Proceedings Paper:
Mcewan, M and Scott, J (2019) Deciphering the Craft of the Laser Cutter. In: Nimkulrat, N, Kuusk, K, Valle Noronha, J, Groth, C and Tomico, O, (eds.) Proceedings of the International Conference 2019 of the DRS Special Interest Group on Experiential Knowledge (EKSIG 2019). EKSIG 2019, 23-24 Sep 2019, Talinn, Estonia. Estonian Academy of Arts , pp. 27-40. ISBN 978-9949-594-82-5

Title: Deciphering the Craft of the Laser Cutter

Maighraed Mcewan, The University of Leeds
Dr Jane Scott, The University of Leeds

Abstract

This research investigates how the experiential knowledge of a maker can be transformed through collaboration with laser technology. The research is situated within craft theory, evaluating the new tool developed through the research against the craft attributes of the hand-made, skill, risk and technology. Practice led experimental research developed a new digital drawing tool, recording the path of the lasercutter using a range of different drawing pens to yield a variety of different crafted marks. All areas of the results show a hybridisation of craft techniques and knowledge of technology, to achieve a collaborative approach to making. The significance of the research is that it demonstrates how collaborations between the handmade and digital can introduce craft thinking into digital workflows, creating a digital craft methodology which can be applied to further technologies in the future.

Keywords
Craft; Hybridity; Laser Technology.

This research is located within the context of experiential knowledge developed through craft and applied to digital technologies. Craft and its definition with association to technology has been assessed and disputed over since the Renaissance, where craft was considered subordinate to other forms of the visual arts (McCullough, 1998). Glenn Adamson (2013) and Tom Crook (2009) both argue that craft must now be analysed alongside modernity and new technologies rather than oppose them. This collaborative approach to the assimilation of technology into craft shall be explored in this research. Technology offers huge opportunities to innovate within craft practice, however in order to retain the "combination of hand, mind and eye - the technical mastery of tools, materials, aesthetic sensibility and design skills" (Fraser, 2010, no page number), therefore it is essential that craft adopt a more holistic approach to practice that encompasses technology.

This study focuses on the digital technology of lasercutting. Laser technology has developed since its advent in manufacturing purposes, and is now commonly used in craft practice. It engraves and cuts through materials (Berens Baker, 2016), and is controlled by human design on a vector based software. The craft-makers of today are not just readily adopting the laser cutter technology into their process alongside other techniques, but also re-imagining the craft of the machine itself, and the creativity it possesses.

1: Background and Theoretical Approach

The theoretical context for the research identifies four areas of craft to be examined; Hand made, Skill, Risk and technology. Technology is included as an important attribute of craft, as the increasing numbers of craft makers using digital tools cannot be ignored. These four areas are combined to use as a basis for experimentation and analysis of results. However, the literature reviewed provides a research gap to explore; whether these traditional elements of craft can be used as a methodology for makers to apply to digital technology.

1.1 Craft is Hand Made

The hand has played a vital role in making and crafting for centuries. Out of all the sensory experiences, touching and connecting with one's hands appears to play the most important role for a craftsman (Treadaway, 2009). Dormer (1997) argues this can be through direct manipulation of a material by the hand but also through tools that the hand controls. Adamson (2010) proposes that once this vital element of the hand is removed, or is not the main tool used in the creation of an artefact, it can no longer be considered craft at all.

Using our hands to touch is an innate capability; "to touch the world is to know the world" (Benjamin, 1936, p. 168). Tacit knowledge which is "experiential" can only be learnt through the hands (McCullough, 1998, p.3), and this makes craft practice instinctual, and a sensory experience (Dormer, 1997, McCullough, 1998, and Shillito, 2013). However, Sennett (2008) argues that intuition is a form of experiential knowledge which can easily be applied when using the hands to control a technology. For the purpose of this research it is important to understand whether touch can be replicated through technology or not. McCullough (1998) argues that if it is only hands that possess skill, then a technology cannot inhabit the sensorial attributes of touch.

In the context of contemporary craft, makers like Sharyn Dunn focus on the importance of the hand in their making process as they combine techniques to produce craft objects. Dunn uses a combination of processes including papermaking, lasercutting and stitch to produce each piece. She reflects on the importance of the hand as a key attribute of craft:

> "*when the personal or the hand crafting part disappears and its pure technology… it's almost like having robots produce each item"* (Dunn, 2018).

Whilst digital tools enable the production of work, ultimately the hand has been prominent throughout. The hand is not just important for ease of human access, but also promotes a personal rapport with the craft.

A different perspective is to see the hand as what it represents. Craft maker Tom Sowden argues that it is rather how the hand is used throughout the process:

> *"by hand I do not necessarily mean by actually using hands, more as a term for the human input into the making process"* (Sowden, 2018).

From this, the ambiguity into what constitutes hand-made elements in craft is still seen to vary for each craft maker. Although the traditional perception of craft is centred around the handmade, Malins et al (2004) argue that it is rather the maker's intended idea and how he or she carry this out, not the connection to the hand that is most important.

1.2 Craft is Skill

Skill is an important attribute of craft. Sowden explains that the main attribute of craft to him is *"the learned application of skill"* (Sowden, 2018), which implies that skill is knowledge. For the purpose of this research, skill is described as a repeated and therefore learned method which produces a high level of work. It embodies knowledge, which is nurtured and practiced. The application of skill is not limited to the traditional craft sectors of pottery, textiles and ceramics, but should encompass the skill acquired in learning new technologies (Perry, 2012).

Repetition is essential in the development of practice. McCullough (1998) argues that these essential repetitions of work reinforce the process into the craftsman's knowledge, developing their skill. Sennett (2008) gives an approximate number of 10,000 hours which must be undertaken in order for a craftsman to become skilled or a master of their craft. During this lengthy period, skills are developed and fine-tuned, creating an inevitable sense of control for the craft maker. This skilled control may be found through attention to detail, and knowledge of one's tools.

Rob Ryan's practice focuses on hand cut work, but also utilises the lasercutter to reproduce designs. His application of lasercut technology exemplifies the point that the skill found in craft is now able to be replicated by technology. It is apparent that both pieces of work share the same amount of skill to the eye, suggesting that technology in this case can be used as an attribute of craft.

