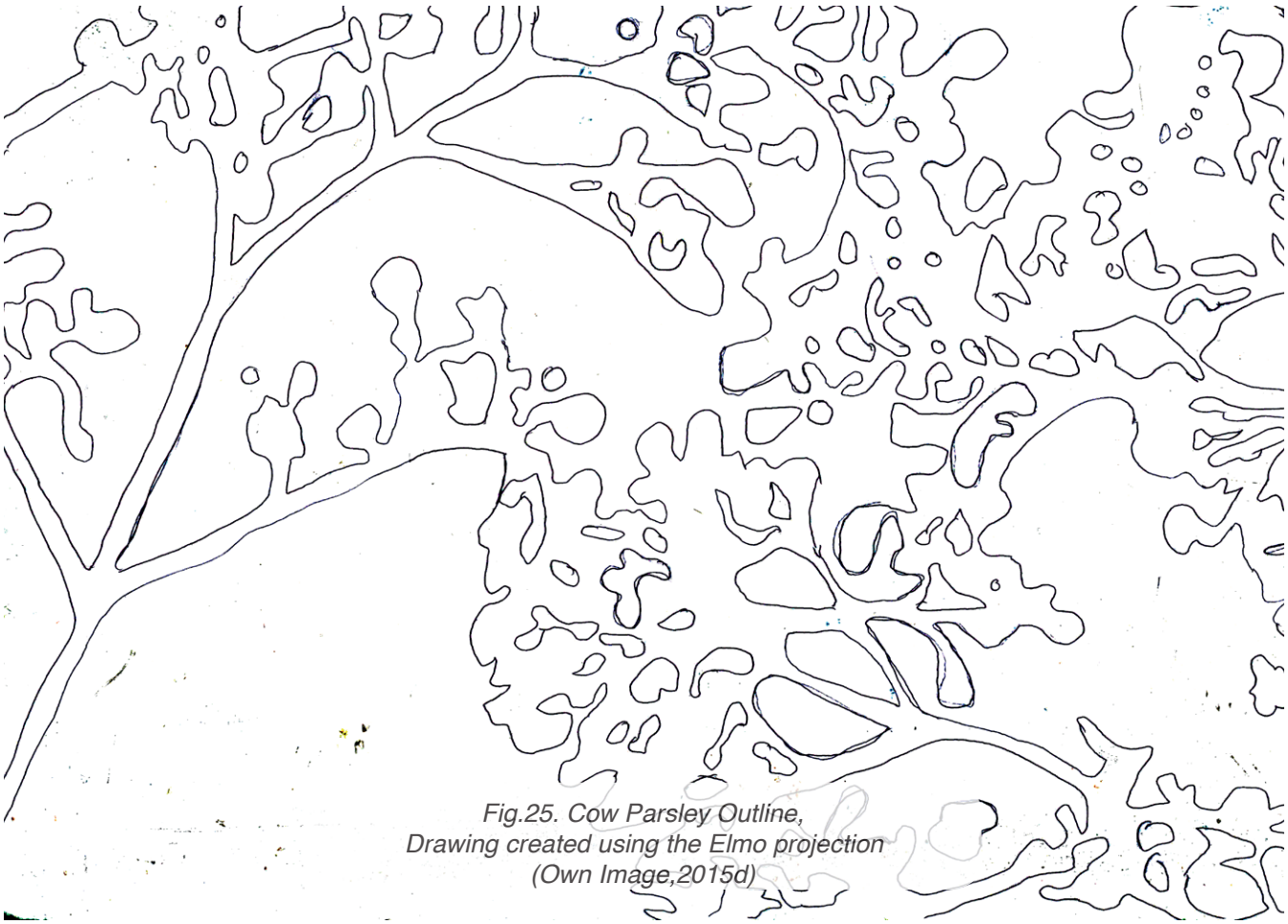


Fig.25. Cow Parsley Outline,
Drawing created using the Elmo projection
(Own Image,2015d)

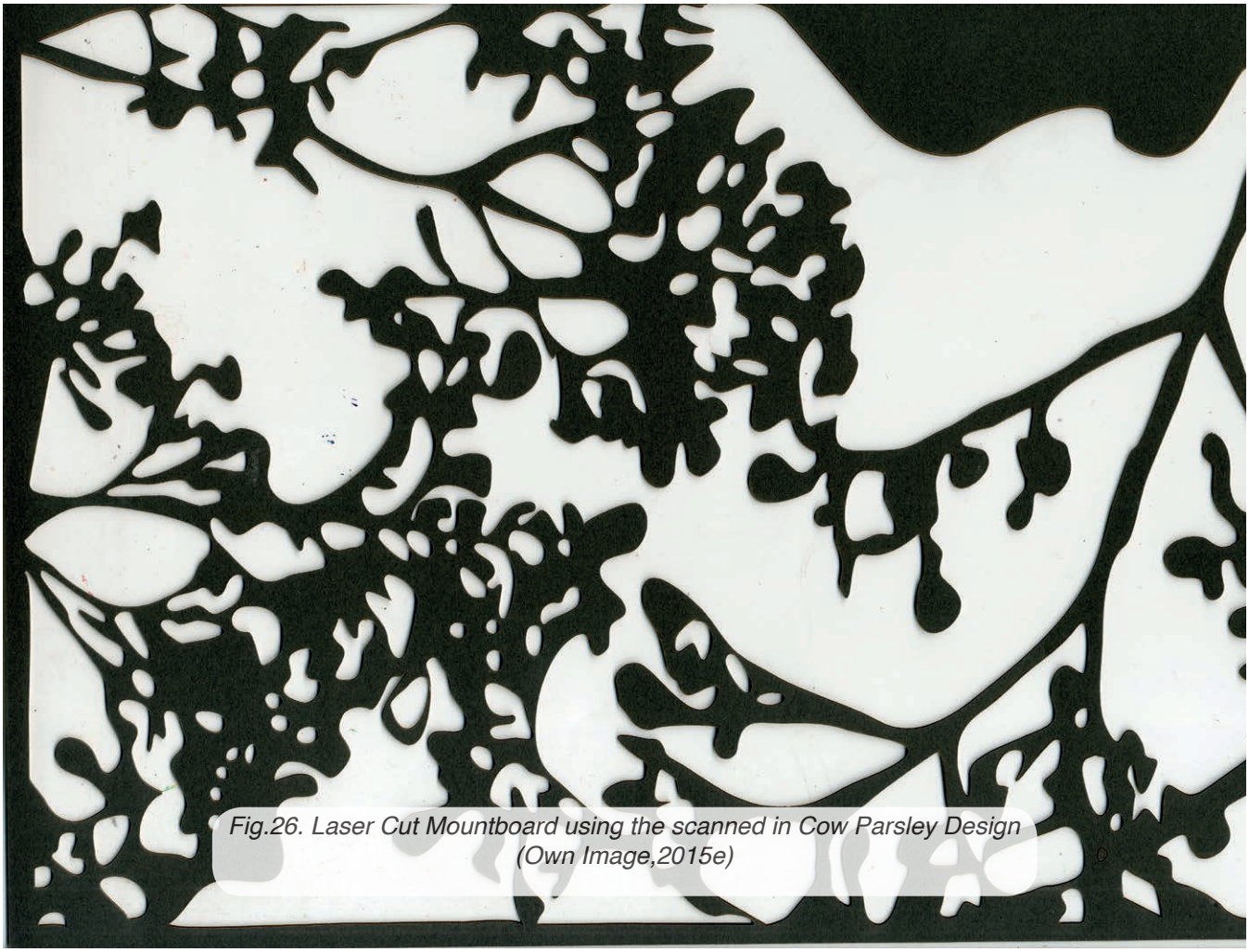


Fig.26. Laser Cut Mountboard using the scanned in Cow Parsley Design (Own Image,2015e)

As a designer, there has always been the desire to create work that is not only beautiful but quick in terms of the initial ideas. Personally there is no enjoyment in the laboriousness of fine sketches or paintings as it does not suit the style of work that is trying to be created. Using machines to improve the ideas stage is a perfect solution for the work, it has always been felt that this work is at its best when there is an impulsive feel to it. Using a machine to aid in the design process is seen as improving productivity, the initial images created are not necessarily pieces of artwork in their own right, but they do become artwork once they have been reworked and combined with other techniques to transfer onto the chosen surface. When referring back to the works of Ruskin and Morris who talked about the machine as 'dehumanizing craft' it could be said that in the context of this work that is simply not true. The machine, in the case of the projector has provided an efficient solution to a problem that would not be possible by hand techniques alone. The projector has facilitated the need to scale up items accurately and quickly, giving the designer more time to focus on the physical applications of my work.

In the context of this work there is a belief that a fusion between hand and digital techniques is a step toward modern 'Digital Craft', embracing these methods has increased my creativity and problem solving skills. The designer has developed the ability to fix problems quickly with the aid of rapid prototyping techniques and can also simulate designs before they are made to save on wasted samples.

8.3 CNC Routing Initial Design Tests.

As mentioned in section 6, the CNC Routing Company have been a large influential factor on this research, their machinery has inspired several different designs and samples, but it has also lead to this research question. Working with industry has always been an essential part of the Surface Design course, it is vital that designers understand how things are made so that they can create pieces that are sympathetic to this manufacturing process. In the Surface Tactility final major project, there were many challenges that arose with working with a CNC manufacturer. The first of these was the designers lack of understanding of the process, CNC routing was not something that played a part in the techniques that had developed through the degree course, but after discussions with managing director of the CNC routing company at the surface Design Show in 2015 it was felt that it may be ideal for up-scaling designs.

The first things that were chosen to test were designs from 'Reclaimed by Nature' project, the images were originally for a laser cut piece which was only of A4 sizing. The design was enlarged to fit a 50x50cm square and sent as it was, with no adjustments to the lines or spacing. This original image was sent to the company first of all for them to check that it would work on the router, this was incredibly important for each of the designs sent through as there was the possibility that they would not work or cause a problem on the machine. The first router test was a success, the images looked as they were supposed to and the bold line structure had created a good texture that would work well on a large wall surface. However, feedback from the CNC programmer revealed that although the image looked OK, there were in fact issues with the design. It was discussed that the image would need to be simplified in order to machine better and that some of the angles in the design were potentially too narrow to work at all.

The main difficulties with these first tests were understanding how the width of the tool dictates the line depth and shape. Having previously only worked with a laser cutter which cuts a line less than a millimetre thick this was a large adjustment. Not only does the line thickness affect the overall design but it also affects how sharp the machine can turn, meaning that extreme bends in designs would not be possible on this type of machine. What was established early on was that CNC routing would be a good solution for geometric patterns and extremely large scale work, the designer was still working on a relatively small scale and used very fluid lines that were not best suited for this machine. Below are a few examples of the pieces of work that were first routed.

These first selection of tests were as mentioned before were not edited, this was to test the designs in their original form to see how CNC and laser cutting compared. As the project evolved with Crystal Doors, there were then more challenges encountered. What developed as this project grew was that in order to have an image created using a CNC router, it must be designed *for* the machine. As a design student, this was a very unfamiliar process, much of the techniques that had been encouraged were developing work that had been created by hand first of all.

Fig.27. Linear Beech Leaves Test File (Own Image,2015f)

Fig.28. CNC Routed 18 MDF with Beech Leaves Design (Own Image,2015g)

The process of CNC routing was one that was felt to be incredibly successful when relating to the aims of this particular project, to create texture, the router has the ability to go much deeper into wood that would not be possible on the laser cutters the designer had access to. On reflection to this particular project, it became increasingly frustrating working with the limitations of the cutter in terms of the design work, there are specific requirements for a design so that lines do not conflict with each other which became a problem in creating organic styled work.

As a reaction to this problem the designer chose to create a few test examples to explore the CNC routers potential for the designs. After deliberating over a few designs for a considerable amount of time it was decided to simplify down elements from the most successful laser cut pieces. The designs that had been created for the laser cutter were chosen because they could be easily manipulated due to already being vector paths. One of the first steps to simplifying the designs were to isolate specific lines, linear elements that still embodied the natural theme of the work were chosen. By choosing to use just a few selected paths it was hoped that the CNC router would work more successfully and there would still be ability to add a high level of detail in other ways such as print. After the elements had been chosen, each line element was then reviewed to ensure that the angles were smoother, this was simply done by using a curve tool on Adobe illustrator.

The single lines were successful to a certain level, the samples were still relatively small so the angles of some of the lines were slightly too narrow which could cause issues if the design were to remain that size but repeated to create a larger piece. The conclusions drawn from this test were that single simplified lined would work quite well and would certainly be easier to CNC route than a large and complex line piece. However, it was noticed that the theme of the work was no longer showing as strongly in these pieces and the original design style was becoming less clear. Although these tests could have been viewed as a success, as a designer they were not the ‘look’ that was being aimed for. It was realised that the focus on the ability to CNC work was overshadowing the main aim of this experiment, which was to translate the designs that were laser cut onto a larger scaled piece. It was allowing the machine in many ways to dictate the design pieces, which certainly does not embody the control and craftsmanship that is admired.

Fig.29. Isolated Line test from the Cow Parsley Design CNC routed and vinyl wrapped (Own Image,2015h)

When looking at this project in terms of craftsmanship, it is clear that for the majority of the pieces created, there was a great level of involvement from the designer. Ultimately there was sole control of the look of the designs and this reflected the unique design style. In each of the processes described the designer has managed to use the machine as a tool to create an effect rather than allowing the techniques to dictate the final outcomes of the designs. This is particularly apparent in the variety of laser cut and UV printed pieces, where it was possible to explore the machinery techniques and test the limits of equipment. It could be said that perhaps the successes of these types of samples was down to having easy access to these machines, it was possible to test and modify work as it was being processed giving a ‘tacit’ learning experience which ultimately gave a better working knowledge of the machines.

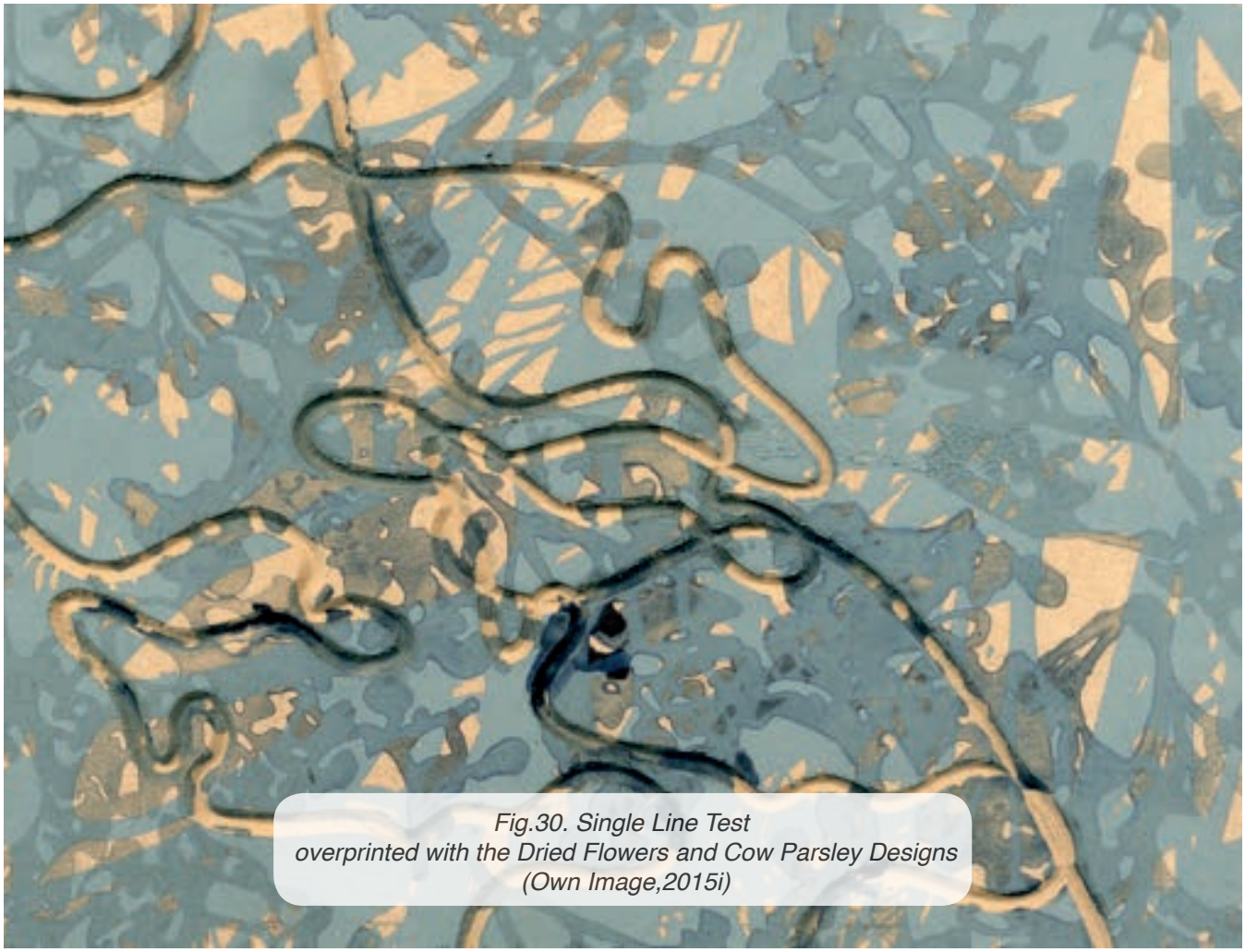


Fig.30. Single Line Test
overprinted with the Dried Flowers and Cow Parsley Designs
(Own Image,2015i)

However, when looking at the CNC routed pieces, there was less involvement during the machining process and the designer was very much relying on information that was provided by the company themselves on what works and what does not. A lack of understanding in terms of the CNC routing process caused a disadvantage in terms of creating pieces suitable for the router. It was not possible to apply any practical knowledge of working directly with the equipment and on reflection this did leave the designer struggling to create work true to the design style.