This connection that the maker builds with their process, embodies a "reflective dialogue with the material world" (Yair and Schwarz, 2011, p.312), which Yair and Schwarz argue is a key characteristic of craft knowledge. By taking its time to develop, skill inadvertently provides a higher level of satisfaction for the maker (Sennett, 2008). Ultimately, the more time given to any collaborative process, yields a larger engagement with the end result. Sennett believes this can be achieved through a process of "embedding" which encompasses the "conversion of information and practices into tacit knowledge" (Sennett, 2008, p.50).

When assessing this point, it is important to address Dormer's writing on the importance of "distributed" and "personal" knowledge (Dormer, 1997, p.139). Personal knowledge is akin to tacit knowledge which is acquired through memory and experience. For as Dormer asserts, "you not only know that you know but you feel that you know" (ibid). Distributed knowledge, is acquired through the culmination of various techniques from different makers. It encompasses the idea that we also are able to use tools that require no previous personal knowledge. In addition it is the possession of this knowledge and the way it is controlled that defines craft, rather than the attention on the hand or skill.

1.3 Craft is Risk

The concept of irregularity in craft is vital, as these nuances and mistakes are what create the intended hand-crafted element. Pye calls this the "workmanship of risk" (Pye, 1995, p.20) where design or artefact can be ruined at any time. The "workmanship of risk" (ibid) can be applied to most craft outcomes. However, digital technologies strive for precision, and this can be seen to erase the "charm of mistakes" (Fraser, 2010, no page number). It is imperative to understand whether the result of risk should be classified as error, mistake, or even a form of play. For many craft makers working in the era of mass production, a fear of making a mistake led to a classification that taking risks was detrimental to craft (Dormer, 1997, p.141). However the opportunity to work with digital technologies enables mistakes to become "dynamic" (Kourteva and McMeel, 2017, p.177). In Kourteva and McMeel's experimental architecture, the unknown and surprising results generated through what could be perceived as mistakes in lasercutting, informed the research process and led to innovation in the practice (ibid).

Many makers are now programming mistakes and imperfections into technology, and see this as a way of emitting craft attributes through a digital realm (Braddock Clarke and Harris, 2012). As the technology progresses in craft, makers shall inevitably devise innovative ways to introduce this element of unpredictability into the machines (Perry, 2012). Variable Projects (Marcus, 2016) explores the amalgamation of risk into technology. Here, drawing is presented through technology, seeking imperfection in the outcomes. Marcus's research presents an important model for this investigation, his use of technology produces marks that are “cumulative and contingent” (Marcus, 2017, p187), and portray a feeling of craft. This project highlights that it is possible to reintroduce the element of risk through modification of technology. This exploitation of the flaws and risks in the technology, leads to a new language being developed, furthering a maker’s knowledge (Fraser, 2010). The interest in this contemporary approach to craft and technology is demonstrated in the success of the touring exhibition Drawing Codes, curated by Adam Marcus and Andrew Kudless. Here technology is used harmoniously with traditional architectural techniques to create a new relationship between maker and the digital realm. The aim of the research presented in this paper is to explore how risk can be enabled and celebrated using laser technology. It is therefore critical to consider the role of technology as a collaborative tool for craft.

1.4 Craft is Technology

Crafts history is rooted in the rejection of technology and the appraisal of hand-made techniques throughout the Industrial Revolution (Malins et al, 2004). However, the use of digital technology has transformed the skills required and the understanding of the handmade within contemporary design/craft practice. McCullough (1998) sees the value in using the computer technology as a tool for craft, which is guided by the skilled hand. This is similar to Jeremy Myerson (1997) who argues the technology of the computer is not a craft in itself rather the pre-existing knowledge of the maker.

The opportunity to explore a range of digital technologies through the lens of craft, has transformed the ability for makers to integrate skill, risk and the handmade into their work. This collaborative approach is observed in Marcus’s research (2016) where the digital tools are adapted to produce a crafted process. Treadaway’s research into “Hybrid Craft” explains how the fusion of digital techniques into practice is now being seen as a positive aid in one’s creative process, rather than reducing the authenticity of a design (Treadaway, 2004). This process has been defined as “interdisciplinarity” (Greenlagh, 2002, p.195), suggesting that the next theme of modernity will come from the linking together of other areas in the arts, resulting in innovative and creative outcomes. These new technological techniques have been acknowledged by Ann Marie Shillito (2013) who suggests unlike Treadaway, that technologically advanced techniques cannot only inform our craft, but are the craft. Shillito values the potential of technology, whilst recognising the knowledge one can acquire from craft experience and its relationship to tactility. It could be argued that as the integration of techniques can be seen as Hybrid Craft, the fusion of craft attributes can now also be a form of hybridity. If craft is based on interdisciplinarity, then it is possible to develop this knowledge into the core attributes of craft itself, and see technology as part of this. Through experimental research, the concept of hybridity as a way to integrate technology into craft research will be evaluated, alongside the other attributes of the handmade, skill and risk critical to understanding craft theory.

2: Materials and Methods

This experimental research investigates how the experiential knowledge of a maker can be transformed through collaboration with laser technology. The research compares the marks produced during a series of design interventions using a laser cutter fitted with a series of alternative devices to replace the laser head. Each experiment records the marks made and evaluates the findings in two ways. Firstly through comparing the results across a series of experiments, and secondly by evaluating the findings against the craft attributes outlined in the theoretical context; Hand-Made, Skill, Risk and Technology.

The objective of the investigation is to provide a basis to understand what craft attributes laser technology can possess. This innovative way to approach craft, although unique, is difficult to quantify. Using the laser head as a drawing tool allows the technology to record not only the marks described through the CAD software, but also to record how the machine creates the marks. This is undertaken by recording the toolpath as it travels across the laser bed.

The laser cutter machine used is a CO2, flatbed laser cutter (CadCam technology). The laser beam moves over the flat surface, according to an x and y axis, following a toolpath unique to the design that is being cut. Every laser cutter varies in velocity and power, these controls can be adapted to produce different effects. In this investigation the speed was adapted to improve the functionality of the alternative pen devices used to replace the laser head.

The research adopts a Practice Led Research (Muratovski, 2016) approach in the form of a series of experimentations testing the craft of the laser cutter machine. This was influenced by Nimkulrat's (2012) study which aimed to understand craft as a new approach of thinking, rather than just an object. In contrast to practice based research the aim here is not to create an end set of final design solutions and artefacts, but a broad range of experimentation, testing the potential of the design intervention using laser technology. The outcome of the experimentation is a variety of contrasting marks produced using different drawing devices. These marks are analysed to determine how experiential knowledge can be developed using the technology through collaboration across craft and the digital production methods.

Initial experiments are carried out in order to understand which variables to test. A variety of pens are tested, with a thin (figure 1, Staedtler stick 430 F), medium (figure 2, STA Aquarelle Brush, no.31101 fine) and thick (figure 3, Pilot super colour marker SCA-6600) type being carried forward for variation. A variety of different speeds and velocities are tested. This ranges from 3-650, which are the minimum and maximum of the laser cutter being used. Three variables are determined from here to ensure a depth of information can be gathered that spans across 3 different velocities and powers. These remain constant throughout. A variety of materials are tested; paper, card, velvet, cotton. However, for ease of reliability the use of paper remains a constant in the experiments.

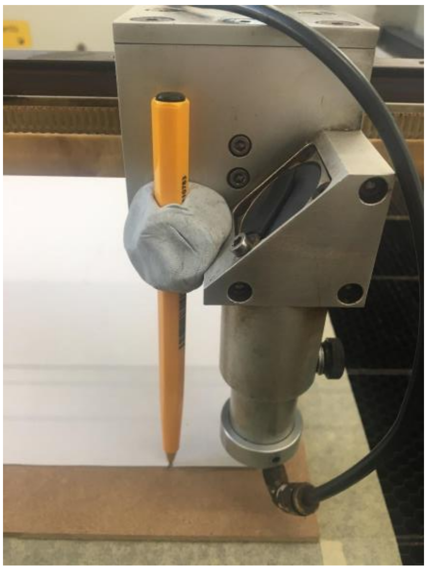

Fig 1. Attachment of Biro to Laser Machine

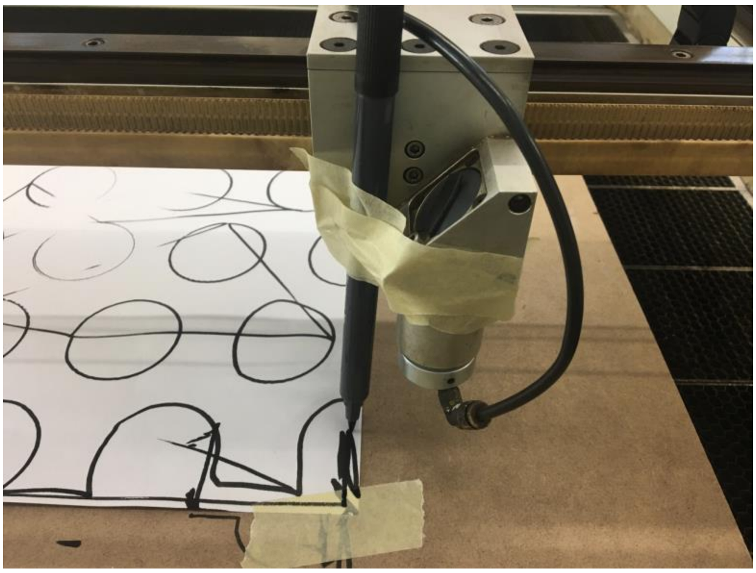

Fig 2. Attachment of Medium Pen to Laser Machine

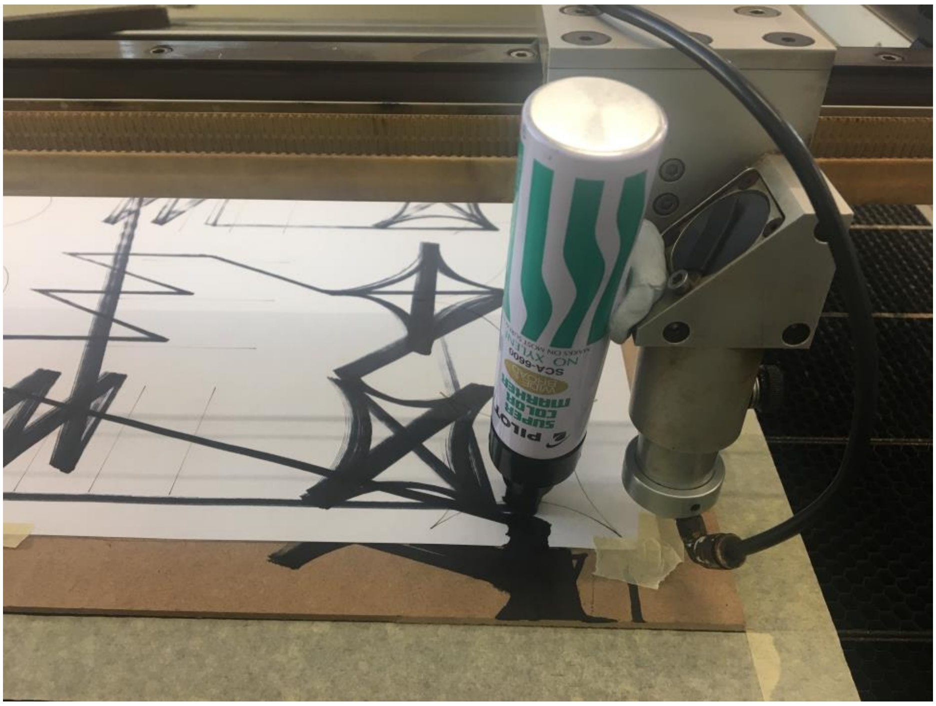

Fig 3. Attachment of Thick Pen to Laser Machine

2.1 Initial Experiments

For the purpose of ease of analysis of results, the sample experiments are given the same pattern shown in Figure 4. At first a pattern of concentric circles was used; however, this did not yield varied results. Figure 4 was subsequently created to encompass all necessary vector points of the laser. The shapes were influenced by those used by Adam Marcus (2016) in his “Variable Projects” work.

The design intervention used in the experimentation is to attach a drawing device, in the form of a pen to the laser head. The laser remains active and is set to etch. In addition, the pen records the toolpath used to create the etched design, determined by the laser technology. Three different pens are attached to the laser machine, at the same point seen in Figures 1, 2, 3. The same pens are used throughout for reliability. The paper used throughout is plain white a3 paper. The placement of paper stays the same throughout. The tests follow the same structure which is to act as a guide for the experiments. The variables explored are the role of the pen, changing the velocity, and disrupting the process by opening the lid during the cutting process. These variables reintroduce Pye’s (1995) workmanship of risk to the technological process and introduce a hands-on element applying the experiential knowledge of the laser cut technology.