8.4 Summary.

Overall, it was felt that these initial explorations were a great opportunity to test the limitations of the design skills in creating textural surface designs. It has been possible to develop several successful methods that can offer unique outcomes for potential future

clients. It has been essential having the opportunity of working on a live brief with The CNC Routing Company has provided a good experience for working with manufacturers and showing the importance of building a good relationship with all people involved in bringing a product into fruition. For the next stages of developing this work, it is important to develop the areas that the designer was least confident with during the initial sampling stages, CNC routing has posed quite a challenge for me and it would be beneficial to be able to better understand the requirements for creating designs for this machining process.

In the next section, the samples that have been created during this research project will be looked at. This will include an initial description of the methods used to create the designs, discussing the challenges of 3D design software. After this there will then be an analysis of the 4 samples created with a brief analysis incorporating the theme of 'Craft and Manufacture', looking at whether digitally designed/manufactured surfaces can be classed as a 'Crafted' product.

9. CNC Router and Laser-Cut Sampling.

9.1 Introduction

This section will look at the sampling that has been conducted as part of this research thesis, it will follow the steps from initial design stages to sampling processes. The look at the challenges faced with design software as well as alternative methods that can be used to create the same effects. After the design stages have been described and discussed, there will then be an analysis of the samples that have been created. The sampling part will look at the aesthetic qualities of the work as well as the viability of the design stages. At the end of this section there will also be a reflection on the work, looking at whether the work created can be considered a craft product or whether the process determines the sector that it comes under.

9.2 CNC Routing Sample Tests.

9.2.1 Initial Design Stages using Solidworks.

Part of this research is to ascertain whether it is possible for a digital technique such as CNC routing to create the desired results that is being looked for in the surface designs. After reflecting on the previous pieces of work that have been created using this process, it was felt that the design process should be adapted to suit the machine better. A large part of this new design method involved altering the way images are tested initially and using simulations to decide whether paths would need to be adjusted from the original drawing or not.

After observing the process that the CNC programmer goes through at Crystal Doors when taking a design into a physical sample, it was decided that this should follow a similar process to create the designs also. This method would theoretically streamline the phase from design to manufacture and enable both myself and the CNC routing company to create work with the best possible results. Simulating the images would allow the designer to properly understand how the images would come out in the end, as the designer bares the majority of the responsibility for how the images would work this would

be incredibly beneficial.

At the beginning of this new sampling process, it was decided to assess the software that was readily available through the University and also programmes available as free-ware. One of the first pieces of software that was looked into creating simulations on was Solidworks, this is a design programme used by engineers and product designers. The software can be used for a variety of things including creating 3D models of engines, specialised parts of machines and electrical plans. During first research and development exercise with Crystal Doors the designer looked at using Solidworks to map out the designs. With this brief introduction to the software it was felt that it would be a good first step to attempting to simulating designs onto a 3D object.

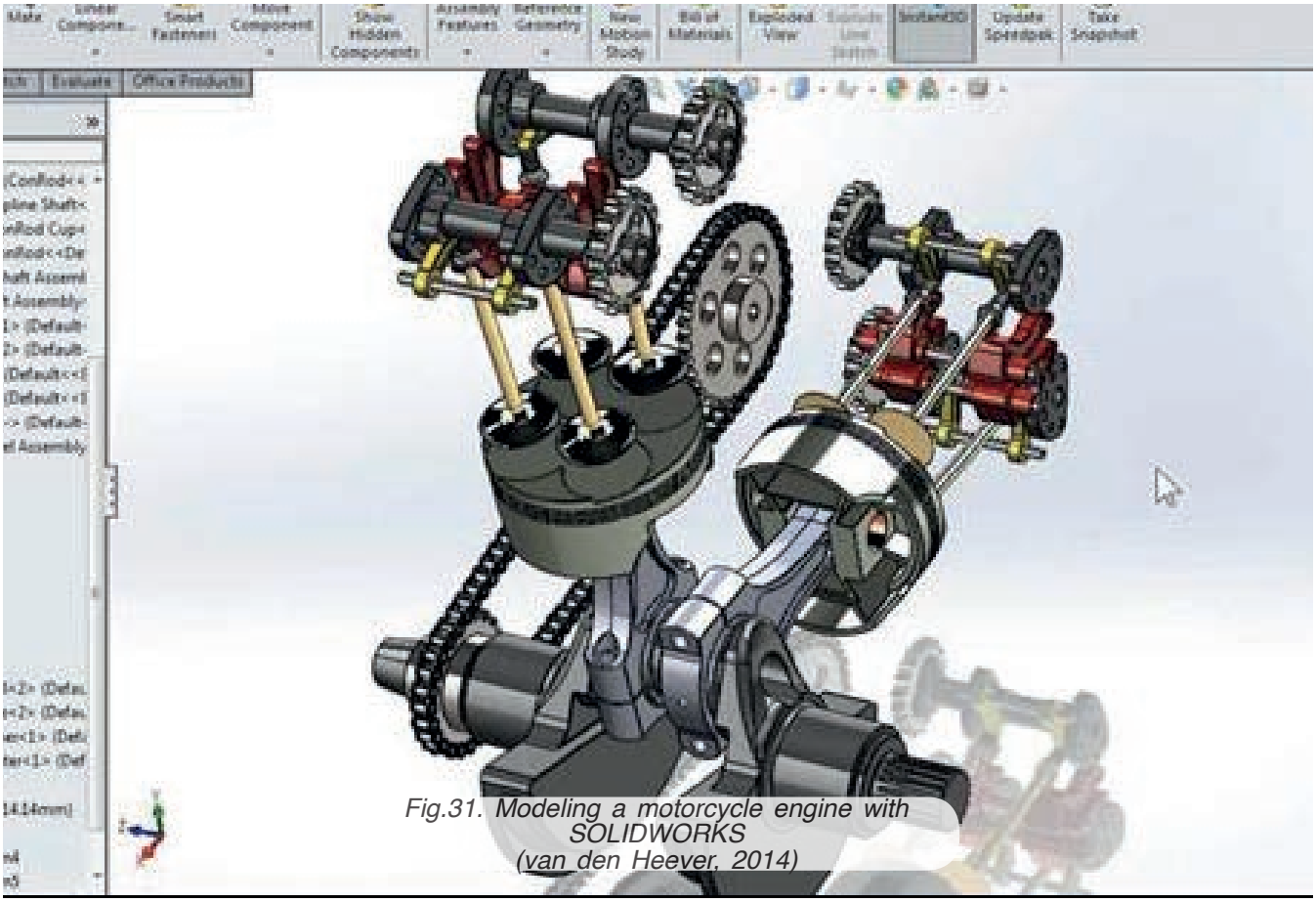
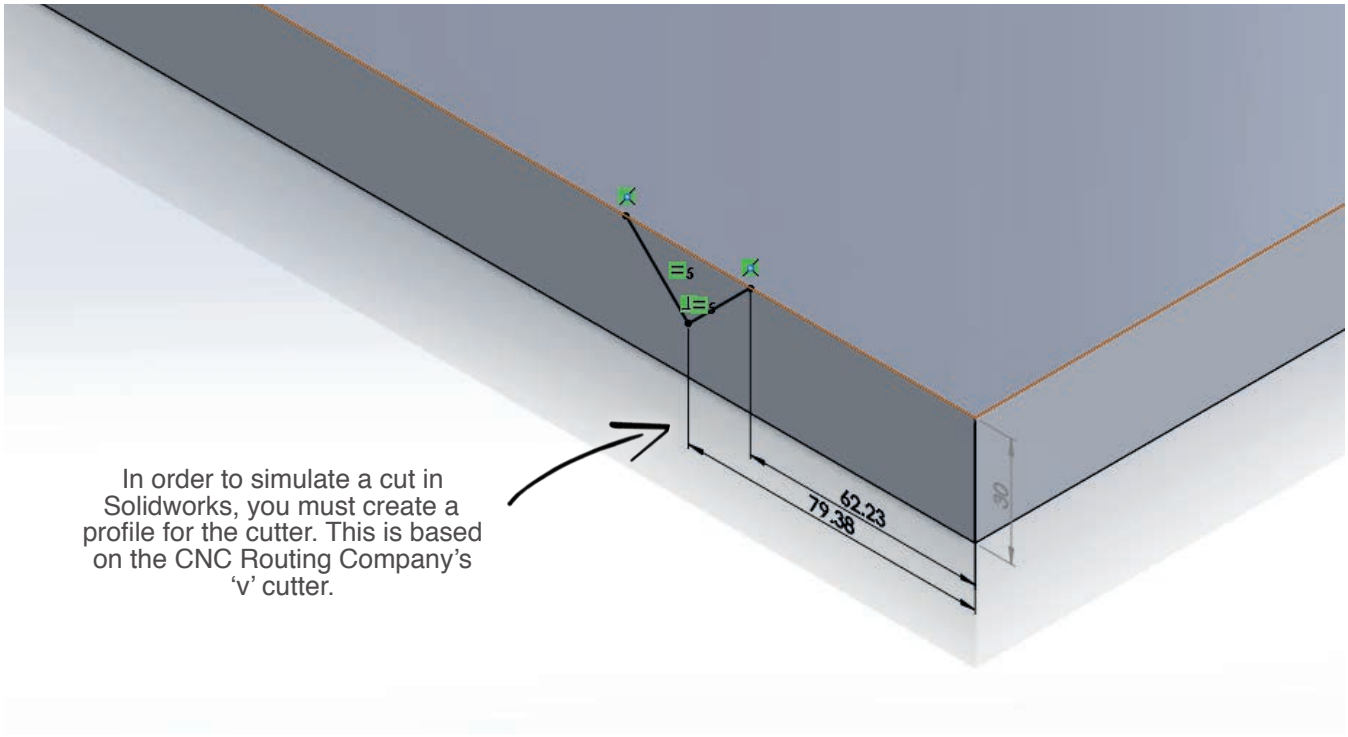


Fig.31. Modeling a motorcycle engine with SOLIDWORKS (van den Heever, 2014)

The first aim for simulating the designs in Solidworks was to ensure that a 3D router path could be created, this was initially done in a series of steps. First a 3-dimensional object needed to be created, the designer used the dimensions that would be required for a sample and created an 18mm deep surface as this was depth that previous samples

had been routed on. Once the surface had been created the designer then needed to map a path as a test to see if the design would work in Solidworks. The initial attempts at mapping a path were unfortunately unsuccessful as although the designer had some experience with Solidworks, it was not enough to create this type of simulation. As a way of getting a better understanding of the software, several video tutorials were used from resources such as lynda.com and youtube.com. These video tutorials were used as a step by step instruction to create a simple line router path, below is an example of the simulation that was created



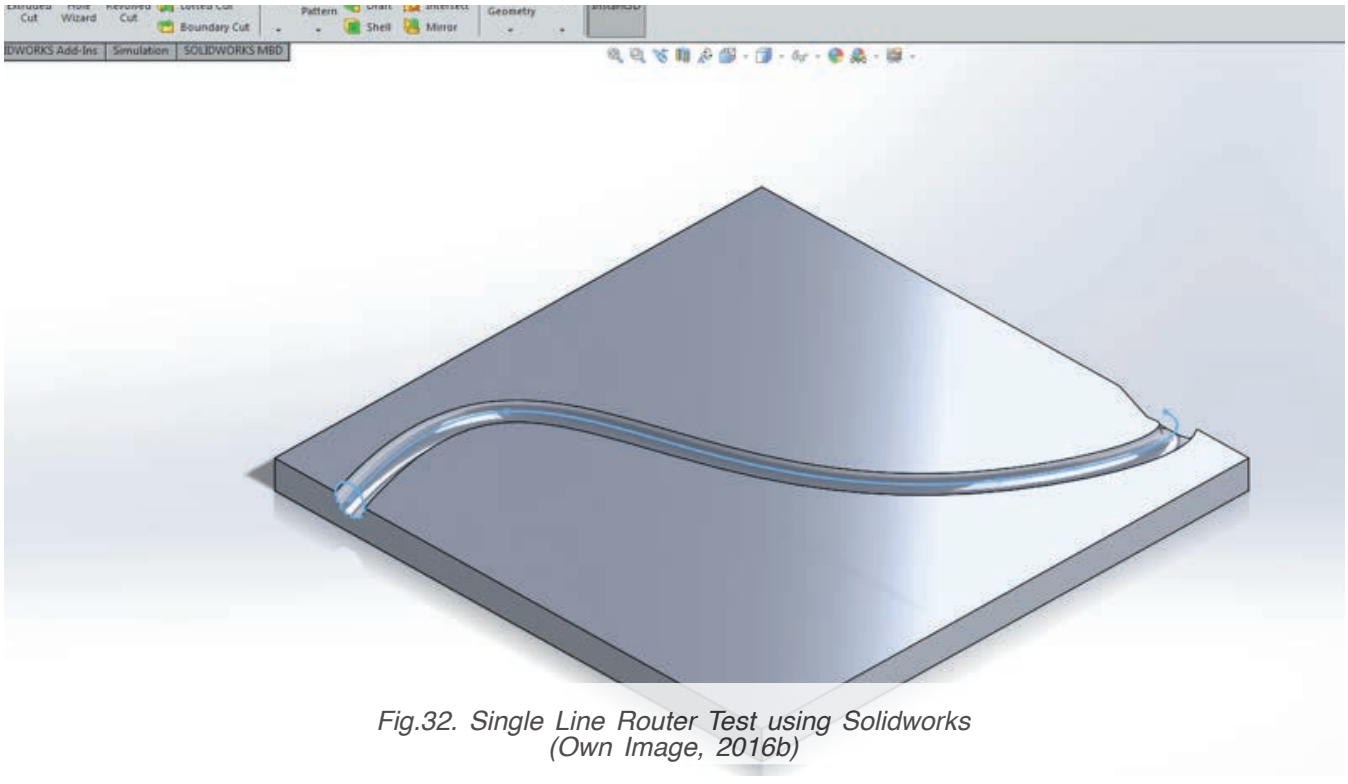


Fig.32. Single Line Router Test using Solidworks (Own Image, 2016b)

After the first test of the single line simulation, it was then difficult to get a piece of the original work to successfully work, one of the main issues was that it was not possible to get a closed path to simulate a 3D cut. Having attempted to get the software to create the desired results on several occasions without much success it was decided to explore other options. What must be taken into account is that the software 'Solidworks' is predominately used by engineers, product designers and those with a 3D design software background. Although it may have been possible to eventually create a simulation using this software, it was decided that perhaps this would distract from the aims of the research and would take much too long to become competent enough. The software was not specifically geared toward simulating CNC routing cut paths either, this meant that it may not have been the best 'tool' for the job of simulating this particular type of work.