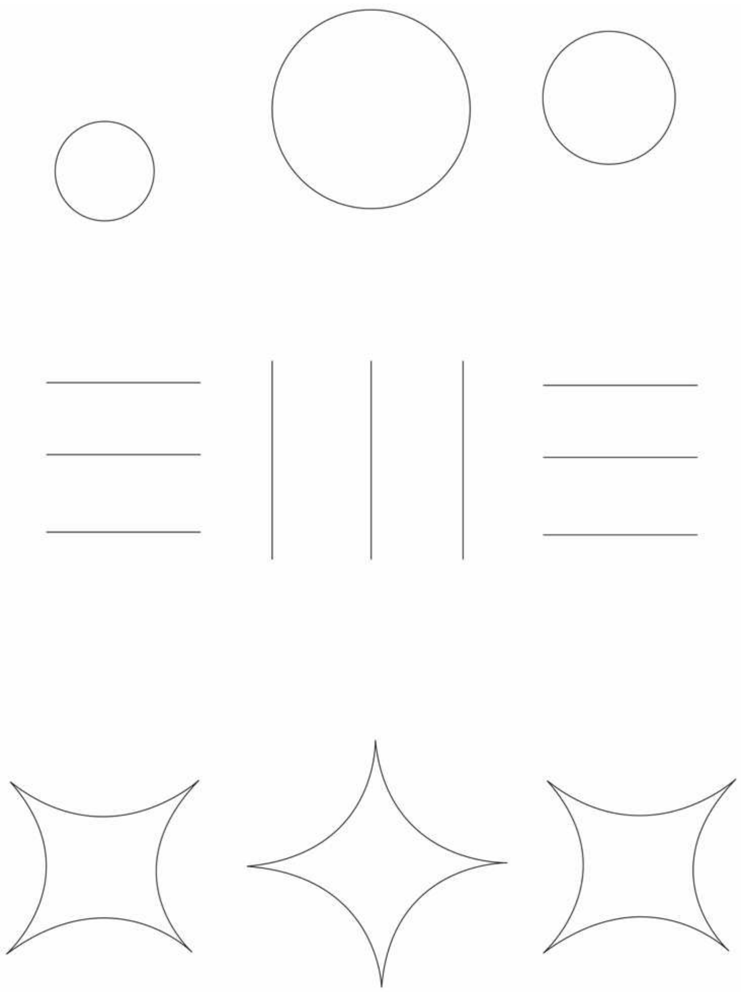

Figure 4. Shapes Used in Experiments

Pen	Results
Biro	*Velocity 50, Power Max 5 Min 3:* Paused to push down biro at 3 vector points on right side. Overall laser marks are faint, however the pen has dragged and created a new shape at the top right of the picture. *Velocity 350 power max 20 min 3* Paused once at bottom right due to no mark appearing. Pen dragged, and did not connect with paper as well as previously. The pen dragging has created an interesting line top left. *Velocity 600 power max 20 min 3* The pen caught on the paper at the bottom right and burnt through the top area of the circles. Pen seemed to not connect with the paper very well. The laser marks are clear.
Medium	*Velocity 50 Power max 5 min 3* No intervention with the laser bed, pen seemed to connect with the paper well. Laser marks are weak, pen marks seem to dominate the picture. *Velocity 350 power max 20 min 3* Paused in the middle due to no mark appearing. Marks created are crisp, and progress from previously. Laser marks are weak again. *Velocity 600 power max 20 min 3* The laser cut through the paper and a large drag occurred at the bottom of paper. Pen marks still very clear and map the laser route. More mistakes can be seen from the pen, with burn marks apparent with the laser too.
Thick	*Velocity 50 Power max 5 min 3* Pen dragged a lot, due to slow velocity. Machine has been paused once in the middle, as pen loosened from attachment, creating interesting marks. The laser marks are faint but clear. *Velocity 350 power max 20 min 3* No intervention with machine. Pen dragged by itself creating interesting marks. Laser marks are faint and not clear. Pen marks are dominant. *Velocity 600 power max 20 min 3* The machine has cut through the paper in multiple areas, and burn marks are much clearer. Pen marks are clear and uniformed. The marks produced vary in depth and regularity.

Table 1. Analysis of Marks Created by Lasercutter

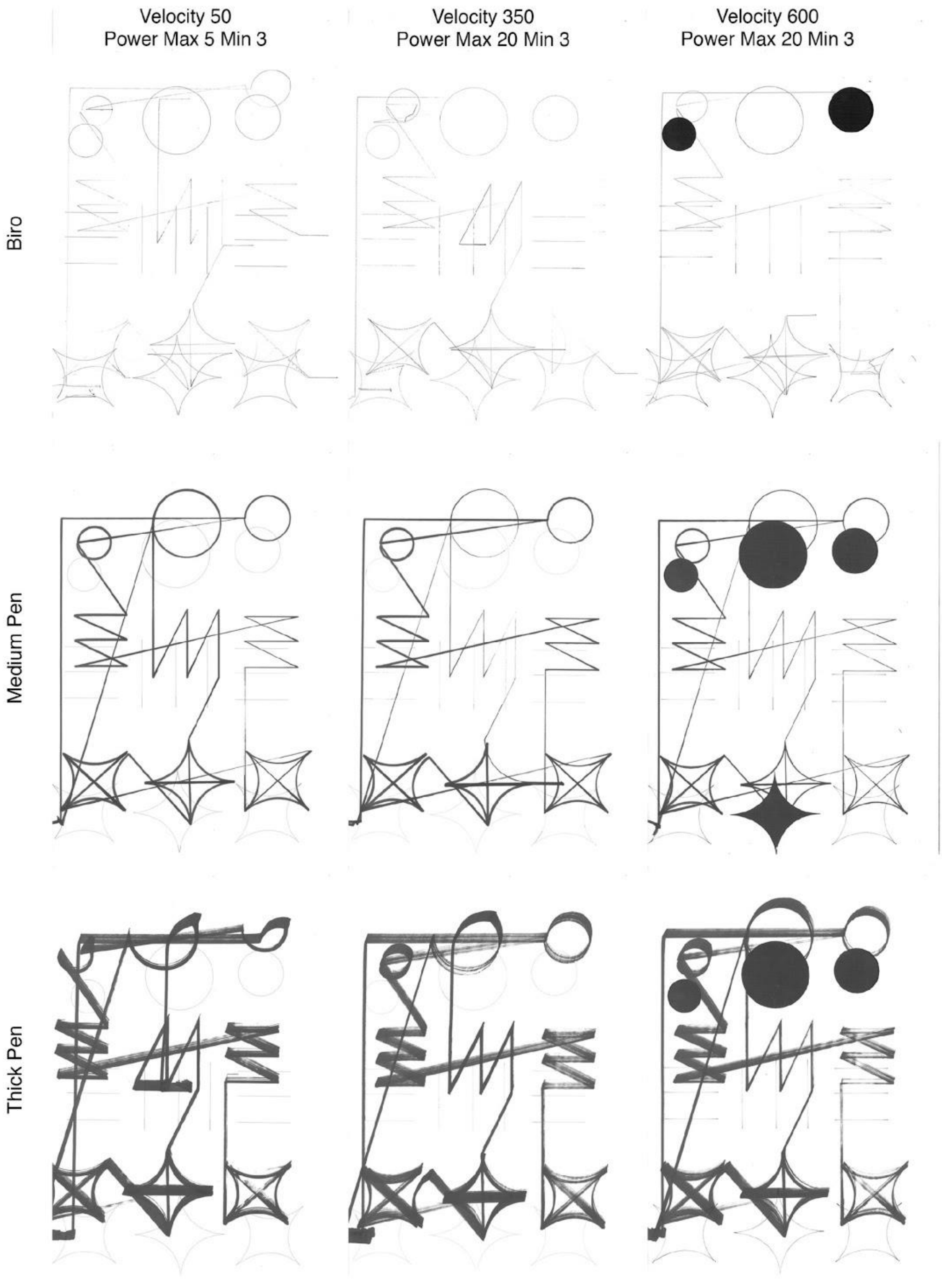

Figure 5. Experiment Results

3 Results

The experiment shows that with each pen used a different mark is produced. With reference to table 1 and figure 5 it is evident that with the medium pen; the connection with the paper has yielded the most precise marks. We are easily able to identify the laser heads path, and the added tool does not appear to veer off course. However, with both the biro and thick pen, the pen has dragged and created nuances in the designs.

It is interesting to note that at the velocity of 350, the marks produced seem to appear the most different for each pen used. The biro is seen to make jagged marks, with a varying pressure indicated in the faded appearance of the lines produced. However, the medium pen appears the most uniform. Although, the pen loses connection to the paper in certain areas of the design, which are not seen at other velocities. The thick pen, appears to produce varying depths of mark due to the colour.

At the velocity of 600 it is obvious in all 3 results with each pen that a cut through of the paper is apparent. These cut throughs, are evident in the same position in each design. The laser marks produced at this velocity also differ to the previous rounds. The marks are faint, and appear lost or integrated into the design.

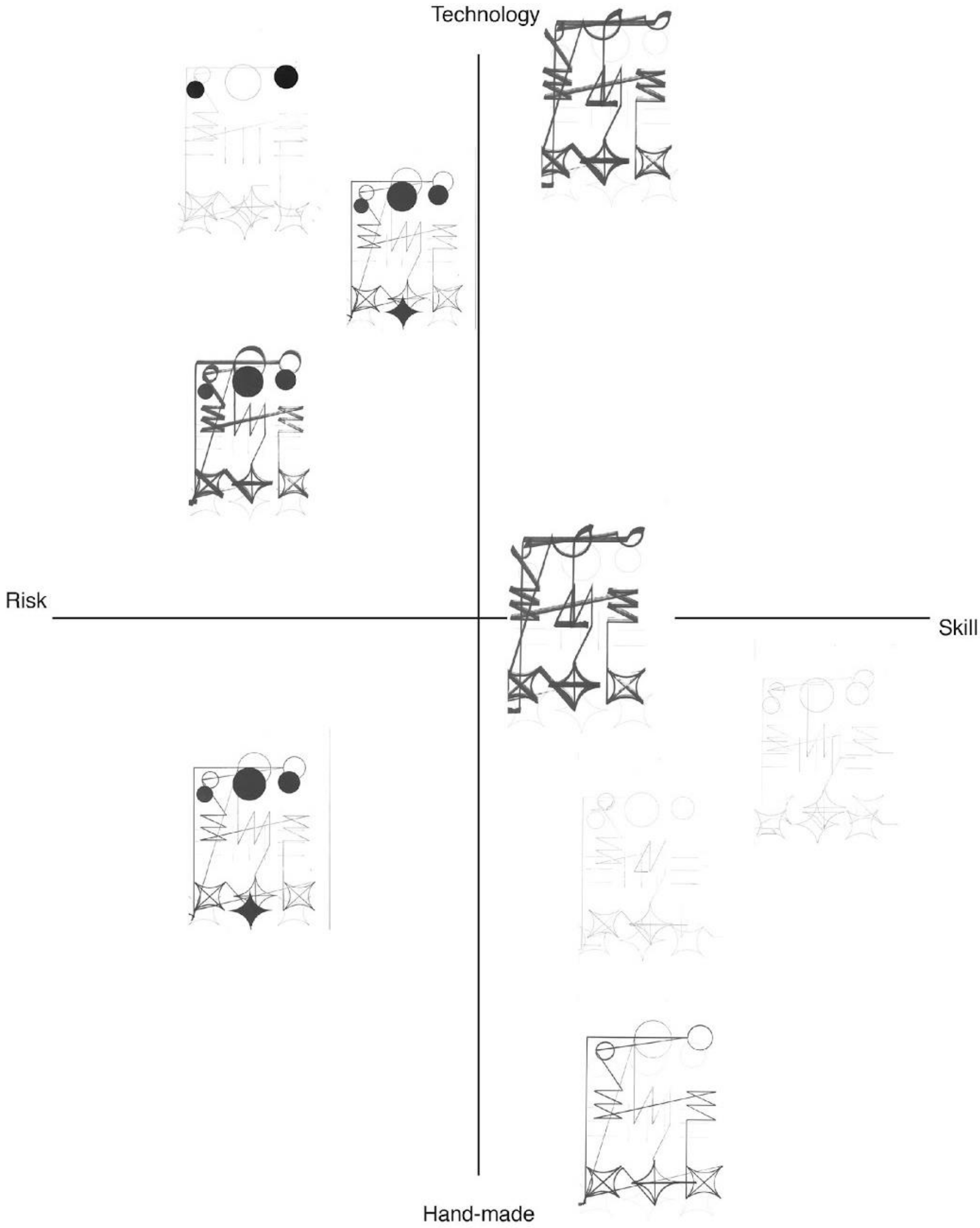

Figure 6. Graph mapping experimental results against craft attributes.