Figure 31 show what was achieved using SolidWorks, as highlighted in the images, it is possible to simulate a single open path on a 3D object. It is also possible using the profiles of the cutters from the CNC routing company's website to draw these into the programme to create a realistic cut shape as highlighted in fig.31. These initial tests, although unsuccessful, created an opportunity to re-evaluate the priorities in the designs that were to be created. Simulating the designs before they were sent to the manufacturers to be cut would have been beneficial to see the end result in advance, however what was realised is it is more important is ensuring that the lines themselves are in the correct place and will still adhere to the requirements of the CNC routing machine.

It is also important to acknowledge that these tests could have been facilitated with the correct software training but due to time limitations this was not possible. In the future, it may be beneficial to collaborate in a multidisciplinary research project in order to test these types of designs further, utilising the experience of other individuals who have a better Solidworks understanding.

9.2.2 Alternative Design Methods for CNC Routing.

As an alternative method of simulating the designs it was decided to use software that was more familiar. The designer was recommended a piece of software named ‘Inkscape’ by the CNC routing company; the programme is a similar to Adobe Illustrator in that it can be used for creating paths, however this software is free to use and its usability made it great for attempting new manipulation techniques. It was also felt, that as the CNC routing company had already recommended this piece of software, having used it themselves that it would be a good place to start off.

Initially there was a desire to create another 3D simulation, like had been started in Solidworks, but again it was quickly found that a lack of understanding and experience of 3D software meant that this proved a much larger task than anticipated. Instead, the designer chose to focus on the lines themselves, as previously mentioned during my first tests with the CNC routing company, issues were encountered with lines becoming less defined due to the two paths coming too close to each other. The designer aimed to work on the lines themselves to make sure that they would be smooth enough to route successfully but also to amend the design so that it would create the right level of texture and still sit in with the original catalogue of work which found so much success, namely the laser cut pieces.

9.2.3 Modifying the Original Design for Machinability.

The first stage of preparing the designs to be CNC routed involved altering the lines from the original design. The designer chose manipulate the original imagery that had been used in the first CNC routing test as this would be a good thing to compare against. The initial tests began by opening up the designs into Adobe Illustrator and altering the line widths, the designer was able to see where lines would conflict by simply altering the path widths in the design and seeing at which points they would touch. This method was something that had not been considered during the first set of tests during the ‘Surface Tactility’ project as it was expected that the lines to work as they do on a laser cutter. The simplicity of this alteration within the design process allowed some reflection to look at the

work in a much clearer way, the designer was able to better understand the issues that were faced by the CNC router in terms of its limitations with line widths and angles.

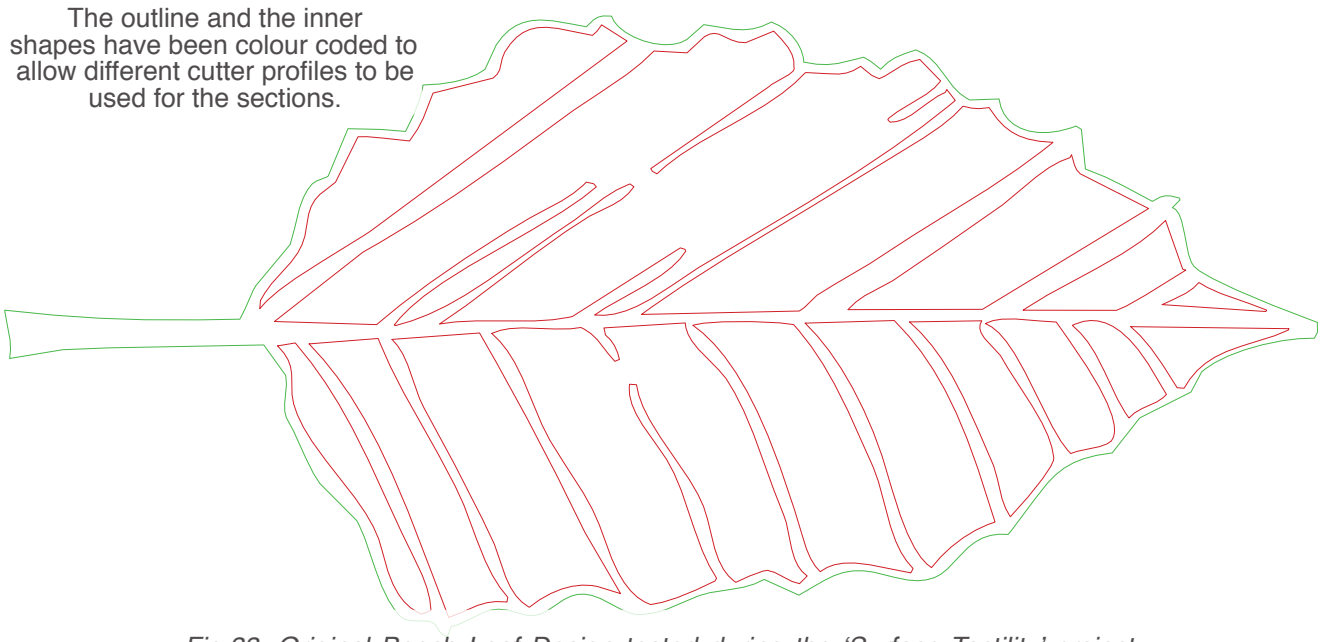


Fig.33. Original Beech Leaf Design tested during the 'Surface Tactility' project (Own Image, 2015j)

Fig.33. Is the first example of the leaf that was selected for the tests, as shown in the image the lines in their original form would be ideal for a laser cutter as there is still enough spacing left to have some material to hold the design together. However, the fragility of the design does not make it suitable for routing, with the line widths in-putted from the basic 'v' cutter on the CNC router, it is clear that the lines are too close together to have enough definition. The conflicting lines were worked on initially by first of all simplifying the shapes, that was done using Adobe Illustrator as it has a great tool for reducing the number of points in a shape. Combining the use of Adobe Illustrator and Inkscape to work on the designs was decided as they both have different functions which would be useful to the design alterations. Once the shapes had been simplified from the design, the angles were then smoothed within the leaf itself to improve the routing. This was done by manipulating each pointed angle, dragging the anchor point into a smooth, curved corner. The reason for smoothing out the corners in each of the pointed edges was to improve the routing path, theoretically if the corners were gentler, there would be less drastic changes in direction which should improve cutting.

After the angles within the leaf design had all been worked, line width tool was used once again to see where there would be conflicting paths that could cause a problem in the design. What was realised, is that due to the original image being a hand drawn one, there were aspects of the image that had extremely narrow sections, in order for these to work well on the scale that had been chosen it would be important to remedy this issue. Combining the thinner shapes together was done to make larger sections that would be simpler to router, the results of this were a much more basic leaf shape which clearly lacked as much detail as the original drawing. The designer also chose to enlarge the outline of the leaf so that the inner shapes did not conflict with it. Although the designer was sceptical about the design itself it was felt that it was important to test this on the CNC router just to see how well it would work.

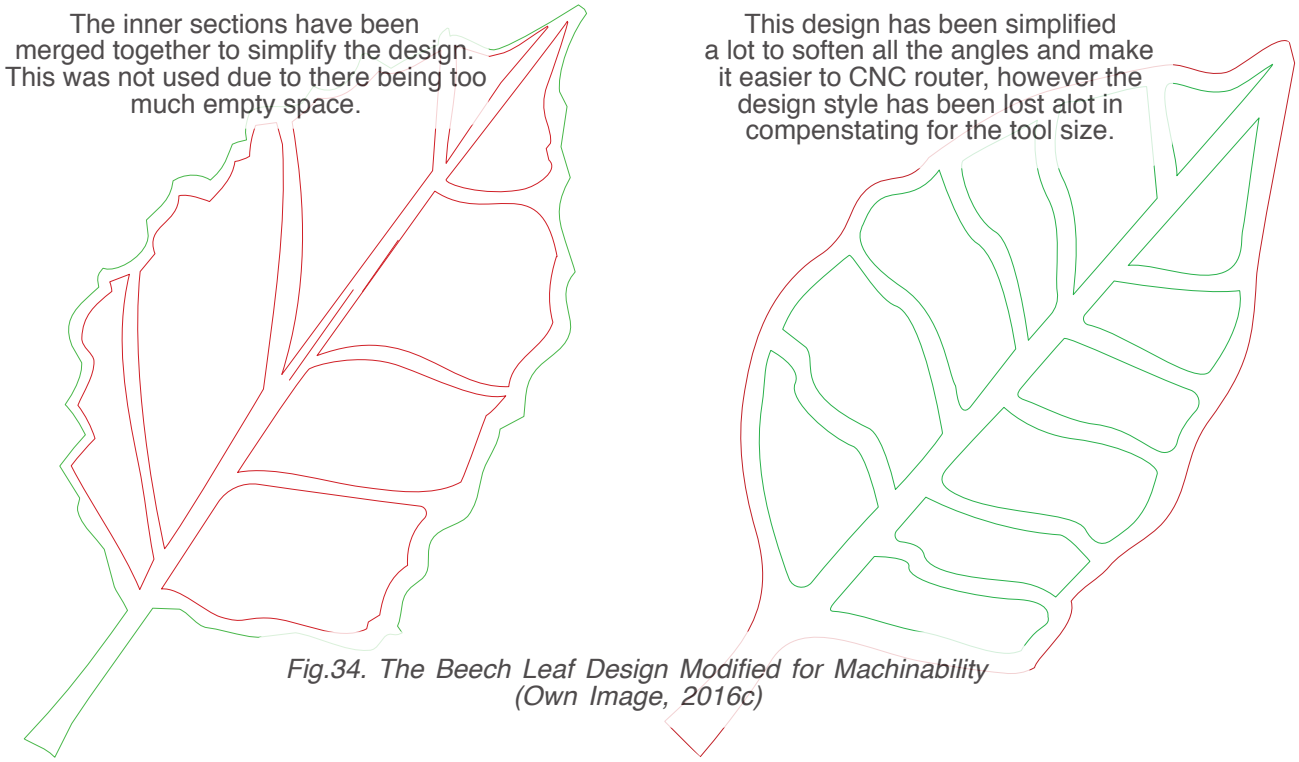


Fig.34. The Beech Leaf Design Modified for Machinability (Own Image, 2016c)

9.2.4 Creating a Ridge Effect for Texture.

The next design created was again using the same leaf design, this time manipulating it in Inkscape. After watching some video tutorials on Inkscape, it seemed beneficial to create a ‘fingerprint’ type design this was mainly to create a different type of texture. In terms of using the design on a large scale, it was felt that a this may work very well as it

creates a different textural experience. As with the first design, the outline of the leaf was simplified slightly just to make it easier to router, the decision to remove the inner details of the original leaf drawing was made. The inner detail was removed the inner details as the outline was suggestive enough of the image that was being conveyed, theoretically it would also be simpler to router as it is just a repeating shape. This technique was one that took inspiration from with one of the older samples in ‘Surface Tactility’ this sample was probably the most successful piece from the CNC routed collection. In the original sample the negative space between shapes was used, within these spaces there were a series of lines created that would go vertically from the top of the shape to the bottom until there was a suggestion of the original shape.

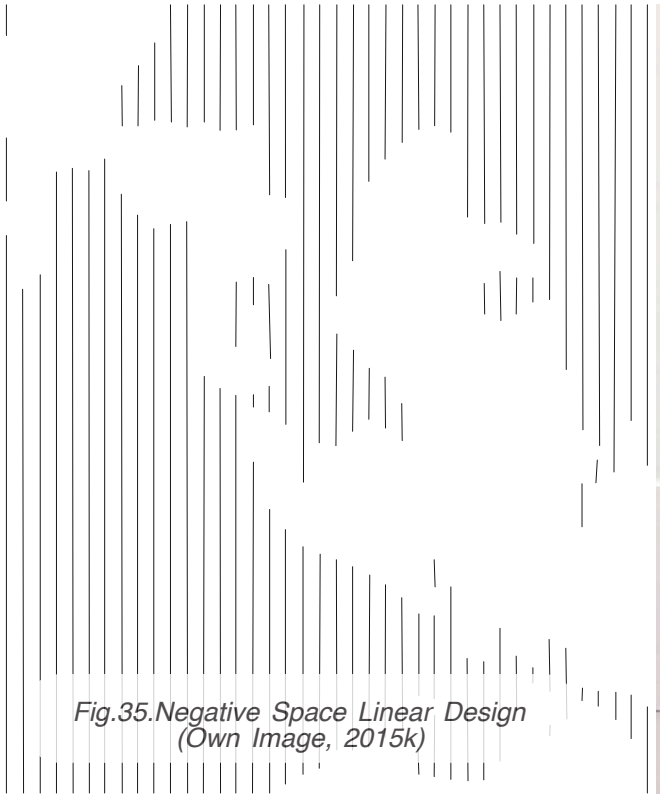


Fig.35.Negative Space Linear Design (Own Image, 2015k)

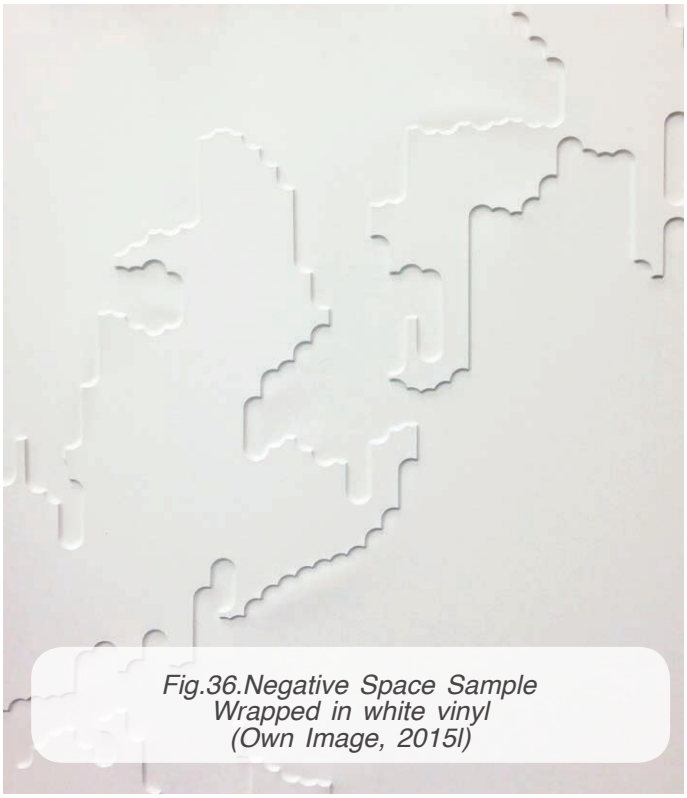


Fig.36.Negative Space Sample Wrapped in white vinyl (Own Image, 2015l)

In order to create the thumbprint style leaf design, a few different functions had to be used within Inkscape, the process was simply a case of duplicating the outline and then reducing it to fit within the previous line. This method was very effective and also provided the ability to control the widths between the lines with great ease. Once the lines had been created there was then one final test of the lines to ensure that they were not going to touch by enlarging the widths to the same dimensions as the ‘v’ cutter.