3.1 Analysis of Results

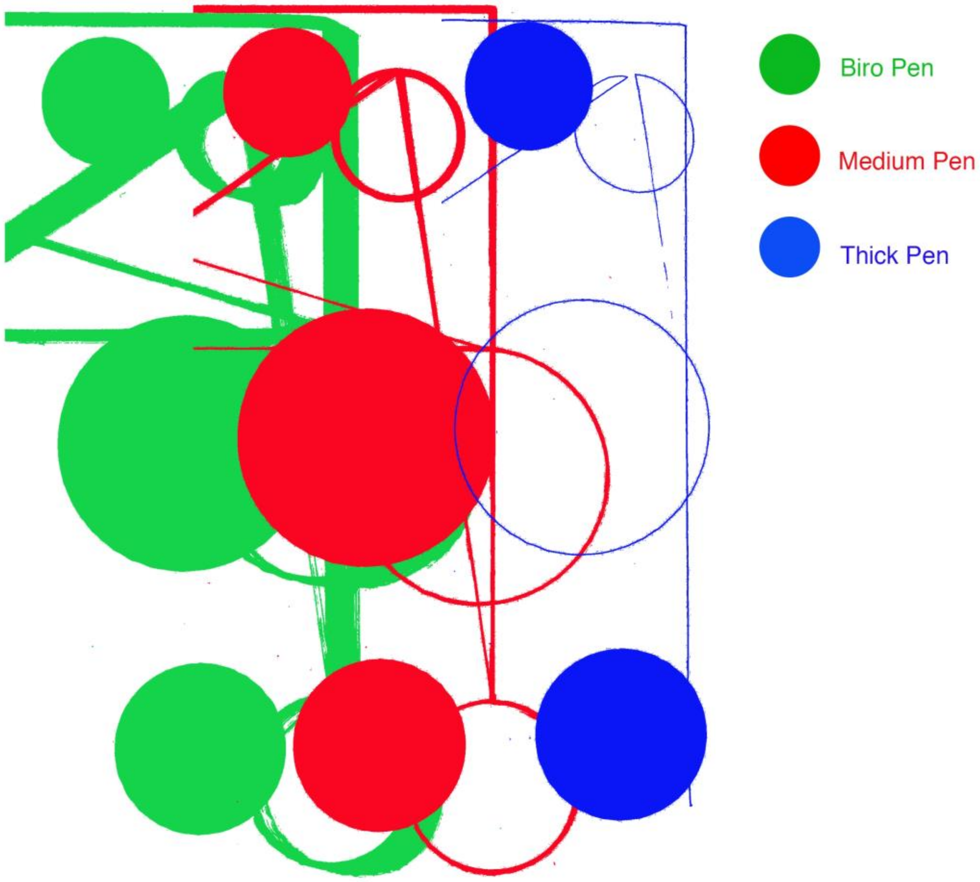

Figure 7. Experiment Results showing the laser cutting through the paper

Figure 7 illustrates the results testing the attachment of a pen to the laser head. It is apparent that for each drawing device where the velocity is raised to 600, elements of the paper have been cut through. This is shown through the large block areas of colour. All of these areas have been placed on the graph (Figure 6) as combining risk and technology. No intervention with the technology was necessary, and the pen marks appeared to make mistakes without intervention from a human hand. This rejects the conclusion by Marcus (2016) who found that risk can only be introduced by a human to a machine in order for it to be crafted. It promotes Pye's (1995) workmanship of risk, and indicates that it is now possible to find this workmanship of risk in laser technology. The areas that have been cut out were not intended to do so when carrying out the experiment, but have been produced due to serendipitous events, which Treadaway (2007) argues promotes the playfulness a maker needs in their process.

The progression of the experiment is repetitive. The marks progress in thickness due to the pens used. McCullough (1998) argues that this repetition produces further knowledge for the maker. This is evident as an awareness of knowing when to pause the machine and readjust the pen occurred. At the velocity of 50, all results show a drag of the pen, see Figure 8 for a comparison of marks made by the pen dragging. This repetitive notion that the technology has reproduced indicates skill. The slower the velocity, the easier it is for the pen to drag, thus creating different marks. It is clear that the blue mark showing the thick pen has dragged the most, indicating that the heavier pen has caused the most disruption to the technology. Through an aid of adding the pen to the machine, the technology has created a skilled process, resulting in diverse marks.