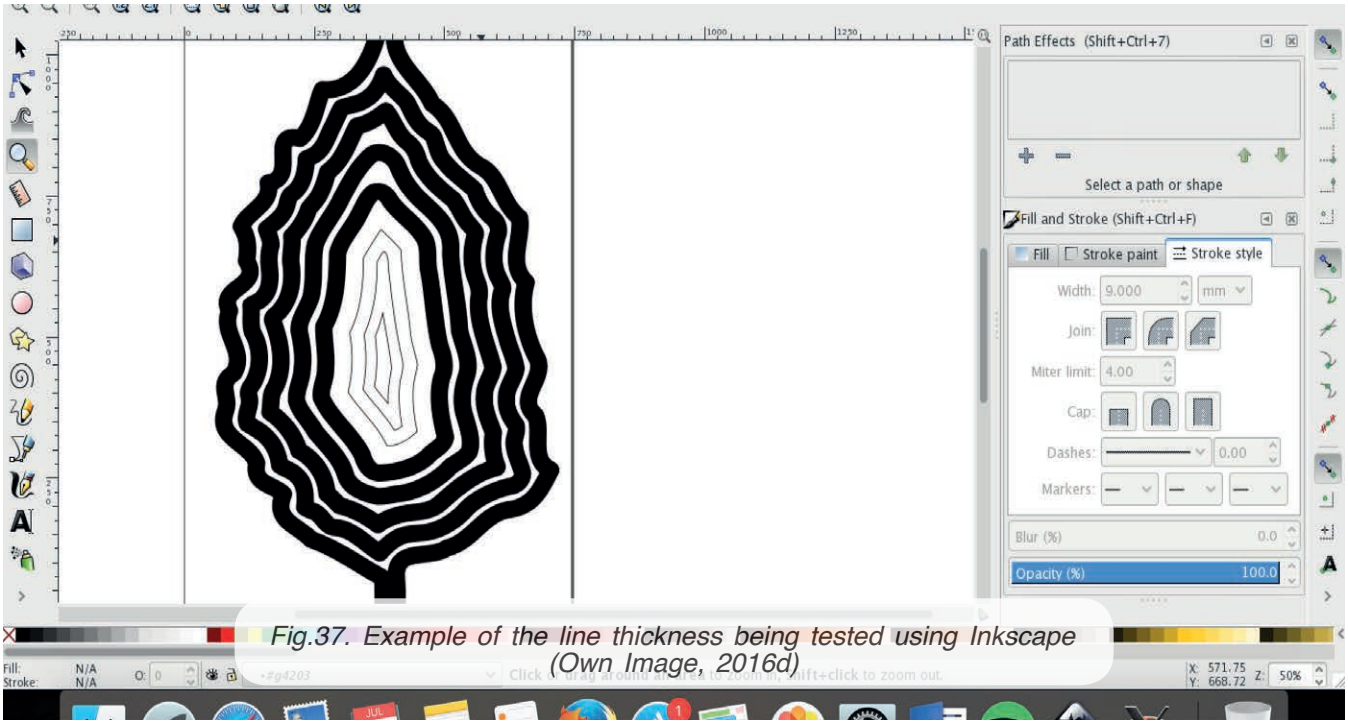


Fig.37. Example of the line thickness being tested using Inkscape (Own Image, 2016d)

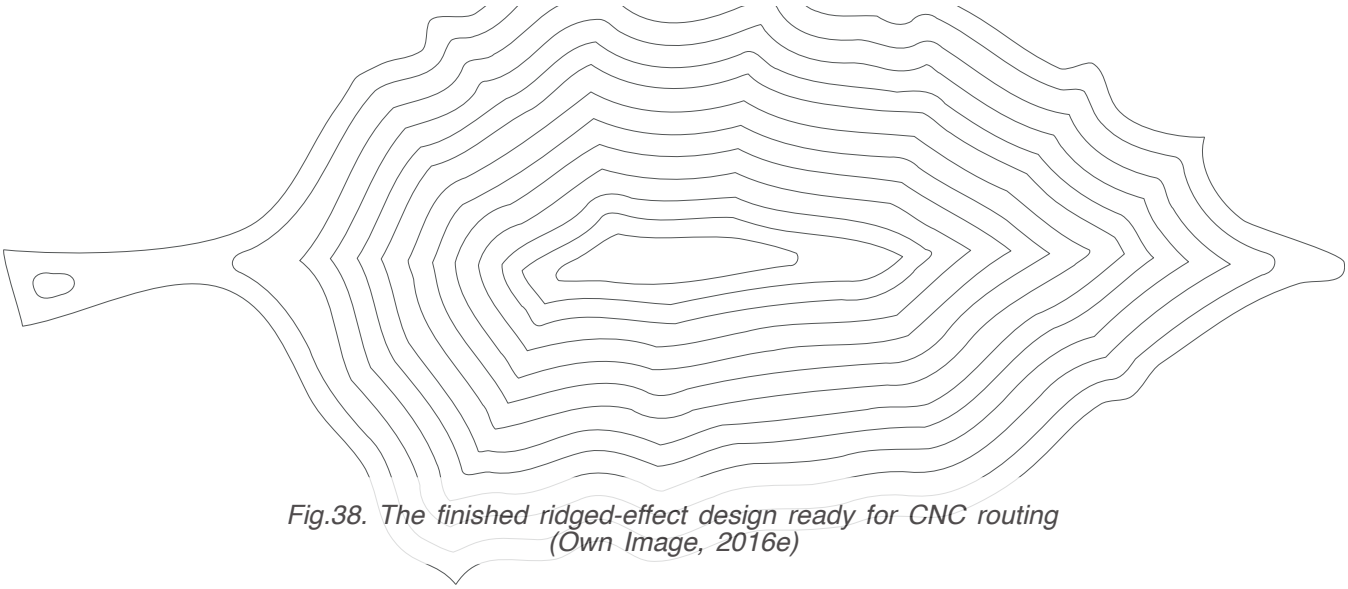


Fig.38. The finished ridged-effect design ready for CNC routing (Own Image, 2016e)

The two designs were then sent to the CNC routing company who simulated each image on their software 'MasterCAM' first, there were still some adjustments that needed to be made as there were too many vector points in the designs. With each design that has been sent to the CNC routing company, there has always been an issue with the design having too many points, this could be a problem when designing in Adobe Illustrator and then having to convert it to a CNC readable format. The visual assessment of the designs has always been that the designs have been simplified as far as they can be whilst still be true to the original, however there are still too many vector points for the router to work successfully. If there had been access to the software MasterCAM or something similar then this could have resolved this issue before it was sent to the routers this would give ultimate control over the work from start to end.

9.2.5 CNC Routing Tests Evaluation.

The results from the CNC routing were very much as expected, although a 3D model could not be simulated of the designs it was known ultimately which design would work visually and which would not. The first test, which was an oversimplified version of the original leaf drawing ended up being far too basic, although the lines are very clear and defined it was felt that the image is too far from the original drawing. Although the success of the cut is important when testing these types of designs, the measure of it as a success is ultimately down to the overall aesthetic. The lines were simplified far too much to look as if they had been hand drawn and when considering whether a product can be classed as a 'craft' item or not, it is key that there is an element of 'hand' involved in the process including it being part of the overall visual effect.

The second sample was much more of a success in terms of the overall aesthetic, the thumbprint or 'tree ring' style that was created had very defined ridges for texture that would definitely add a great element to the surface design. If this technique was applied to a surface that had already been printed on, it would create a wonderful visual effect. In terms of the design being suitable for a large scale piece, the designer would be happy leaving the design at the size it is currently, however if the image were to be put in a form of repeat pattern it could be too much for the CNC router to cope with. Although the design is a success personally, it would not necessarily work very well using the CNC router if it were to be repeated as there would be far too many points in a single design which can cause problems with the equipment.

Both of these CNC routing tests have proven incredibly useful in terms of the theme of manufacturing and craft. Working with a CNC routing business has created insight into the process from surface design concept to manufacture in a different way, one that many designers would undoubtedly be following when taking their own work to a retail worthy state. There is definitely a conflict between maintaining the aesthetic of the original work and adapting the design so that it can be processed on the machine successfully. It could be said that perhaps in the case of this work, the adaptations that are required to make the design successful on a CNC router are too many. As mentioned before, the design

process very much involves starting off the work in a hand drawn format and then editing it from that point to the final design. The hand drawn element causes many challenges when working with a CNC router as it works best with simplified imagery created on the computer, the designer particularly believes that organic, natural forms that are used throughout the work are simply not suitable for this particular type of machining. If there had perhaps been more time to better understand the designing process with 3D simulation then the results may be slightly better, but given the time constraints this was simply not possible.

As potential future research, it may be a good do a collaborative project with someone who specializes in CNC routing and 3D design software. It would be a great opportunity to combine the design knowledge from this work with the technical expertise of someone else to really push the limits of the CNC routing process. Throughout studying Surface Design, there has often been potential connections between my subject area, Product Design and even Architecture. With the ever-evolving nature of the Surface Design industry there are often areas that cross over with other disciplines, areas such as textiles and surface pattern are often associated with this discipline but Product Design and Architecture are also incredibly relevant. This collaboration would have great benefits for this research, being able to translate the designs into 3D and work around the obstacles that have been encountered with CNC routing. It is also felt that for the right people, it could hold great benefits for them too, being able to work on a live brief and develop skills for working with someone from a different skill-set would offer a good preparation for working life. There is still the desire to develop a product that could also have a multi-functionality, not only being a decorative piece but also have acoustic qualities, this type of research would be a good opportunity to connect different areas within the Art and Design faculty and could lead on to further collaborations within the school.

In the next part of the sampling tests, there will be a look into laser-cutting techniques investigating two techniques; the cut-through and the raster. These processes will be briefly described in terms of preparing a design for this type of machining and the results will be analysed, looking at the preparation of the work as well as the aesthetic outcomes.

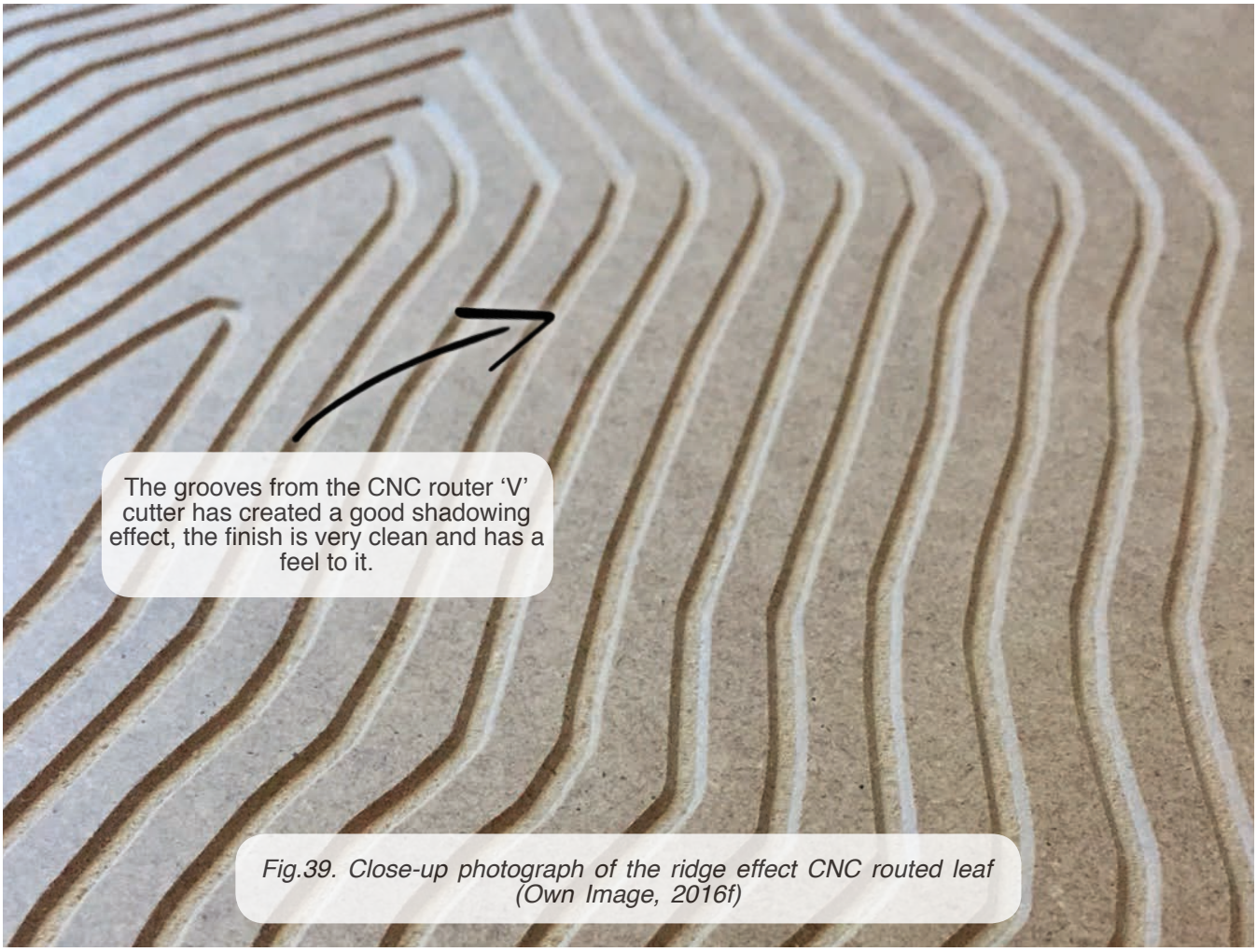


Fig.39. Close-up photograph of the ridge effect CNC routed leaf (Own Image, 2016f)

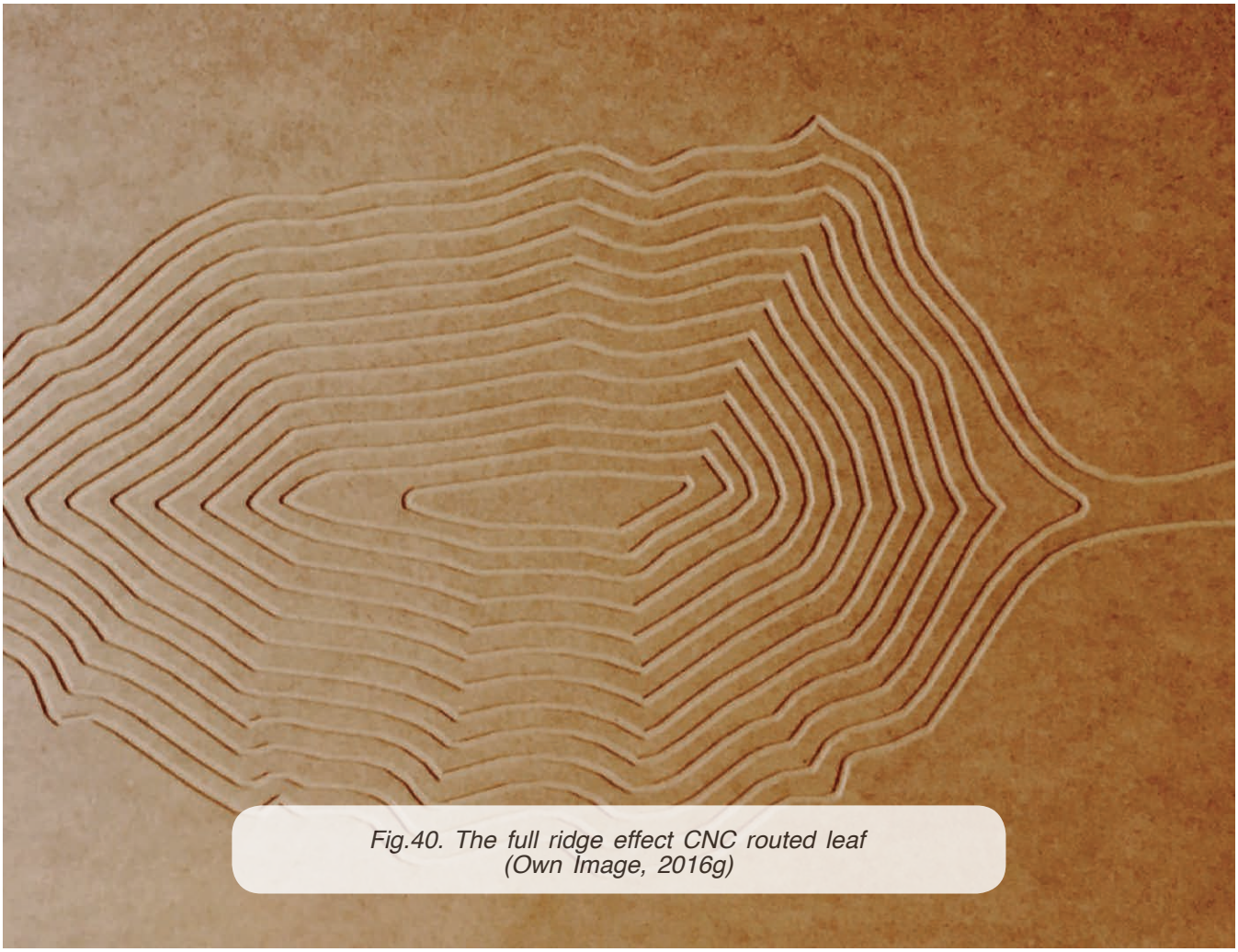


Fig.40. The full ridge effect CNC routed leaf (Own Image, 2016g)

Fig.41. Close up of the over-simplified beech leaf design (Own Image, 2016h)

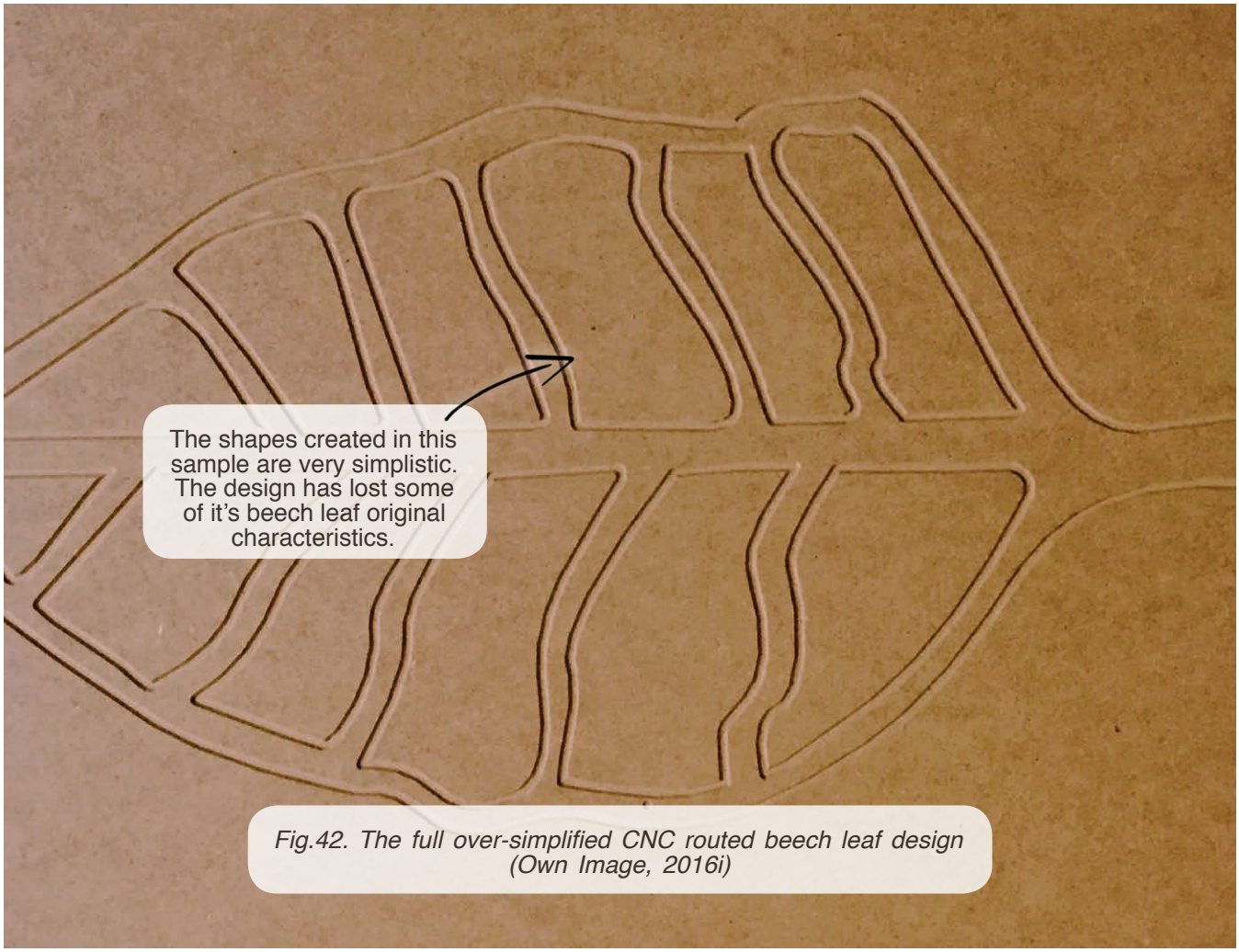


Fig.42. The full over-simplified CNC routed beech leaf design (Own Image, 2016i)

9.3 Laser-Cut Sampling.

9.3.1 Introduction

During the design modification stages for the CNC routed samples, it was also decide that it would be beneficial to test two laser-cut designs as well. These tests were designed to compare the process of preparing the design for machining and look at the end results in a comparative way. Working with a laser cutter is a process that is much more familiar with as this piece of equipment has been used frequently by the designer over the past four years for a variety of different projects. When working with a laser-cutter, there is much more flexibility in terms of the designs that can be machined, however there are limitations in the types of materials that can be cut. On the laser-cutter that was being used at the university there were limitations to a material depth of just 5mm, in terms of creating a piece for a larger scale this could be problematic as the material will not be very strong. However, in larger commercial machines, laser cutters are used for a wide variety of materials and material depths, so scaling up the work with a laser cutting company would be simple enough.

Two tests were done to demonstrate the effects that can be created on a laser cutter, although it only works in a two-dimensional way it is still possible to get subtle texture and bold shapes.

9.3.2 Raster Engrave Effect Test.

The first test that was decided to do was a raster effect, this technique is a way of cutting slightly into the wood to create a shadow effect. A raster engrave is a method of making an image where the laser engraves the surface by moving from side to side. The speed of the cut is dependent mainly on the strength of the laser and the size of the design. This method is best suited for prototyping and single runs due to the time it takes to complete the image. This effect has been used previously very successfully in ‘Surface Tactility’, there was a method that enabled a deep raster cut which made a good textural effect, this was done by slowing down the speed of the laser. In order to successfully raster the leaf

design onto my chosen 3mm MDF the file need to be prepared slightly first of all. Like when preparing the designs for CNC routing, the outline of the leaf design was enlarged for more visual impact.

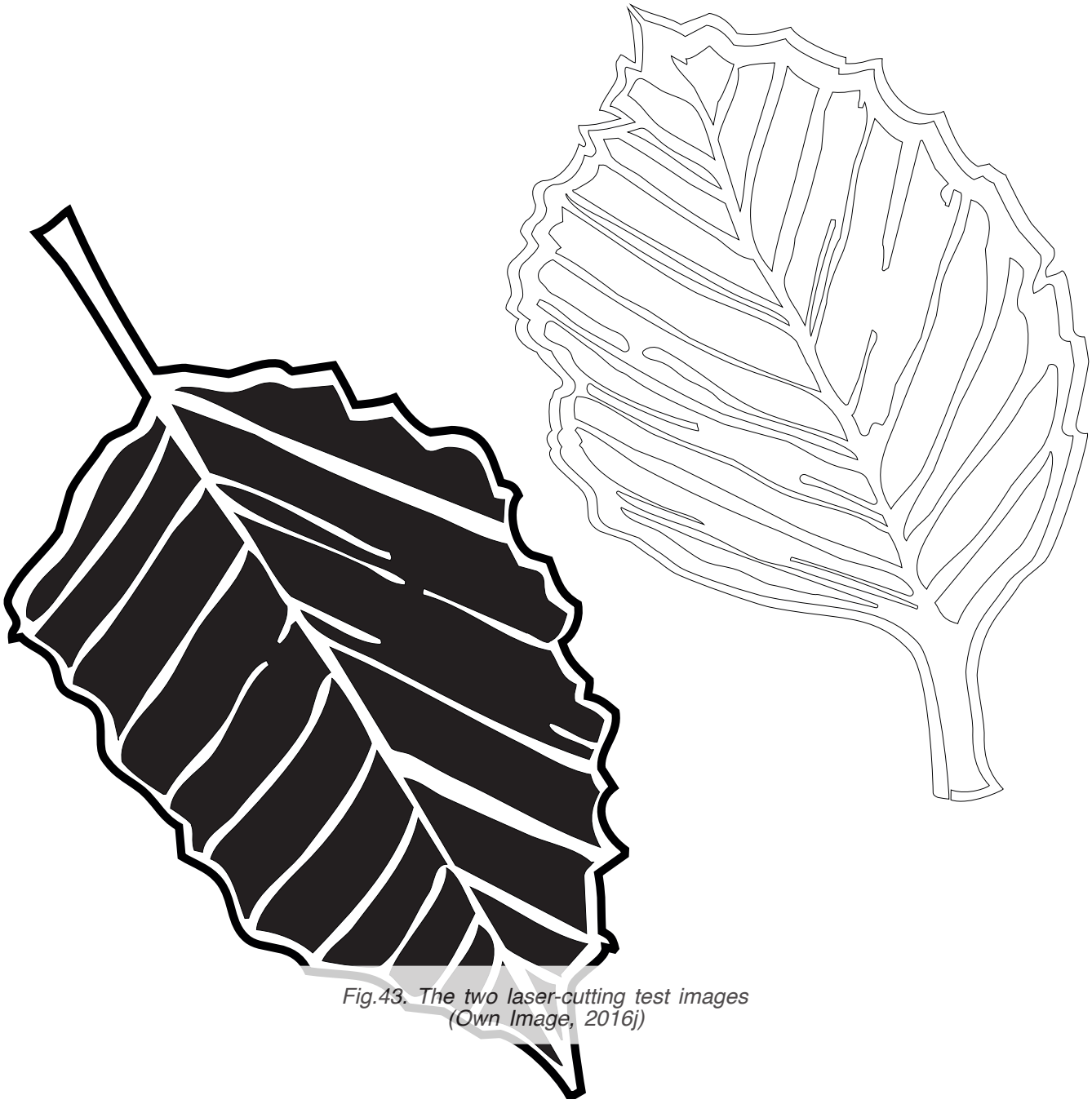


Fig.43. The two laser-cutting test images (Own Image, 2016j)

After the outline was altered, the internal shapes needed to be filled in solid black, this is very important as the raster effect engraves the black lines and shapes. The design itself had very little amendments made to it as there were no additional considerations to be taken into account, the beauty of a raster effect is that any image can be done providing it is in black and white. The results of this first test were very positive, the depth of the raster was increased by adjusting the machines' settings; this meant that the impression

was more defined. Aesthetically the design worked very well, the shapes being in almost the same format to the original drawing meant that the desired aesthetic style was not compromised by the machining process. However, it must be taken into account how long a raster design can take, the machine works by engraving in a series of straight lines that are less than a millimetre thick, so over a larger surface area this can be a considerable amount of time. The effect itself is excellent but not necessarily practical for large scale applications.

9.3.3 Cut-Through Effect Test.

The second laser cutting test chosen was to do a cut through design, the cut through effect is the most recognisable laser effect and products very detailed cut-outs which have very clean lines. For this type of cut-out, it was decided to try a slightly different technique, in the past when a design has been cut out the piece internal pieces have been completely detached from the original piece of material. However, for this attempting a cut-out effect which suspended the design within the material itself seemed more beneficial. In order to successfully suspend to design in the wood there needed to be a few adjustments made to the image, the first being amending the outline of the leaf.

The outline needed to be adjusted in order to keep the rest of the design within the wood, for this the line was broken into 2 sections, the outline was also made into a double line, effectively making it into a shape itself rather than a single line. The break in the outline would work like a tab, holding the shape in place, these were made as thin as reasonably possible to ensure that structurally the design would still be stable. As with the raster, there were very little changes to be made to the internal shapes as this design has been previously tested on a small scale, it was felt that this would still work on the laser cutter but on a larger scale.

The results of this test were also very successful, the design worked really well on the 3mm MDF and is a very bold option for creating textural surfaces. This design may work well if layered up with another cut-out and this would then have a good 3-dimensional effect. The cutting itself went very well, due to the simplicity of the line, it took very little

time to cut taking just a few minutes and would definitely be a good option for making a large installation in terms of project turn around and cost effectiveness. The laser-cutting process was very straight forward and both designs were completed within a relatively short amount of time. The cut-through experiment was a great success, the boldness of the cut-out and the deep charred effect that comes with this process really creates a great visual effect, this additional tone paired with the shadows created would simulate a good three-dimensional surface.

9.3.4 Laser-Cut Sampling Evaluation

When these tests began, there was an expectation to still prefer laser cutting to CNC routing as the process is much more familiar, understandably with either process there are still some limitations but even when altering designs for machining, the laser-cut was still much simpler and better suited to the original design background. The process of simulations for the laser-cutter was also very useful, this is easily done by using Adobe Illustrator and can also be done in Inkscape, as the laser-cutter works on a two-dimensional basis it is simply a case of filling the shape in to see how it would look when cut as demonstrated in fig.43.

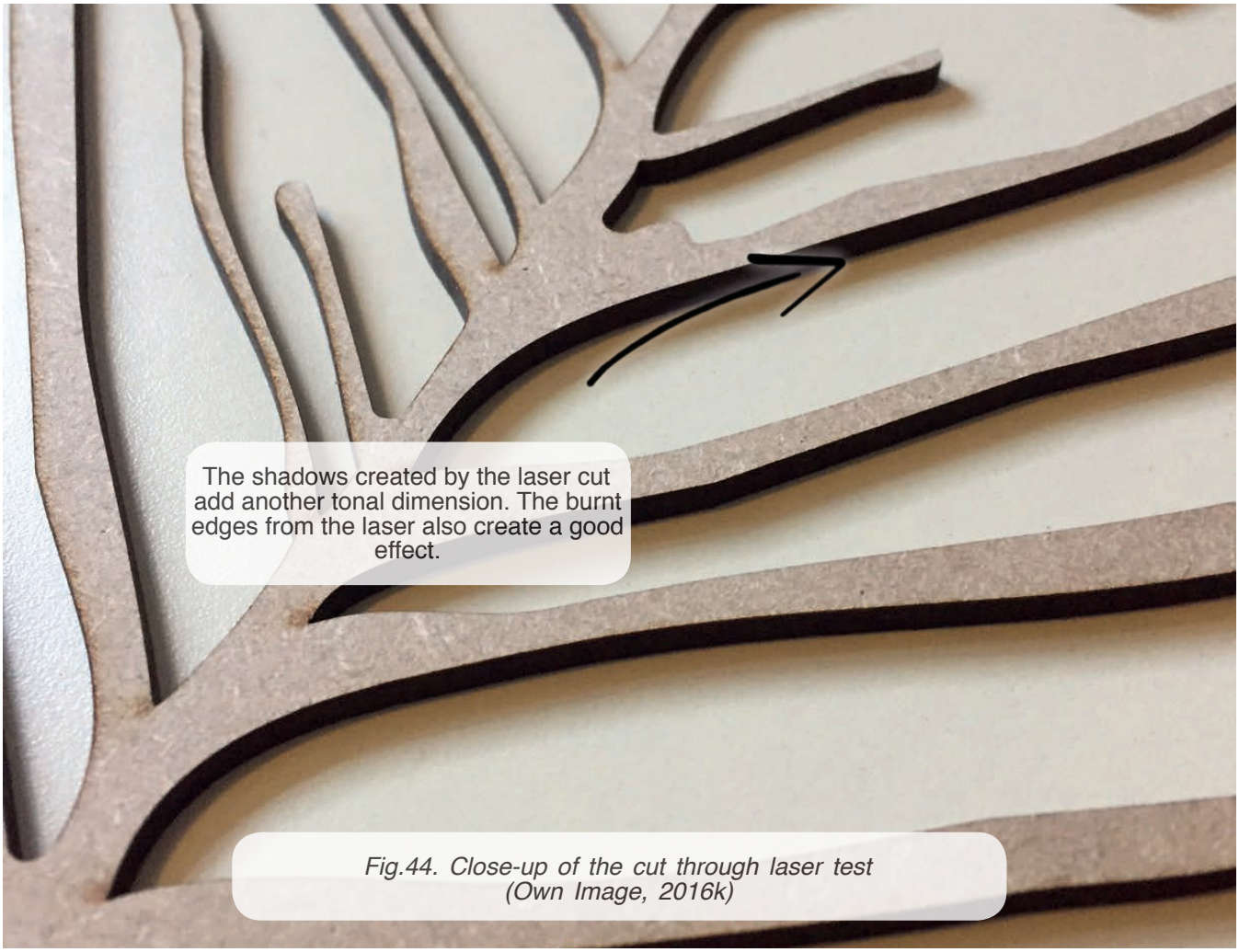


Fig.44. Close-up of the cut through laser test (Own Image, 2016k)

Fig.45. The full cut-through laser test using the beech leaf design (Own Image, 2016l)