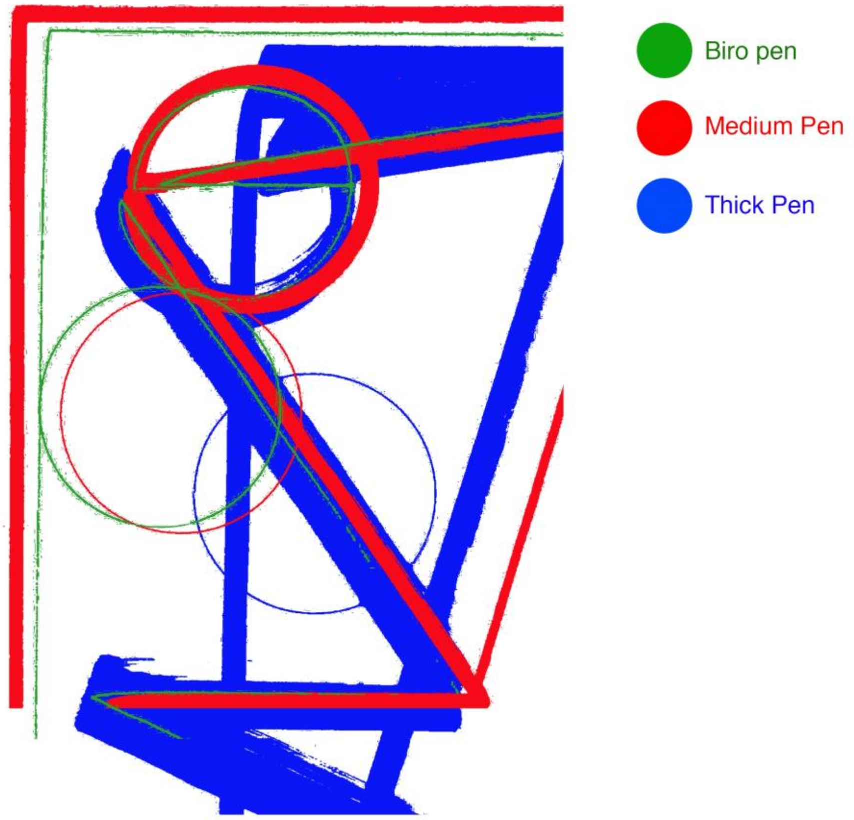

Figure 8. Experiment Results showing the pen dragging on the paper

Human intervention with the process has been noted throughout the experiment. The hand has intervened by adding the pen to the technology, utilising the pen as a tool for the hand, which Dormer (1997) argues can be determined as hand-made. By opening the machine and adjusting the pen, the maker initiates a tactile stimulation with the process. This opposes McCullough's (1998) argument that a technology cannot possess skill due to the absence of the hand. The connection that the pen has had with the paper has not been strong enough to yield a mark, mainly occurring when the velocity of the machine is lowered. This indicates that the higher the velocity, the more scope the machine has to create the marks itself.

The marks produced using the thick pen at a velocity of 50 and the power at 5, have been placed nearest to the centre of all 4 attributes in Figure 6. Figure 9 shows these marks. The marks produced show an element of skill, as it has been discovered that the lower the velocity the more varied the marks will be due to the drag of the pen. This drag is also an element of risk, as it could be deemed as a mistake in the experiment. The machine has also been paused, as the pen caught during the experiment. This intervention with the process indicates a need for the human hand, due to a mistake in the technology. In this case, the pen loosened from the machine. The marks produced from the laser are clear, however due to a pen being attached, the machine has created crafted areas for investigation.

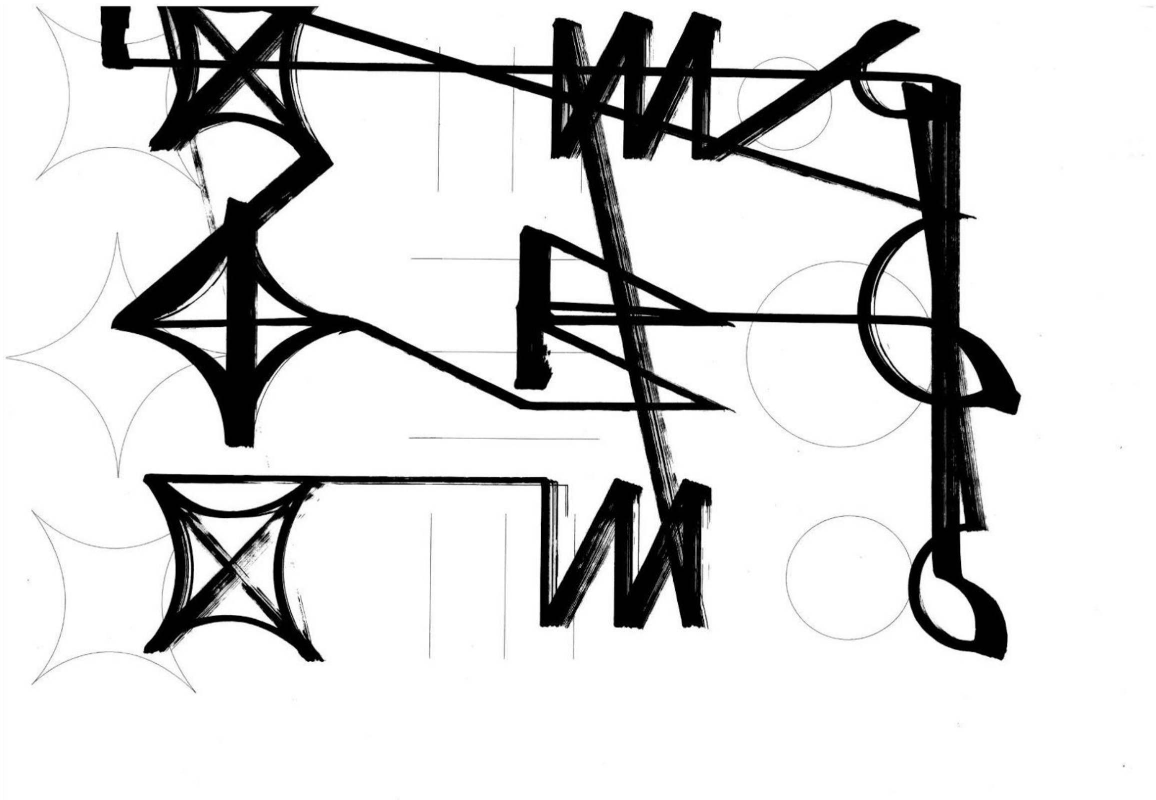

Figure 9. Experiment Results with elements of all 4 attributes

It is important to note the marks that track the lasers journey from one point to another. This would not have been evident without the addition of the pen. It invites the viewer to feel a sense of a train of thought, or an innate and experiential knowledge, one which would be felt by a craft-maker. This innate, tacit knowledge that Dormer (1997) and Yair and Schwarz (2011) highlight as being imperative to craft, is now being shown through the machine itself, through the process of collaboration with the technology.

5. Conclusions

The results from the experiments have demonstrated how technology can collaborate with other elements of craft, using the laser cutter machine to produce craft outcomes. The knowledge of the maker has not only informed the technology, but also the technology has informed the maker, resulting in an ongoing collaboration between maker and machine. The hybrid approach, where the maker and technology are not separated but rather work together, collaboratively, displayed the most craft attributes. This hybridisation has only been made possible through a greater understanding of craft knowledge, and knowledge of the technology, working together as a methodology to proceed with the study.

The analysis of results against the four attributes attained in the literature review is subjective. Although this has been taken into account due to the creative and experimental nature of the study, the marks produced may not display the craft elements to every viewer. Although a clear methodology has been put in place, ultimately, the parameters are different for every person.