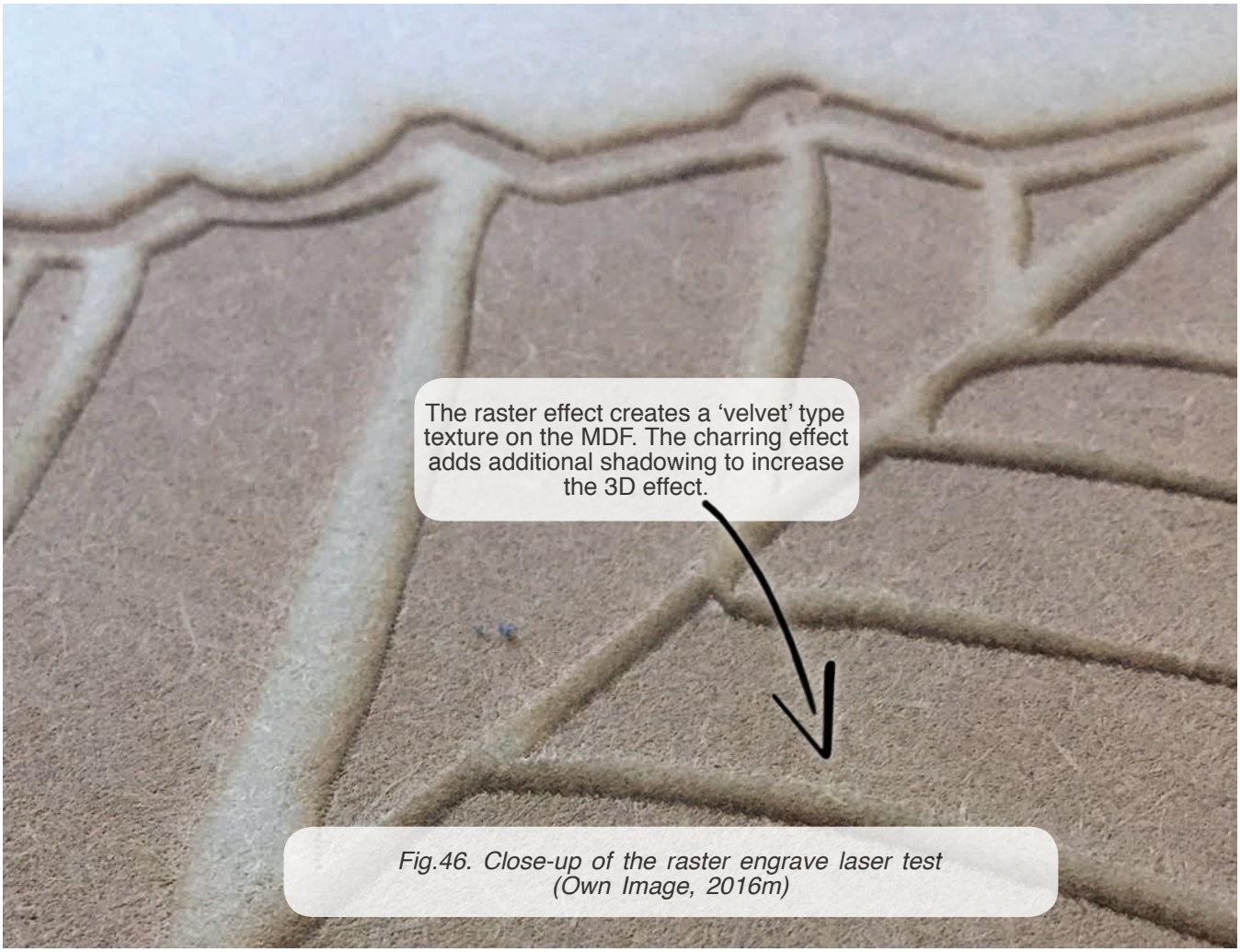


Fig.46. Close-up of the raster engrave laser test (Own Image, 2016m)

Fig.47. The full raster engrave laser test in the beech leaf design (Own Image, 2016n)

9.4. Sampling Summary.

The laser-cut tests were designed for comparison with the CNC routed samples, both techniques have their merits and when wanting to create a bold textural surface it can be said that CNC routing may be the best option. Throughout this process it has shown that although a certain technique may be the best fit for the results desired, it may not be the suitable option as the designer. Ultimately there needs to be confidence working with the machinery and processes that are being utilised, and with CNC routing there is still not enough understanding of how to create appropriate designs for this machine. In terms of a comparison between the laser-cut and CNC routed samples, the laser-cutting has yielded the best results. This may be due to the familiarity with the machinery and the knowledge to manipulate techniques to create specific effects.

When working with a machine to create surface designs, it is important that it feels like an extension of the designers hands, the technique needs to replicate the drawing style. The CNC routing process added unnecessary stages into the sampling process, not only did designs need to be so they were suitable for the machine process but in some instances, they had to be completely changed and designed specifically for the machine. The technique is undoubtedly excellent for creating carved surfaces, based on the visits made to the CNC routing factory there are many different applications that this can be used for, however when it comes to complex nature-based designs it is not necessarily the best tool for the job. The intricacy of the image is most successfully created when using a laser cutter due to the tool width being less than a millimetre, allowing for finite detail to be incorporated.

10. Research Findings.

This section will explore the results of this research thesis, assessing the positive and negative outcomes. The key research areas in the thesis will be reviewed and analysed looking at the conclusions that can be taken from each area.

10.1. Defining Craft

The initial assessment of 'Craft' highlighted the flexibility that this area has in terms of incorporating technologies into craft processes. At this current stage of the research, there has been two clearly defined areas within craft, traditional and digital, however as this question continues to evolve there may be potential for further approaches to be identified. Traditional craft encompasses the craft makers and artisans that continue to use traditional methods to create their product as it could be a method that continues to be reliable and produces great results every time. The digital crafts-person is someone who embraces modern day technologies, utilizing these tools to create new and innovative products.
In both categories of craft there is great skill and devotion in what they do, there is no reason for these areas to conflict. Both traditional and digital craft can co-exist, the digital crafts-people can learn from traditional techniques and perhaps traditionalists can embrace modern techniques to allow more development of new designs and ideas.

10.2. Craft and Manufacture

During the reflective study and sampling stages the theme of 'Craft and Manufacture' has been explored this has included investigating whether products that have been made using a digital manufacturing process can be considered craft or whether the themes of craft are centralised around hand-made. With the experience of recording and testing designs using this method it could be said that in the case of both Laser-cut and CNC routing that there must be a context to how this machine is being used to then determine whether the product is in fact craft or not. Direct interaction with the machine making the product can earn its craft status, similarly to how a carpenter may use a chisel, the machine is

being used simply as a tool to do a job. It can also be said that companies such as 'The CNC Routing Company' have some craft values such as working directly with their customers and creating a personalised product for their needs. The case study evaluation of the company highlighted that although they are a large scale manufacturer, they do still have the values of a small craft business. The services that they provide may not be considered as a 'Craft' but they do follow many of the same principles as a craft maker would, ensuring that they offer a high quality product, accountability for their services as well as choosing only the best raw materials to create their routed products.

10.3. Design Sampling

The samples that have been created during this research project have not necessarily been successful in terms of creating the desired aesthetic. They have however highlighted that familiarisation with a manufacturing and the designing technique is key to making a successful product. Aesthetically the laser cut samples had the best result this could be due to the manufacturing method being most familiar. The laser cutting technique works well due to the ability to translate a drawing straight into a laser format and to create incredibly detailed cuts. Creating the samples on a larger scale has highlighted that although designs can work well at the actual size, for creating something that is designed to impact on a large surface it is better to scale up for ease of machining and to create a bold image.

There may be more potential design development using a CNC router, this is due to the variations available in terms of tool dimensions and variety of cutting profiles. With this in mind, there could be some additional avenues for further research in the future, in particular looking at a collaborative project with experienced 3D designers and those with CNC routing expertise, this could open up new methods for creating tactile surfaces.

10.4. Findings Summary

Overall, it can be said that this research has been successful in highlighting the

development of Craft in a digital age. This theme is important particularly for future development when considering where the textured surfaces would be placed within the surface design industry. This theme has also influenced the design outcomes throughout the machine tests, mainly due to the researchers design preferences, but also based on current trends. The machining tests were not necessarily successful in creating a viable product for large scale manufacture, however they have highlighted areas for further development. These areas include further 3D design training and also highlight the benefit of a collaborative project with a more experienced designer. The design experiences from this research will inform further design tests, and the methods created for simulating lines before laser cutting and CNC routing will benefit any further experiments.

11.0 Conclusion.

This research has endeavoured to explore the themes surrounding craft and manufacture starting with highlighting some of the key inspiring factors for the initial statement '*Maintaining the Aesthetic: exploring the process from Surface Design concept to manufactured product".* The Surface Design Show at the Business Design Centre in Islington, London, has played a large part in informing the initial research question and during the 2016 trade show it was clear that there is a demand for three-dimensional surfaces as demonstrated by many of the exhibiting companies in the sector. Exhibiting the 'Surface Tactility' project at the show also helped reinforce the view that textural surfaces would be a sought after product in this industry.

The CNC Routing Company has also contributed vastly to the research in the form of a case study focused around their business and the initial samples created during the 'Surface Tactility' Project, as well as utilizing their manufacturing facilities for further sampling stages. Their company set-up and values has highlighted how "craft values" can be incorporated in large scale manufacture.

The conclusions from researching into the definition of craft highlighted that the work created in this project can be considered as 'Digital Craft'. The key to a digital craft product is the human element of the product being still visible, unlike large mass manufacturing companies, digital craft products still have an individual who is accountable and has control over the outcome of the product. As highlighted previously it is often how the tools are used that determines how it is categorised as is shown in Marx's *A Reader 'In handicrafts and manufacture, the workman makes use of a tool, in the factory, the machine makes use of him.'* This again reinforces the notion that the decision-making steps in the process determines its status within consumer society.

The design experiments that were conducted did highlight a number of areas for improvement, not only on a personal level but also on an educational level. The results highlight the need for inter-disciplinary work within the university, this would not only benefit this project but also inform many others.

The research has explored the themes surrounding craft and manufacture, what is clear from the themes that have been analysed and discussed is that both industries are vast and varied in what they can offer. There is a movement of innovators who are pushing the concept of craft to the next level, introducing cutting-edge techniques and marrying these with highly skilled craft processes. Ultimately, as mentioned in section 7, the subject area of craft is fluid, and although this can be seen by some as being inconsistent, it can be said that this shows the flexibility and willingness to adapt to new environments. Craft and Manufacture are both undergoing great change at the moment and undoubtedly the rules that reside will change, it will be interesting to see how the two industries evolve to embrace the changes afoot and how they learn to support each other.

This research has been a very reflective journey, highlighting the struggles and successes of one individual. Although the results will not necessarily be the same for other individuals, it is hoped that this research highlights key areas when considering taking designs into large-scale manufacture.

11.1. Future Research.

This research has started as an initial dialogue looking into the themes of craft and design. This has the potential to advance further in several different directions, as previously stated, there is plenty of room to advance the designs that have been tested in this project through collaborative projects and further technical training. This area definitely needs further exploration as it is still a relatively unknown area, there are many companies using CNC routing and Laser cutting for practical applications, however using these techniques for intricate decorative pieces does require further exploration.

In addition it is important to continue to explore the theme of ‘Craft’ perhaps by conducting larger studies into consumers opinions with certain craft terms. This research would not only create a better understanding of the term itself but could prove to be useful to businesses who are looking to market themselves within that industry.

In Text References.

Baur, C., & Wee, D. (2015, June). Manufacturing's next act. Retrieved January 6, 2017, from McKinsey & Company, http://www.mckinsey.com/business-functions/operations/our-insights/manufacturings-next-act

Carberry, G. (2016, October 20). UK manufacturing post-brexit: Global possibilities. . Retrieved from http://www.manufacturingglobal.com/lean/1010/UK-manufacturing-post-Brexit:-global-possibilities

Charny, D. (2011). Power of making: The importance of being skilled. London: V&A Publishing and the Crafts Council.

cncrouterworks.com. (2004). CNC routing explained [] CNC RouterWorks. Retrieved January 6, 2017, from http://www.cncrouterworks.com/cnc-routing.htm

Collins, H. (2010). Creative research: The theory and practice of research for the creative industries (required reading range). Lausanne: AVA Publishing SA.

Crafts Council. (2010). Consuming Craft. Retrieved from http://www.craftscouncil.org.uk/content/files/consuming_craft_full_report.pdf

Definition of aesthetic in English (n.d.). In Oxford Dictionaries. Retrieved from https://en.oxforddictionaries.com/definition/aesthetic

Definition of craft in English. Retrieved June 25, 2016, from Oxford Dictionaries, https://en.oxforddictionaries.com/definition/craft

Definition of manufacture in English (n.d.). In Oxford Dictionaries. Retrieved from https://en.oxforddictionaries.com/definition/manufacture

Definition of process (2017). In Merriam-Webster. Retrieved from https://www.merriam-webster.com/dictionary/process

Deloitte. (2015). Made-To-Order: The rise of mass personalisation. Retrieved from http://www2.deloitte.com/content/dam/Deloitte/uk/Documents/consumer-business/deloitte-uk-consumer-review-mass-personalisation.pdf

Denscombe, M. (2010). The good research guide: For small-scale social research projects (4th ed.). Maidenhead, England: McGraw-Hill Professional Publishing.

Dictionary.com (1900). In . Dictionary.com. Retrieved from http://www.dictionary.com/browse/router

Eckersley, C. (2014). Real craft: Chris Eckersley. Retrieved October 26, 2016, from http://www.chriseckersley.co.uk/section781789.html

The Economist. (2014, January 4). The art and craft of business. Retrieved 2016, from The Economist, http://www.economist.com/news/business/21592656-etsy-starting-show-how-maker-movement-can-make-money-art-and-craft-business

EEF The Manufacturing Organization. (n.d.). UK MANUFACTURING 2016 / 17, THE FACTS. Manufacturing facts and figures. Retrieved 5 January 2017, from https://www.eef.org.uk/campaigning/campaigns-and-issues/manufacturing-facts-and-figures

Frayling, C. (2012). On craftsmanship: Towards a new Bauhaus. London: OBERON BOOKS.

Gray, C., & Malins, J. (2004). Visualizing research: A guide to the research process in art and design. Aldershot, England: Ashgate Publishing.

Ingraham, J. (2013, January 29). Ten reasons for using digital textile printing technology. Retrieved January 4, 2017, from http://digitaltextilereview.com/?p=794

ISA. (2016, June). Cover story: Industry 4.0: Intelligent and flexible production. Retrieved October 26, 2016, from https://www.isa.org/intech/20160601/

Johnson, L. (2015, April 12). Animal spirits: Handmade in Britain - the quiet revolution for craftsmen. . Retrieved from http://www.thesundaytimes.co.uk/sto/business/small_business/article1556778.ece

Johnston, L. (2015). Digital handmade: Craftsmanship and the new industrial revolution. United Kingdom: Thames & Hudson.

License, A. (2014). Measuring the craft economy defining and measuring craft: Report 3. Retrieved from http://www.craftscouncil.org.uk/content/files/Measuring_the_craft_economy.pdf

Lloyd-Jones, T. (2011, August 17). What is the role and value of crafts today? Retrieved from https://blog.britishmuseum.org/2011/08/17/what-is-the-role-and-value-of-crafts-today/

Macdonald, J. (2005). Concepts of Craft. In M. Rampley (Ed.), Exploring visual culture: Definitions,

concepts, contexts. Edinburgh: Edinburgh University Press.

Make Works Ltd. (2015, February 4). Guide to laser cutting. Retrieved November 27, 2016, from https://make.works/blog/guide-to-laser-cutting

Marr, B. (2016, June 20). What everyone must know about industry 4.0. Forbes. Retrieved from http://www.forbes.com/sites/bernardmarr/2016/06/20/what-everyone-must-know-about-industry-4-0/#2c0f5c064e3b

McDonough, W., & Braungart, M. (2003). Cradle to cradle: Remaking the way we make things. New York, NY: Farrar, Straus and Giroux.

Miller, D. (2011). The Power of Making. In D. Charny (Ed.), Power of making: The importance of being skilled. London: V&A Publishing and the Crafts Council.

Morris, W. (2012). Hopes and fears for art (1882). Read Books Design.

Moses, R. (2010). Designer's support: Manufacturing Marriages. In Batch; craft, design and product: The work of the designer maker (pp. 126–127). London: Bloomsbury USA Academic.

Musson, N. Surface design; What is it, how is it changing and what are the ingredients of a successful curriculum? — ADM-HEA. Retrieved June 27, 2016, from http://www.adm.heacademy.ac.uk/resources/features/surface-design-what-is-it-how-is-it-changing-and-what-are-the-ingredients-of-a-successful-curriculum/

O'Reilly, J. (2014, May 16). How the craft trend happened: Three moments Retrieved from https://blog.imagesource.com/craft-trend-happened-three-moments/

Perry, G. (2016, May 12). Are computers killing off craft? Not a chance. The Guardian. Retrieved from https://www.theguardian.com/higher-education-network/2016/may/12/are-computers-killing-off-craft-not-a-chance

Plant, A. V. C., Harrison, D. J., Griffiths, B. J., & De Coster, R. (2010). Design for manufacture and sustainability in new product development. Retrieved from http://bura.brunel.ac.uk/bitstream/2438/5955/2/Fulltext.pdf

Redshaw, V. (2016, February 20). KEY TRENDS at the surface design show, London | consumer & design trend forecasting Retrieved from http://scarletopus.com/2016/02/key-trends-at-the-surface-design-show-london/

Rowmark. (2005). Laser engraving and cutting terminology definition of terms used in laser engraving and cutting. Retrieved from https://rowmark.com/MARK/techhelpdocs/terms_definitions/laser_cutting_terms.pdf

Swift, K. G., & Booker, J. D. (2014). Manufacturing process selection handbook from design to manufacture. United Kingdom: Butterworth-Heinemann.

Thomas Publishing Company. (2017). Mechanical cutting vs. Laser cutting vs. Milling. Retrieved June 23, 2016, from http://www.thomasnet.com/articles/custom-manufacturing-fabricating/mechanical-vs-laser-cutting

Wood, R. (2014, November 17). What is real craft? The place of machines and the alienation of labour? - Robin Wood Retrieved from http://www.robin-wood.co.uk/wood-craft-blog/2014/11/17/real-craft-alienation-labour/

Woolley, M. (2011). The Making: value and values in the craft object. In L. Valentine & G. Follett (Eds.), Past, present & future craft practice (pp. 136–150). Edinburgh: NMSE - Publishing.

Figure References.

Fig.1. Kennametal (2015). Subtractive vs Additive Manufacturing Graph. [image] Available at: http://chronicle.kennametal.com/benefits-of-3d-printing-subtractive-vs-additive/ [Accessed 24 Jun. 2017]

Fig.2. Accenture. (2016). Infographic showing the four waves of big manufacturing change. Retrieved 10 December 2016, from https://www.accenture.com/gb-en/blogs/blogs-digital-industry-4-0

Fig.3 Surface Design Show. (n.d.). The Surface Design show at the Business Design Centre. Retrieved 6 January 2017, from http://www.surfacedesignshow.com/files/3912/2017/photos/home/news-cta.jpg

Fig.4. Surface Design Show. (2016). LOOKING FOR INSPIRATION AND INNOVATION WITHIN SURFACE DESIGN? Retrieved 2016, from Surface Design Show, http://www.surfacedesignshow.com/visiting

Fig.5. Own Image. (2016a). The 'Surface Tactility' collection displayed at the 2016 Surface Design Show.

Fig.6. Scarlet Opus. (2016). The Surface Tactility Collection. KEY TRENDS at the surface design show, London | consumer & design trend forecasting. Retrieved 5 October 2016, from http://scarletopus.com/2016/02/key-trends-at-the-surface-design-show-london/

Fig.7. Surface Design Show, & GRG Acoustics. (2016). GRG Acoustic's panelling display from the Surface Design Show. SURFACE DESIGN SHOW. Retrieved 8 August 2016, from http://www.surfacedesignshow.com/sds-2016-gallery

Fig.8. Heliot and Co. (n.d.). Jesmonite Hex Textured Stone Tiles. Retrieved 8 August 2016, from http://heliotandco.com/surface-jesmonite-hex-stone/

Fig.9. Surface Design Show, & Amarestone. (2016). 3D Effects: Carving Techniques Inspire Textural Patterns within Surfaces: Amarestone CNC Carved Limestone. Surface spotlight: Post show trend report part One - surfaces. Retrieved 8 August 2016, from http://www.surfacedesignshow.com/news/Post-2016-Show-Surfaces

Fig.10. Own Image. (2014a). Cutout Leaves Sample from the "Reclaimed by Nature" collection.

Fig.11. Own Image. (2015a). Printed and Routed 12mm MDF.

Fig.12. Visual News, & Anderson, M. (2015a). CNC Machined Plywood. Retrieved 20 August 2016, from https://www.visualnews.com/2015/01/15/stunning-geometric-textures-carved-plywood-using-cnc-machine/

Fig.13. Visual News, & Anderson, M. (2015b). Finished example of 3D routed plywood by Michael Anderson. Retrieved 20 August 2016, from https://www.visualnews.com/2015/01/15/stunning-geometric-textures-carved-plywood-using-cnc-machine/

Fig.14. The Original Morris & Co. (n.d.). Bird and Pomegranate Wallpaper by William Morris. The original Morris & Co - arts and crafts, fabrics and wallpaper designs by William Morris & company. Retrieved 6 January 2017, from https://www.william-morris.co.uk/shop/wallpaper/morris-archive-wallpapers-ii/bird-and-pomegranate/?code=DARW212537&act=ssocomplete

Fig.15. .Converse. Retrieved October 26, 2016, from http://www.converse.com/uk/en/dyo/design-your-own-chuck-taylor-marble/155349C3.html

Fig.16. Own Image. (2014b). Sample 22 from the "Reclaimed by Nature" Collection.

Fig.17. Own Image. (2014c). Petal and Leaf Print.

Fig.18. Own Image. (2014d). Digitally Modified Petal Print for UV Printing.

Fig.19. Own Image. (2014e). Hand Drawn Floral Pattern.

Fig.20. Own Image. (2014f). Modified Design Ready for Laser-Cutting.

Fig.21. Own Image. (2014g). Close-up image of the Finished Sample.

Fig.22. Own Image. (2015b). The Elmo Projector, showing the document bed.

Fig.23. ELMO. (2016). P10HD. Retrieved November 20, 2016, from https://www.elmousa.com/product/p10hd/

Fig.24. Own Image. (2015c). Orange Segment Projection.

Fig.25. Own Image. (2015d). Cow Parsley Outline.

Fig.26. Own Image. (2015e). Laser Cut Mountboard using the scanned in Cow Parsley Design.

Bibliography.

Albert, A. (2008). Understanding CNC Routers creating forest sector solutions. Retrieved from http://www.solutionsforwood.com/_docs/reports/UnderstandingCNCRouters.pdf

Black, W. (2015, July 27). Making it personal – One in three consumers wants personalised products | Deloitte UK. Retrieved October 26, 2016, from Deloitte, https://www2.deloitte.com/uk/en/pages/press-releases/articles/one-in-three-consumers-wants-personalised-products.html

Communications, S. (2016, January 6). The 'sensational' role of texture in surface design. Retrieved 2016, from http://www.interiorsandsources.com/article-details/articleid/20357/title/the-sensational-role-of-texture-in-surface-design/viewall/true.aspx

Crafts council. (2014, September 30). Retrieved 2016, from http://www.craftscouncil.org.uk/articles/why-machines-are-not-the-enemy/

Dormer, P. (1997). Culture of craft: Status and future (studies in design and material series) (7th ed.). Manchester: Manchester University Press.

Eha, B. P. (2016, July 14). Forget 3D-Printed Knick-Knacks: The Maker Movement Is Entering a New Phase. Retrieved January 4, 2017, from http://fortune.com/2016/07/14/3d-print-maker-movement/

Environmental Policy. (2016, April). Retrieved June 23, 2016, from Crystal Doors , http://www.crystaldoors.co.uk/environmentalpolicy

Etsy. (2013). Redefining Entrepreneurship: Etsy Sellers' Economic Impact. Retrieved from https://blog.etsy.com/news/files/2013/11/Etsy_Redefining-Entrepreneurship_November-2013.pdf

Ferreira, J. R. (2012). The green life of wood -LCA workshop. Retrieved from https://www.unece.org/fileadmin/DAM/timber/meetings/20121015/Joao_Ferreira_Cork.pdf

Future of manufacturing: a new era of opportunity and challenge for the UK - summary report. (2013, October). . Retrieved from https://www.gov.uk/government/publications/future-of-manufacturing/future-of-manufacturing-a-new-era-of-opportunity-and-challenge-for-the-uk-summary-report

Greenlees, R. (2016, November 21). The UK craft sector isn't a "hipster" economy. It's sparking innovation. The Guardian. Retrieved from https://www.theguardian.com/commentisfree/2016/nov/18/uk-craft-sector-isnt-hipster-economy-manufacturing

Hoque, A. S. M., Halder, P. K., Parvez, M. S., & Szecsi, T. (2013). Integrated manufacturing features and design-for-manufacture guidelines for reducing product cost under CAD/CAM environment. Computers & Industrial Engineering, 66(4), 988–1003. doi:10.1016/j.cie.2013.08.016

Karana, E., Barati, B., Rognoli, V., & Zeeuw van der Laan, A. (2015). Material driven design (MDD): A method to design for material experiences. International Journal of Design, 9(2), 35–54. Retrieved from http://www.ijdesign.org/ojs/index.php/IJDesign/article/viewFile/1965/687

Klein, N. (2009). No logo: No space, no choice, no jobs (10th ed.). London: HarperCollins Publishers.

Korn, P. (2015). Why we make things and why it matters: The education of a craftsman. United Kingdom: Square Peg.

Kruger, B. (2012). Explore media networks. Retrieved 2016, from http://www.tate.org.uk/visit/tate-modern/display/media-networks/explore-media-networks

LCA, LCI, LCIA, LCC: What's the difference? (2016). Retrieved April 20, 2016, from http://www.athenasmi.org/resources/about-lca/whats-the-difference/

Lefteri, C. (2012). Making it: Manufacturing techniques for product design. London: Laurence King Publishing.

Liz, S. (2013, March 7). Digital Craft. Retrieved October 12, 2016, from https://www.prote.in/journal/articles/digital-craft

Maeda, J. (2010). Design education in the post-digital age. Design Management Journal (Former Series), 13(3), 39–45. doi:10.1111/j.1948-7169.2002.tb00317.x

McDonough, W. (2002). Design for the triple top line: New tools for sustainable commerce. Corporate Environmental Strategy, 9(3), 251–258. doi:10.1016/s1066-7938(02)00069-6

Medium density Fibreboard (MDF). (2014). . Retrieved from http://woodforgood.com/assets/Downloads/MDF_v1.2_2014-03-18.pdf

Mills, C. E. (2012). Navigating the interface between design education and fashion business start-up. Education + Training, 54(8/9), 761–777. doi:10.1108/00400911211274873

Papanek, V., & Fuller, B. R. (1972). Design for the real world. London: Thames and Hudson.

Plant, A. V. C., Harrison, D. J., Griffiths, B. J., & De Coster, R. (2010). Design for Manufacture and Sustainability in New Product Development. Retrieved from http://bura.brunel.ac.uk/bitstream/2438/5955/2/Fulltext.pdf

Recycling MDF: Are we there yet? - wood based panels. (2012, March 9). Retrieved April 14, 2016, from wood based panel international, http://www.wbpionline.com/features/recycling-mdf-are-we-there-yet/

RofinLaser Inc. (2013). The difference between CNC router and CNC laser machine - company news - Jinan Ruofen laser machinery. Retrieved June 23, 2016, from http://www.ruofencnc.com/html/News/Company_News/36.html

Rosen, M. A., & Kishawy, H. A. (2012). Sustainable manufacturing and design: Concepts, practices and needs. Sustainability, 4(12), 154–174. doi:10.3390/su4020154

Scallan, P. (2003). Process planning: The design/manufacture interface. Boston, MA: A Butterworth-Heinemann Title.

Sennett, R. (2009). Craftsman (UK edition). London: Penguin Books.
The future of manufacturing | Deloitte | manufacturing | articles | insights. (2013, October). . Retrieved from

http://www2.deloitte.com/global/en/pages/manufacturing/articles/future-of-manufacturing.html

Appendix.

Appendix A. The Reclaimed by Nature Collection
"Booklet front cover"
(Own Image, 2014)

Appendix A. The Reclaimed by Nature Collection
"Geometric Sublimation print"
(Own Image, 2014)

Appendix A. The Reclaimed by Nature Collection
"Leaf Repeat UV Print"
(Own Image, 2014)

Appendix A. The Reclaimed by Nature Collection
"Laser Engrave and UV Print leaf design"
(Own Image, 2014)

Appendix A. The Reclaimed by Nature Collection
"Ghost Leaf UV Print"
(Own Image, 2014)

Appendix A. The Reclaimed by Nature Collection
"Laser Engrave Beech Lead and Flower Design"
(Own Image, 2014)

Emma Linney Joanne Harris - Post Graduate Research (Masters by Research)
University of Huddersfield

University of HUDDERSFIELD
Inspiring tomorrow's professionals

Maintaining the Aesthetic

Exploring the process from surface design concept to manufactured wall installation and the transition from the sample to the manufactured end product.

Key Words...

Sustainable, Tactile, Manufacture, Material-Aesthetic, Surface, Machine, Craft

Abstract

This research topic will look at the process and transition of the surface designers concept sample through the manufacturing process – questioning the loss of aesthetic through material choices, cost, scale and production. The focus of the manufacturing process is specific to interior wall coverings and surfaces. The research will also look at the use of sustainable materials, focusing around the use of MDF and Cork as a basis for all samples and testing.

Introduction

As a new designer it is very difficult to know where to start with taking work into manufacture, coming from a surface design background I have often worked to create design concepts, but not neccessarily to take a product through to maunfacture and then retail. This proposal aims to not only successfully test and produce a finished product ready for the commercial market but to also discover and document the most efficient and appropriate decision making steps to get the results I desire.

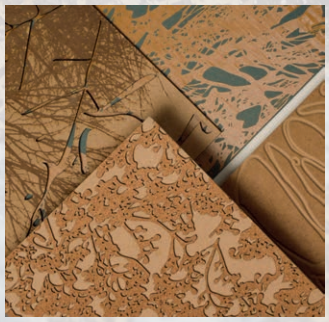
This research is about finding appropriate manufacturing methods for the surface concepts but in addition to this it is also about discovering whether large scale manufacturing is the right choice for the type of product I wish to produce. This research will also ask if the selected process and choices made to transform concept to manufacturing also depict the practice position as a craft designer or a commercial surface designer and how the methods of production are perceived by the end customer or user.

Aims

- To successfully develop a feature wall panel using sustainable materials and techniques, creating an aesthetically impacting piece that has been created through a cohesive relationship between design and manufacturer.
- To develop a better knowledge of working with manufacturers and businesses and how this can develop into future product and business ventures.
- To decide whether CNC routed products in this context can be considered as a "craft" product or whether that element comes directly from the type of techniques used.

Objectives

- To explore manufacturing techniques to develop a visually impacting feature wall panel for commercial interiors, focusing on creating a piece that is complex and intricate.
- To consider whether a loss of aesthetic is necessary when taking a product through from concept to manufacture, or if this can be avoided through appropriate design making techniques.
- To assess the sustainability aspect of the piece not only in the material and manufacturing choices made but also considering end of life and



Here are a few examples of the pieces of work create for the 'Surface Tactility' collection for my Major Project last year. The pieces were very experiemental and focused around the surface quality of the matericals being used as well as image placed on them.

Key Research Questions...

Is a loss of aesthetic a neccessary stage when taking a product through to manufacture?

Can a product with a unique aesthetic really be cost effective as well?

Can manufactured products still possess a 'craft' quality?

Where do i position myself in the surface design market?

Can I develop a product that is both sustainable and innovative in its design?

Research Methods

A variety of research methods will be used to answer the research questions, including observational and reflective techniques. This research will be very personal to the researcher, drawing on personal experience for much of the design and research outcomes.

The research will determine material choices and question the sympathetic qualities of surface application to the intended end use and environment using academic publications to support the decisions as well as material data and analyses.These will be supported by drawing from personal experiences within this research as well as some case studies from crucial areas of the research. One being the business that will be supporting the work 'Crystal Doors' and the other being the exp... the 'Surface Design show' in London.

Key Literature

Karana, E., Barati, B., Rognoli, V., & Zeeuw van der Laan, A. (2015). Material driven design (MDD): A method to design for material experiences. International Journal of Design, 9(2), 35–54. Retrieved from http://www.ijdesign.org/ojs/index.php/IJDesign/article/viewFile/1965/687

Lefteri, C. (2012). Making it: Manufacturing techniques for product design. London: Laurence King Publishing.

McDonough, W., & Braungart, M. (2003). Cradle to cradle: Remaking the way we make things. New York, NY: Farrar, Straus and Giroux.