When considering how this research can be carried further, the concept of hybridisation is key. From the experiments of the study, the marks produced which convey all four areas of craft, and work together harmoniously yield the most crafted results. This suggests that the laser technology can possess all areas of the hand-made, skill, risk and technology, and when these areas of craft all work together they produce the most original results. These four elements of craft, which now encompass technology as an integral feature of craft, can be carried forward as a methodology to be used in assessment of other technologies. It is important to note that the incorporation of technology has not meant the eradication of the human touch or error. Rather by introducing new innovative elements into the technology as a form of hybridisation of techniques, and creating a dynamic relationship between the hand and the machine, this study has located the inherent craft attributes of the machine.

Overall, through the hybridisation of techniques and the fusion of traditional and modern elements of craft, this research has been able to uncover the craft of the laser cutter. It is clear that through the knowledge the maker learns throughout their process, this in turn informs experimentation, whether that be via technology or not. These qualities now include technology as a pillar of craft, and one that is being shown to assimilate in craft makers practice all over the field.

References

Adamson, G. 2013. *The Invention of Craft.* Bloomsbury Academic

Adamson, G. 2010. Ed. *The Craft Reader.* Berg.

Benjamin, W. 1936. *The Work of Art in the age of Mechanical Reproduction.* Schocken/Random House.

Berens Baker, L. 2016. *Laser cutting for Fashion and Textiles*. Laurence King Publishing

Braddock Clarke, S. and Harris, J. 2012. *Digital Visions for Fashion and Textiles*. Thames & Hudson Ltd

Crook, T. 2009. Craft and the Dialogics of Modernity: The Arts and Crafts Movement in Late-Victorian and Edwardian England. *The Journal of Modern Craft*. **2**(1) pp. 17-32

Dormer, P. ed. 1997. *The Culture of Craft.* Manchester University Press.

Dunn, S. 2018. *Interview with M. Mcewan.* 18 January. Leeds.

Fraser, M. 2010. *Lab Craft: Digital Adventures in Contemporary craft.* [Online] [Date accessed: January 2018]. Available from: http://www.labcraft.org.uk/_downloads/Lab-Craft-galleryguide.pdf

Greenlagh, P. 2002. Ed. *The Persistence of Craft: the applied arts today*. Rutgers University Press

Kourteva, E. and McMeel, D. 2017. Entropy: Unpacking the form through post digital making. *The Design Journal.* **20** (1)

Marcus, A. 2016. *Variable Projects.* [Online]. [Date accessed: November 2016]. Available from: http://www.variableprojects.com/#/signal-noise/

Marcus, A. 2017 Signa;/Noise: Code and Craft in Architectural Drawing. In eds. Lamere, J, and Alonso, C. (20170 Projects Catalog of the 37th Annual conference of the Association for Computer Aided design in Architecture, MIT, Boston.

Malins, J., Press, M. and Mckillop, C., 2004. Craft connexity: developing a sustainable model for future craft education. Available from OpenAIR@RGU. [Online]. Available from: http://openair.rgu.ac.uk

McCullough, M. 1998. *Abstracting Craft: the practiced digital hand.* Cambridge, MIT Press

Muratovski, G. 2016. *Research for Designers.* Sage Publications Ltd.

Myerson, J. 1997. Tornadoes, T-Squares and Technology: can computing be a craft. In: Dormer, P. ed. *The Culture of Craft.* Manchester University Press.

Nimkulrat, N. 2012. Hands-on intellect: integrating craft practice into design research. *International Journal of Design.* **6** (3) p. 14.

Perry, 2012. Are computers killing off craft? Not a chance. *The Guardian.* [Online]. [Date accessed: November 2017]. Available from: https://www.theguardian.com/higher-education-network/2016/may/12/are-computers-killing-off-craft-not-a-chance

Pye, D. 1995. *The Nature and Art of Workmanship.* The Herbert Press.

Sennett, R. 2008. *The Craftsman*. Penguin Books

Sowden, T. 2018. *Interview with M. Mcewan.* 18. January. Leeds.

Shillito, A M. 2013. *Digital Crafts: Industrial Technologies for applied artists and designer makers.* Bloomsbury Publishing Plc.

Treadaway, C. 2004. Digital Imagination: The impact of Digital Imaging on Printed Textiles. *Textile: The Journal of Cloth and Culture*. **2:3** pp. 256-273

Treadway, C. 2004. Digital Reflection: The integration of Digital Imaging Technology into the Creative Practice of Printed Surface Pattern and Textile Designers. *The Design Journal.* **7**(2) pp. 2-17

Treadaway, C. 2007. Digital Crafting and Crafting the Digital. *The Design Journal.* **10**(2) pp. 35-48

Treadaway, C. 2009. Hand E-Craft: An Investigation into Hand Use in Digital Creative Practice. *Proceeding of the seventh ACM conference on Creativity and Cognition*. pp 185-194.

Yair, K. and Schwarz, M. 2011. Making Value: craft in changing times. *Cultural Trends.* **20** (3-4) pp. 309-316

Maighraed Mcewan

Maighraed is a textile design graduate from the University of Leeds. Her work presented won the Foster Prize at the University for the highest grading dissertation in the school of design. Subsequently, she is now enrolled into the Royal College of art to study Global Innovation Design, where she will study in London, Beijing and Singapore. This course is focused on providing creative solutions to deliver positive socio/economic and environmental change.

Her practice is based on the intersection between technology and craft. Focusing heavily on the use of laser technology to create innovative interior design solutions. These examples have been displayed at New Designers in London, and Artonomy events in Leeds. Previously, she has worked in textile design studios in New York, and London Fashion week.

Dr Jane Scott

Dr Jane Scott is an award winning designer and educator whose interdisciplinary research challenges how emerging technologies can transform thinking in textile design. She works as a senior teaching fellow in the School of Design at The University of Leeds, and as a visiting research fellow at Central Saint Martins in London. She holds a PhD from The University of the Arts, London where she developed Programmable Knitting; an environmentally responsive biomimetic textile system.

Her work has been exhibited internationally, and she has recently presented her research at Massachusetts Institute of Technology, The Baltic, The University of Michigan, Make/Shift, the Microsoft Research Centre, Cambridge and The London Design Festival. In 2016 she received the 2016 Autodesk ACADIA Emerging Research Award (projects category) for her work Programmable Knitting.