Rosen, M. A., & Kishawy, H. A. (2012). Sustainable manufacturing and design: Concepts, practices and needs. Sustainability, 4(12), 154–174. doi:10.3390/su4020154

The future of manufacturing | Deloitte | manufacturing | articles | insights. (2013, October). . Retrieved from http://www2.deloitte.com/global/en/pages/manufacturing/articles/future-of-manufacturing.html

Scan here to view my website!

Emma Linney
Surface Design

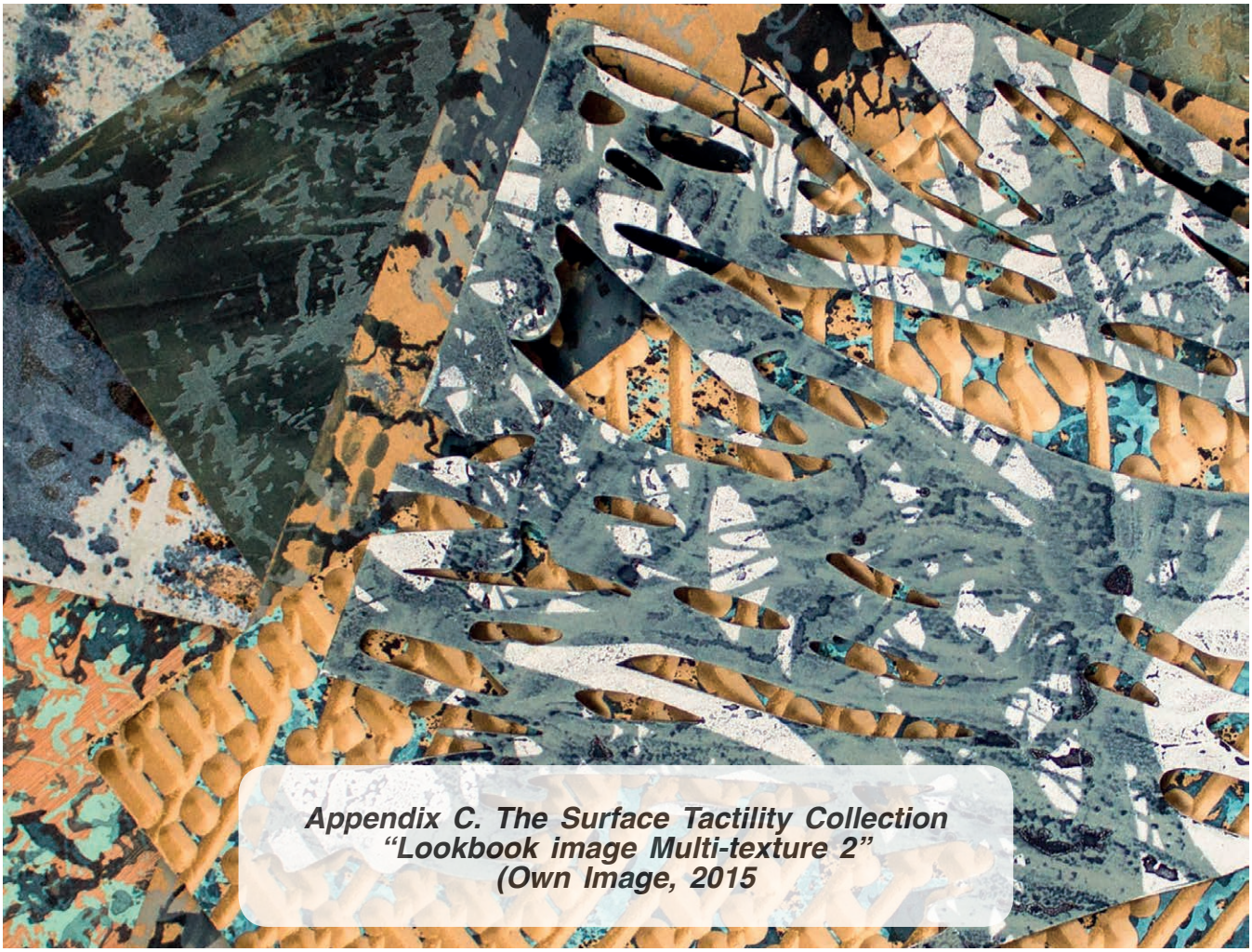
Appendix B. Research Poster (Own Image, 2016)

Appendix C. The Surface Tactility Collection
"Lookbook Image Blue Overlay"
(Own Image, 2015

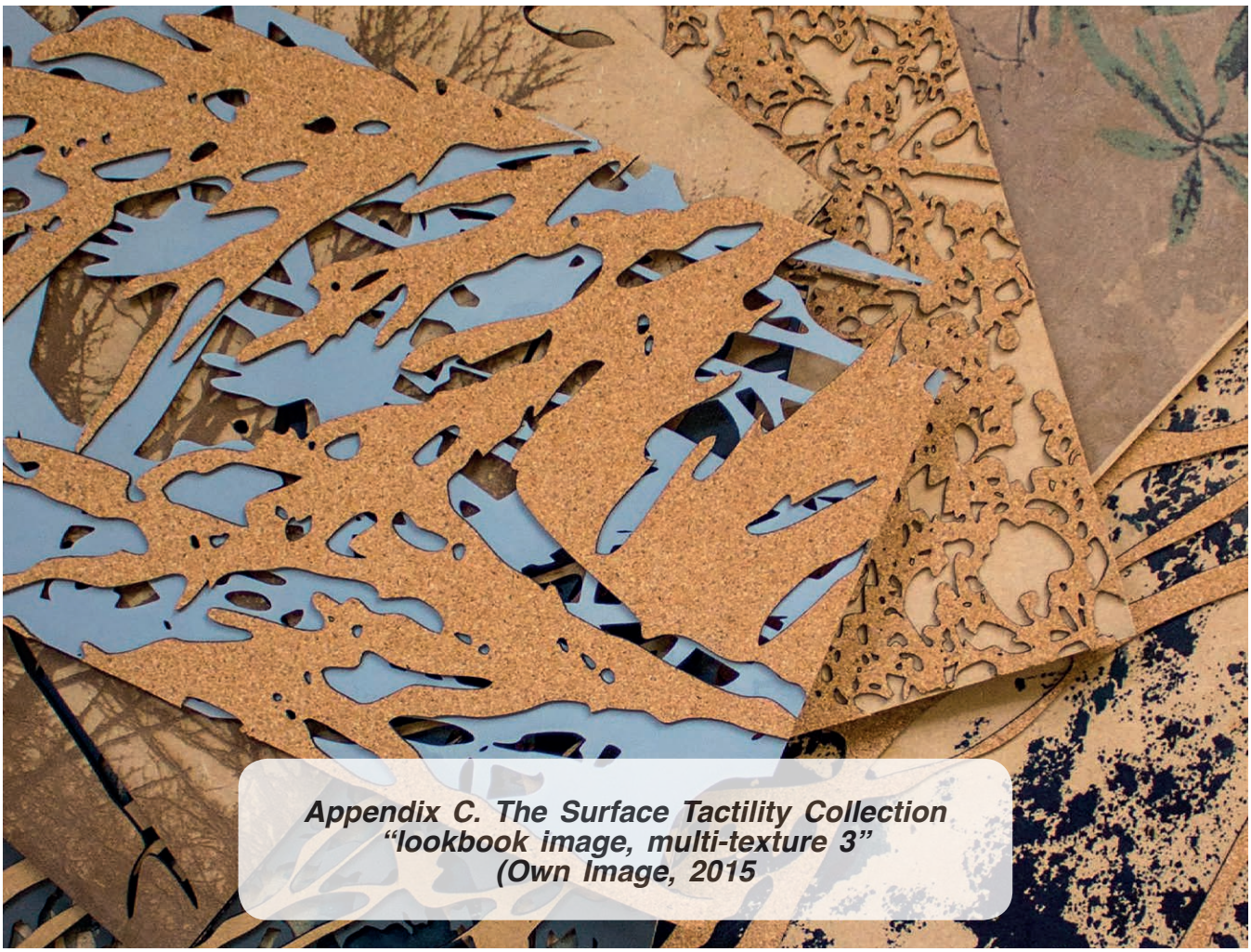
Appendix C. The Surface Tactility Collection
"Lookbook image, stacked samples"
(Own Image, 2015

Appendix C. The Surface Tactility Collection
"Lookbook image Cow parsley print and laser-cut"
(Own Image, 2015

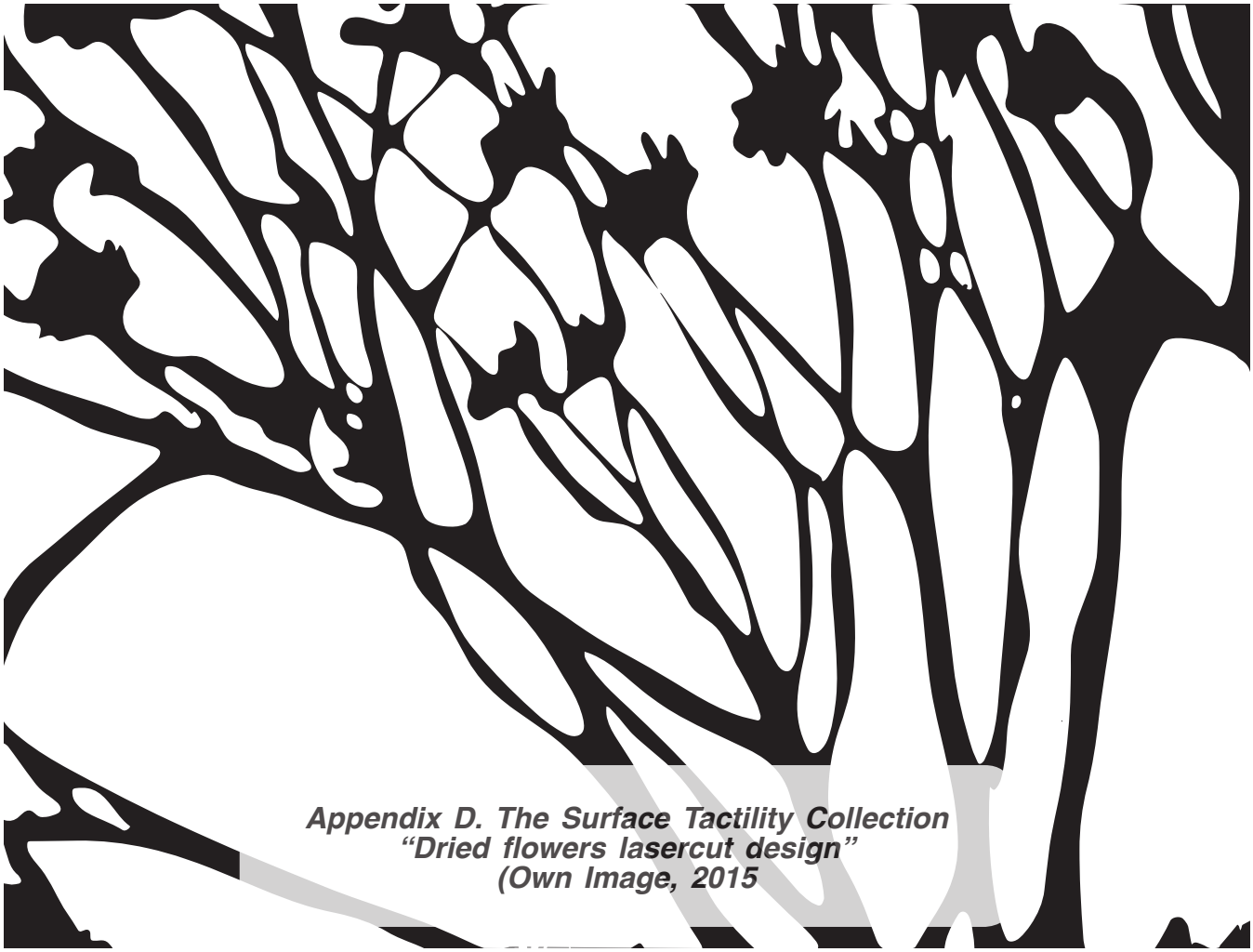
Appendix C. The Surface Tactility Collection
"Lookbook image, multi texture"
(Own Image, 2015



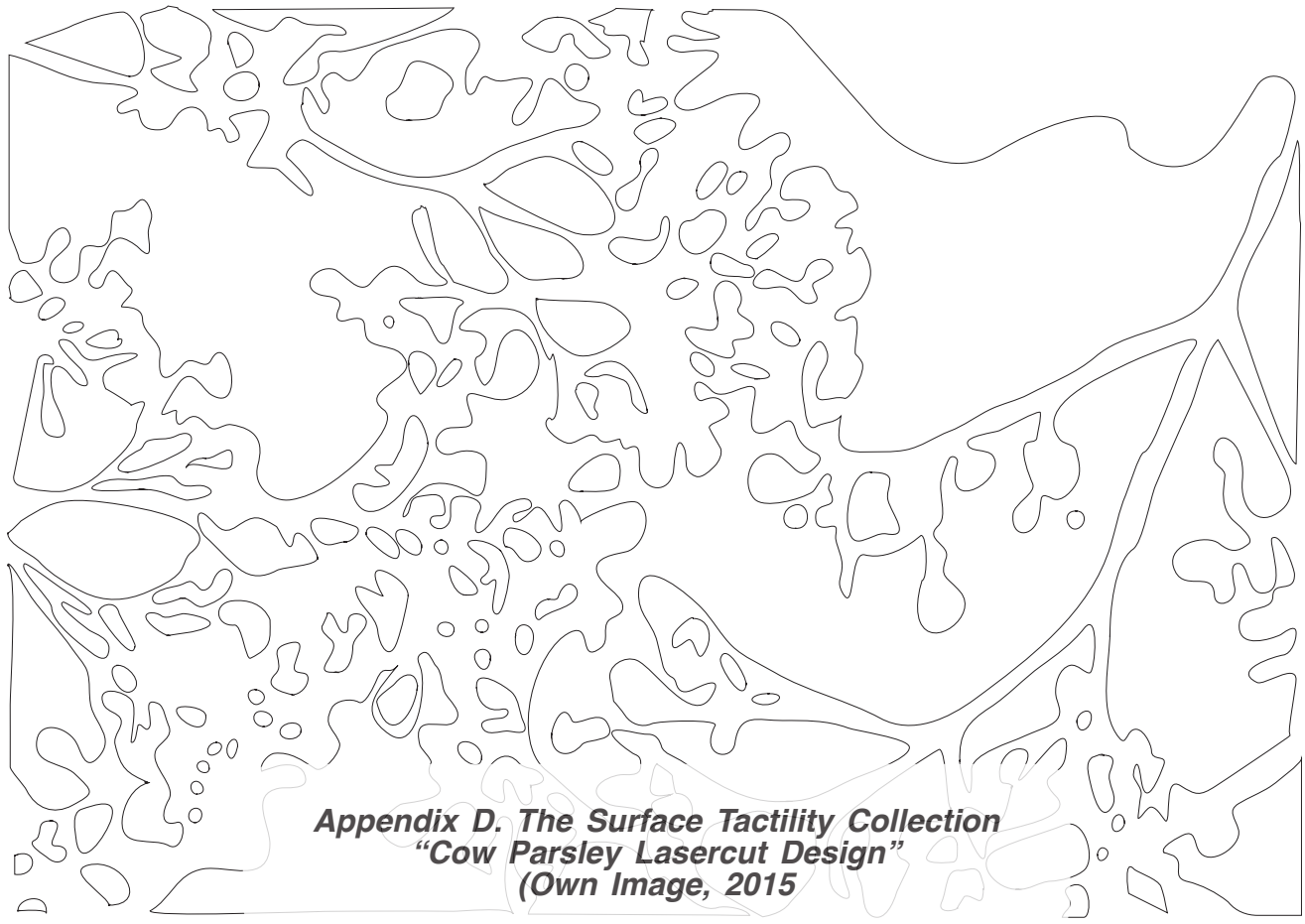
Appendix C. The Surface Tactility Collection
"Lookbook image Multi-texture 2"
(Own Image, 2015



Appendix C. The Surface Tactility Collection
"lookbook image, multi-texture 3"
(Own Image, 2015



Appendix D. The Surface Tactility Collection
"Dried flowers lasercut design"
(Own Image, 2015



Appendix D. The Surface Tactility Collection
"Cow Parsley Lasercut Design"
(Own Image, 2015